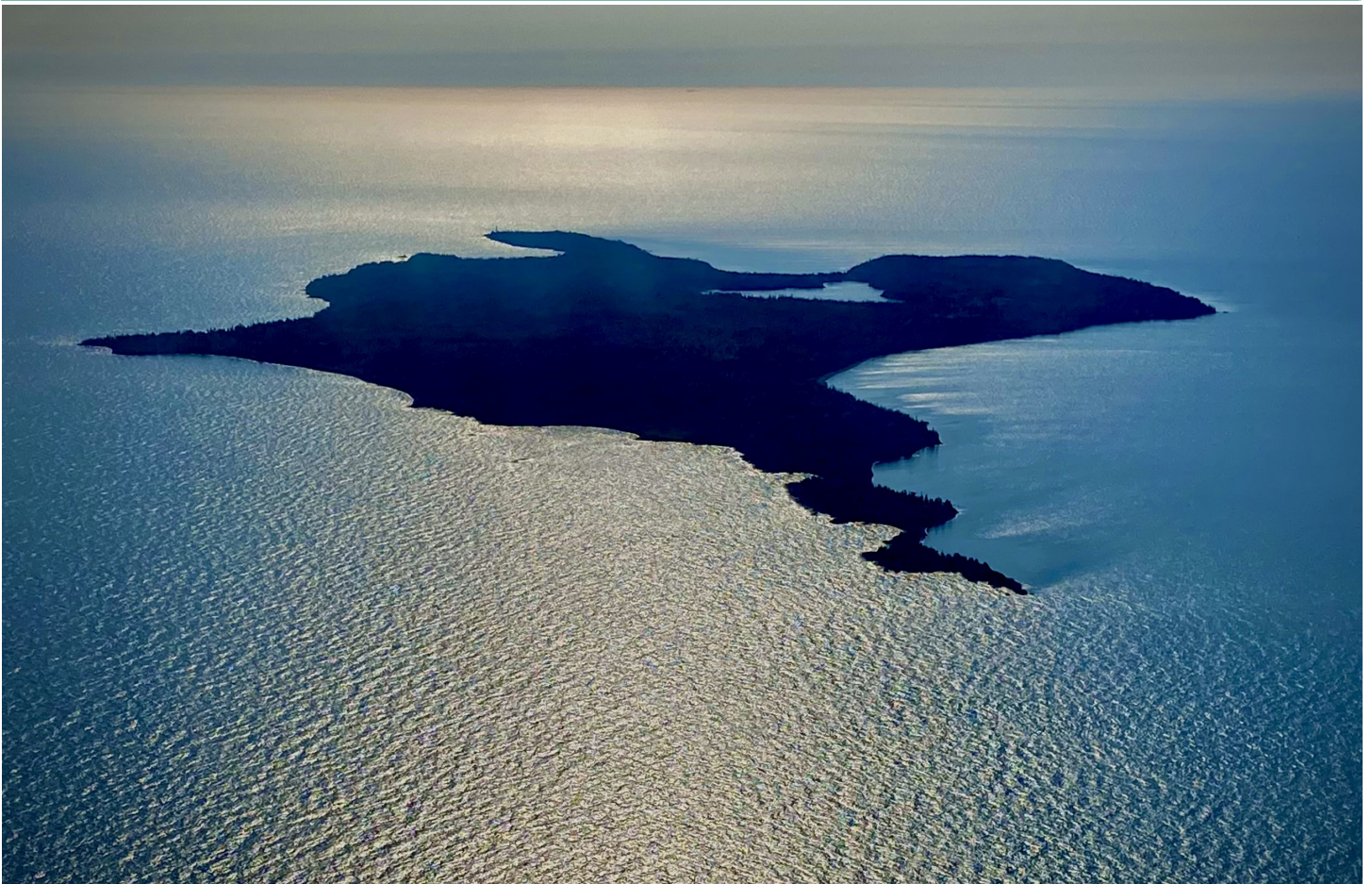


# Natural Community Surveys of Manitou Island Lake Superior



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**Land Acknowledgement:** We collectively acknowledge that Michigan State University occupies the ancestral, traditional, and contemporary Lands of the Anishinaabeg – Three Fires Confederacy of Ojibwe, Odawa, and Potawatomi peoples. In particular, the University resides on Land ceded in the 1819 Treaty of Saginaw. We recognize, support, and advocate for the sovereignty of Michigan’s twelve federally-recognized Indian nations, for historic Indigenous communities in Michigan, for Indigenous individuals and communities who live here now, and for those who were forcibly removed from their Homelands. By offering this Land Acknowledgement, we affirm Indigenous sovereignty and will work to hold Michigan State University more accountable to the needs of American Indian and Indigenous peoples.

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# TABLE OF CONTENTS

<b>ACKNOWLEDGMENTS</b> .....	<b>iii</b>
<b>INTRODUCTION</b> .....	<b>1</b>
Landscape Context.....	.2
Historical Context .....	.2
<b>METHODS</b> .....	<b>5</b>
Field Survey Prioritization.....	.5
Field Survey.....	.8
Natural Community Stewardship Prioritization .....	.9
<b>SURVEY RESULTS</b> .....	<b>10</b>
<b>SITE SUMMARIES</b> .....	<b>13</b>
1. Boreal Forest.....	.13
2. Northern Shrub Thicket .....	.21
3. Northern Wet Meadow .....	.24
4. Poor Conifer Swamp.....	.28
5. Poor Fen .....	.32
6. Volcanic Bedrock Glade .....	.36
7. Volcanic Bedrock Lakeshore .....	.41
8. Volcanic Cobble Shore .....	.48
9. Volcanic Lakeshore Cliff.....	.52
<b>STEWARDSHIP PRIORITIZATION RESULTS</b> .....	<b>57</b>
<b>DISCUSSION</b> .....	<b>59</b>
<b>CONCLUSION</b> .....	<b>60</b>
<b>REFERENCES</b> .....	<b>61</b>

## LIST OF FIGURES

<b>Figure 1.</b> Map of Manitou Island. ....	3
<b>Figure 2.</b> Spatial data used to prioritize survey effort. ....	6
<b>Figure 3.</b> Decision matrix to determine natural community survey targets. ....	7
<b>Figure 4.</b> Stewardship prioritization score schematic. ....	9
<b>Figure 5.</b> Natural community element occurrences on Manitou Island. ....	12
<b>Figure 6.</b> Stewardship prioritization for Manitou Island.. ....	57

## LIST OF TABLES

<b>Table 1.</b> Natural community element occurrences documented on Manitou Island .....	11
<b>Table 2.</b> Stewardship prioritization for Manitou Island natural community element occurrences. ....	57

## APPENDIX

<b>Appendix 1.</b> Global and State Element Ranking Criteria .....	63
<b>Appendix 2.</b> Floristic Quality Assessments .....	64
<b>Appendix 3.</b> Ojibwe Names for Plants Observed on Manitou Island .....	84



Boreal forest, Manitou Island. Photo by Joshua G. Cohen.

# Introduction

Great Lakes islands provide critical habitat for native biodiversity and support rare and endemic natural communities. A diverse assemblage of over 32,000 islands occurs across the Great Lakes and in the connecting channels with over 400 islands in Lake Superior (Henson et al. 2010). Many of the islands within the Great Lakes are remote, difficult to access, and challenging to survey due to lack of infrastructure and rugged terrain. Despite limited access, these islands face a variety of threats to native biodiversity and rare taxa including establishment and spread of invasive plant and animal species and the impacts of climate change. However, within these unique geographies biodiversity data is limited or outdated, which hinders effective management and decision-making.

To address this information gap, the Michigan Department of the Environment, Great Lakes, and Energy (EGLE) contracted Michigan Natural Features Inventory (MNFI) through U.S. Environmental Protection Agency (EPA) funding to conduct natural community surveys over the course of three years on Lake Superior islands. In 2023, surveys were conducted on Manitou, Grand, and Rabbit Islands. In 2024 and 2025, surveys will be conducted on Isle Royale National Park. This report focuses on the

natural community surveys conducted in 2023 on Manitou Island. For information on the natural community surveys conducted in 2023 on Grand Island and Rabbit Island refer to Cohen et al. 2024a and Cohen et al. 2024b.

A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances. Historically, Indigenous Peoples were an integral part of natural communities across the Great Lakes region with many natural community types being maintained by native cultural practices such as cultural burning, wildlife management, and plant harvesting, seeding, and planting (Kimmerer and Lake 2001, Stewart 2009). MNFI's natural community classification recognizes 77 natural community types in Michigan (Kost et al. 2007, Cohen et al. 2015). Protecting and managing representative natural communities is critical to biodiversity conservation, since native organisms are best adapted to environmental and biotic forces with which they have evolved over the millennia (Kost et al. 2007, Cohen et al. 2015).



Manitou Island volcanic lakeshore cliff. Photo by Joshua G. Cohen.

A critical goal of this project was to collect updated and new data for natural communities to provide natural resource managers and planners with accurate, detailed, standardized baseline information on the current status of ecosystems on these islands that can help guide biodiversity stewardship and restoration and ongoing planning efforts. Qualitative surveys assessed the integrity, classification, and delineation of natural community occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities associated with each site. This baseline information is critical for facilitating site-level decisions about biodiversity stewardship; prioritizing protection, management and restoration; monitoring the success of management and restoration; and informing landscape-level biodiversity planning efforts. This report summarizes the findings of MNFI's natural community surveys and also presents a prioritization of stewardship and monitoring of the natural communities documented on Manitou Island.

### **Landscape Context**

Manitou Island is located in Lake Superior about three miles east of the northern tip of the Keweenaw Peninsula (Figure 1). The 1,011-acre island is about three miles long and up to a mile wide at its widest point. Manitou Island, like the adjacent Keweenaw Peninsula, was formed about a billion years ago during the Keweenawan Period of the Precambrian during a prolonged period of extensive surface volcanic activity. During this period, basaltic lava flows or "traps" were deposited with interbedded conglomerate and sandstone layers (Reed and Daniels 1987, Dorr and Eschman 1984). Copper Harbor Conglomerates make up the majority of the Manitou Island shoreline (80%), but basaltic lava flows or Lake Shore Traps occur locally. The Lake Shore Traps mostly occur on Manitou Island's north shore. The shallow, rocky soils that cover the interior of the island are formed from locally derived glacial drift (Marr et al. 2009).

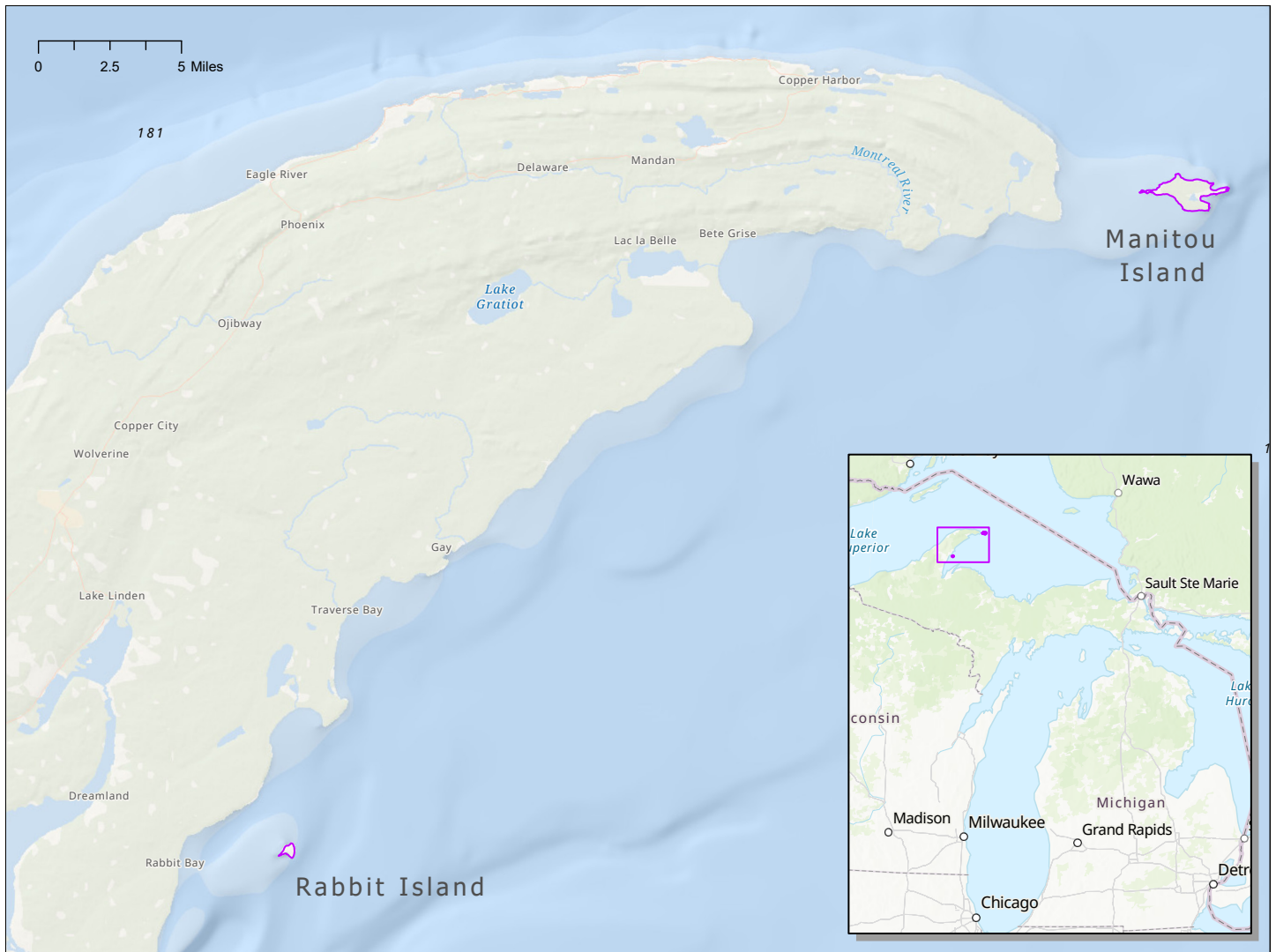
Manitou Island supports a diverse array of high-quality natural communities that are subject to frequent disturbance from Lake Superior storms. The shoreline is primarily volcanic bedrock lakeshore and volcanic cobble shore, which intergrade. Coves and bays and high energy stretches of shoreline are characterized by volcanic cobble shore. Approximately 2.5 miles of volcanic cobble shore occurs along the island. The cobble shores are composed of cobbles from weathering, glacial erosion, and wave action breaking down the island's conglomerates (Marr et al. 2009). Several embayments also support sand and gravel beach. Volcanic lakeshore cliff occurs locally along the eastern end of the island. The interior of the island is dominated by uneven-aged boreal forest that is subject to

frequent disturbance including windthrow, fire, and beaver felling. The east-west orientation of Manitou Island and its position in unprotected waters of Lake Superior result in the island experiencing frequent high winds across the island and high waves along the shorelines. Windthrow is prevalent across the island, generating many areas of open-canopied boreal forest. Several recently burned patches of boreal forest occur along the eastern end of the island. Beaver activity is concentrated around Perch Lake with beaver felling both understory and overstory trees within the boreal forest and contributing to open-canopy conditions locally. The majority of the island interior supports boreal forest but there are localized wetlands that include poor conifer swamp, northern shrub thicket, northern wet meadow, and poor fen. Inclusions of rich conifer swamp occur along the narrow band between the boreal forest and the southern shore of Perch Lake. The wetlands occur in the island's drainageways and depressions. In addition, volcanic bedrock glade occurs locally in the interior of the island northeast of Perch Lake.

Manitou Island provides critical habitat for a diversity of breeding and migratory bird species and supports a large number of rare plant species (Youngman 2004, Marr et al. 2009). Rare plant species associated with volcanic bedrock lakeshore occur in high concentrations along the island's shoreline. Many of these rare plant species are more prevalent in arctic and alpine habitats further to the north or west. Manitou Island, like many areas of shoreline along the Keweenaw Peninsula experience low summer temperatures and fogs that create suitable growing conditions for rare plant species associated with cool and moist temperatures (Albert et al. 1997, Marr et al. 2009).

### **Historical Context**

In Ojibwe, Manitou means "god" or "spirit" (Nichols and Nyholm 1995). Indigenous peoples likely used Manitou Island as a base for seasonal fishing activities and continue to fish the waters off of the island. An old copper mine pit has been documented on Manitou Island and may have been established by Indigenous peoples before it was later expanded by miners in the 19<sup>th</sup> century during the copper boom (Fadner 2003). The first lighthouse was built on the island in 1849. Construction of the current lighthouse was authorized by Abraham Lincoln in 1861 and the modern lamp in the tower is a functioning aid to navigation maintained by the U.S. Coast Guard. Additional structures include a brick storage building added in 1895 and a concrete fog signal built in 1930. The station was automated in 1953. Logging on Manitou Island was likely restricted to cutting for fuel wood and concentrated near the light station and dock (Marr et al. 2009).



**Figure 1.** Map of Manitou and Rabbit Islands. Manitou Island occurs just east of the tip of the Keweenaw Peninsula in Lake Superior.

The Manitou Island lighthouse occurs on the eastern end of the island about 0.6 miles from the island's single dock located in a north shore cove. The dock and lighthouse are connected by a foot path that also branches west towards the north end of Fisherman's Bay. Several private parcels occur on the island along Fisherman's Bay and at the western end of the island but only constitute 3% of the island. The majority of the island (56%) is owned by the federal government. The remainder is part of the Baraga Forest Management Unit (32%) or owned by the Keweenaw Land Trust (9%) and part of the Manitou Island Light Station Preserve (Marr et al. 2009). The federal and state portions of the island are managed for native biodiversity and wildlife habitat. The Keweenaw Land Trust manages the preserve for both biodiversity and as a cultural heritage site. The Keweenaw Land Trust acquired the 93-acre preserve along the eastern end of the island from the U.S. Government under the auspices of the National Historic Lighthouse Preservation Act of 2000. In addition to boreal forest, the property includes the historic light station structures.



The Manitou Island Lighthouse was first constructed in 1849 and construction of additional structures was completed by 1930. Photo by U.S. Coast Guard.





Perch Lake occurs in the interior of Manitou Island just west of Fisherman's Bay. Photo by Jesse M. Lincoln.



Volcanic lakeshore cliff occurs along the eastern end of Manitou Island and is backed by boreal forest in the interior of the island. The white line extending under water from the cliffs is a quartzite dyke. Photo by Jesse M. Lincoln.

## Methods

Natural community surveys were conducted on Manitou Island from August 21<sup>st</sup> through August 23<sup>rd</sup>, 2023 on foot and by kayak. Prior to this survey effort, natural community surveys were last conducted by MNFI staff on Manitou Island in 1996 with peripheral surveys of the shoreline conducted by boat in 2007 (MNFI 2024).

### **Field Survey Prioritization**

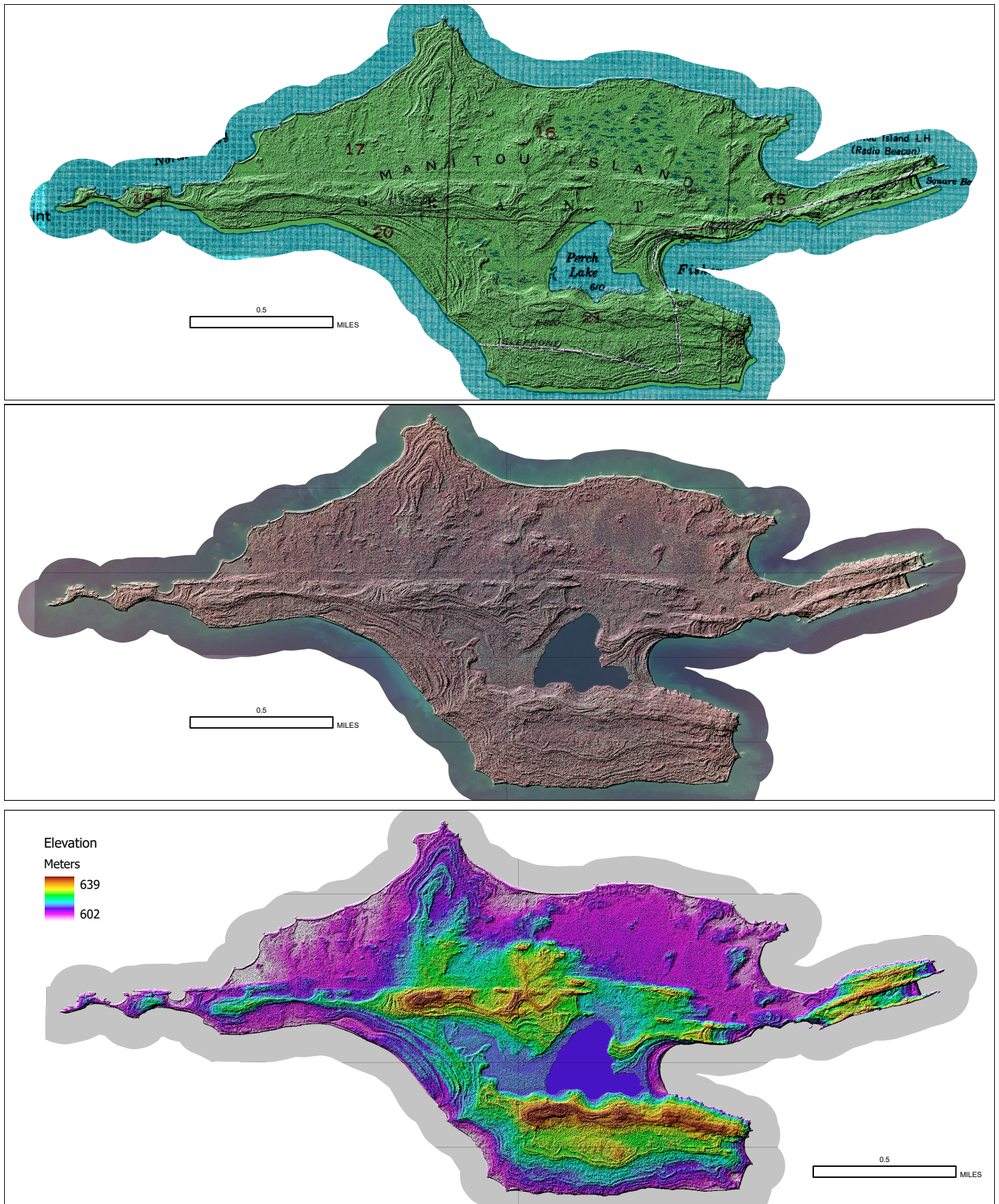
Prior to on-the-ground-surveys, MNFI ecologists conducted GIS analysis and aerial photo interpretation to delineate preliminary natural communities for Manitou Island and identify potential survey targets. To assist with delineation, we evaluated multiple series of aerial imagery, including color infrared imagery (1998 and 2022) (USDA 1998, State of Michigan 2022), true color leaf-off imagery (State of Michigan 2022), true color leaf-on imagery (2020) (USDA 2020), and also topographic maps (USGS 2024) and LIDAR digital elevation models with shaded relief (USGS 2022) (Figure 2). The preliminary delineation of natural community types across the island helped focus subsequent

surveys of high-quality natural communities. The MNFI natural community classification system was used as the classification framework (Kost et al. 2007, Cohen et al. 2015, Cohen et al. 2020).

The targets for the natural community assessment were prioritized based on the rarity and estimated integrity of the preliminarily delineated natural communities using the Natural Heritage sampling prioritization principal. This prioritization principal emphasizes that natural community survey efforts should be focused on the rarest and highest quality natural communities (Figure 3) (NatureServe 2002, Rocchio et al. 2018). Rarity is determined by evaluating a natural community's conservation status both at the state and global levels (i.e., S and G Ranks) (Appendix 1). Integrity is determined by employing Natural Heritage methodology, which considers three factors to assess a natural community's ecological integrity or quality: size, landscape context, and condition (Faber-Langendoen et al. 2008, Faber-Langendoen et al. 2016).



MNFI ecologist Joshua Cohen collecting soil data from the Manitou Island poor fen. Photo by Jesse M. Lincoln.



**Figure 2.** Spatial data layers and imagery used to prioritize survey effort. From top to bottom: topographic map (USGS 2024), color infrared imagery (2022) (State of Michigan 2022), and elevation with shaded relief (State of Michigan 2022).

Global / State Conservation Status Rank Combination	Ecological Integrity Assessment Rank			
	A Excellent Integrity	B Good Integrity	C Fair Integrity	D Poor Integrity
G1S1, G2S1, GNRS1, GUS1				
G2S2, GNRS2, G3S1, G3S2, GUS2				
GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR				
G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5				
<b>Red Shading</b> = Natural Community Survey Targets				

**Figure 3.** Decision matrix to determine natural community survey targets (NatureServe 2002, Rocchio et al. 2018). G = Global Rank, S = State Rank, U = currently unrankable, NR = not ranked; lower numbers are more imperiled than higher numbers. For more information, see Appendix 1.



MNFI scientists compiled comprehensive plant species lists for each high-quality natural community element occurrence. Volcanic lakeshore cliff along the eastern shoreline of Manitou Island. Photo by Joshua G. Cohen.

## **Field Survey**

A qualitative, plotless sampling design was employed to survey natural communities on Manitou Island. MNFI ecologists evaluated each natural community type that was delineated during the GIS analysis described above and ground-truthed targeted natural community type polygons through meander surveys. Prioritized communities (rare community types and high-quality examples of any community type) were targeted during this survey effort. The meander survey covered a representative sample of each polygon, and involved investigating typical and unique aerial signatures, traversing topographic variation, and visiting noticeable vegetation zones and soil moisture types. A Samsung Tablet in tracking mode was used during the meander surveys to create a record of routes taken within the surveyed natural community polygons. According to Natural Heritage Methodology, if a site meets defined requirements for ecological condition, landscape context, and size of the area of interest (MNFI 1988) it is categorized as a high-quality example of that specific natural community type, entered into MNFI's database as an element occurrence, and given a letter rank. Ecological field surveys were conducted during the growing season to evaluate the condition and classification of the sites. To assess natural community size and landscape context, a combination of field surveys, aerial photographic interpretation, and Geographic Information System (GIS) analysis was employed.

The ecological field surveys involved:

- a) compiling comprehensive plant species lists to be summarized in a floristic quality index and noting dominant, co-dominant, and representative species
- b) estimating percent coverage of prevalent or key overstory and understory species
- c) describing site-specific structural attributes (e.g., vegetative zonation, vegetative strata, and coarse woody debris) and ecological processes (e.g., windthrow, ground-water seepage, paludification, wildfire, and beaver flooding)
- d) measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants (where appropriate)
- e) analyzing soils and recording representative soil texture, pH, and depth
- f) describing hydrology (e.g., noting high-water marks, indicator vegetation, and soil mottling)
- g) noting current and historical anthropogenic disturbances (e.g., ditching, trails, and logging)
- h) evaluating potential threats to ecological integrity (e.g., invasive plant species, pests, diseases,

herbivory) with an emphasis on recording geospatial locations of invasive plant infestations

- i) ground-truthing aerial photographic interpretation using GPS (Samsung Tablets were utilized)
- j) taking digital photos and GPS points at significant locations
- k) surveying adjacent lands when possible to assess landscape context
- l) evaluating the natural community classification and mapped ecological boundaries
- m) determining the ecological integrity of mapped high-quality natural communities by assigning or updating element occurrence ranks
- n) noting management needs and restoration opportunities

Following completion of the field surveys, the collected data were analyzed and transcribed to update or create element occurrence records in MNFI's statewide biodiversity conservation database (MNFI 2024). Tracks and GPS points collected during the field visits were transposed on aerial imagery to facilitate the generation of natural community boundaries for new element occurrences or re-mapping of previously documented element occurrences. This natural community element occurrence mapping is distinct from the preliminary delineation of natural community types that was based solely on GIS analysis and aerial photo interpretation and was used strictly for planning purposes. Data compiled from the field surveys were used to produce site descriptions, threat assessments, and management recommendations for each natural community element occurrence, which appear within the **Survey Results** section.

For each high-quality natural community, floristic data were compiled into the Universal Floristic Quality Assessment Calculator (Reznicek et al. 2014, Freyman et al. 2016) to determine the Floristic Quality Index (FQI) for each natural community element occurrence. The floristic quality assessment is derived from a mean coefficient of conservatism and floristic quality index. Each native species is assigned a coefficient of conservatism, a value of 0 to 10 based on probability of its occurrence in a natural versus degraded habitat. Species restricted to a specialized or undisturbed habitat are assigned a value of 10, implying the species has extremely strong fidelity to a specific habitat. Native species that are not particular or indicative of natural conditions are assigned a low value of 0 or 1.

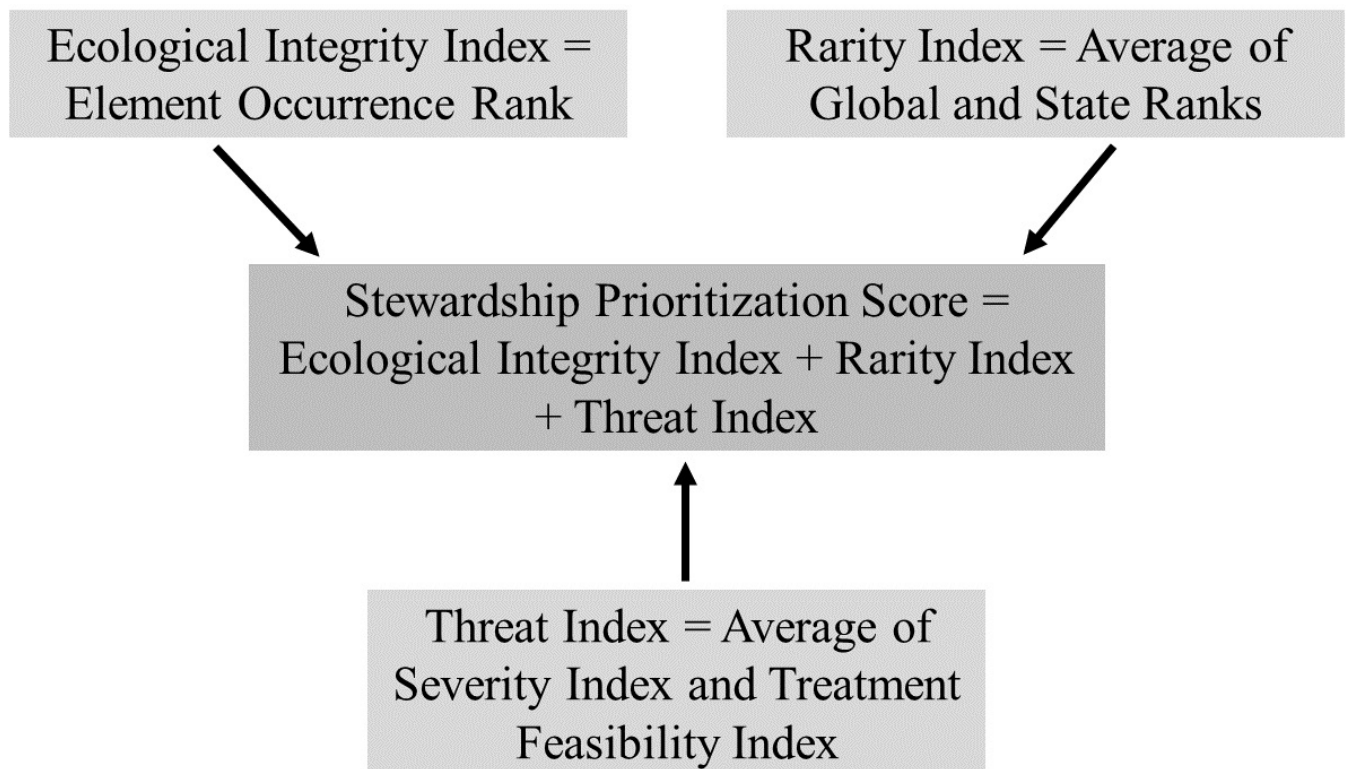
The coefficient of conservatism is determined by experts on the flora of a region, and so may vary for a given plant species from region to region. We employed a regionally

appropriate FQA for Michigan (Reznicek et al. 2014). From the total list of plant species for an area, a mean C value is calculated and then multiplied by the square root of the total number of plant species to calculate the FQI. Michigan sites with an FQI of 35 or greater possess sufficient conservatism and richness that they are considered floristically important from a statewide perspective (Herman et al. 2001). FQI scores greater than 50 indicate exceptional sites with extremely high conservation value (Herman et al. 2001). Species lists for each natural community element occurrence are provided in Appendix 2. Nomenclature of plant species for these lists and throughout the report follows Michigan Flora (Voss and Reznicek 2012). We provide a crosswalk of Ojibwe names to scientific and common names in Appendix 3 for all plant species observed on Manitou Island that are listed in “Plants used by the Great Lakes Ojibwa” (Meeker et al. 1993).

**Natural Community Stewardship Prioritization**

MNFI developed a scoring matrix for natural community element occurrences to provide a framework for the prioritization of stewardship. For this scoring matrix, we developed the following three indices: an ecological integrity index, a rarity index, and a threat index. We used the element occurrence rank to determine the ecological integrity rank, with higher scores for higher-ranked element occurrences. The rarity index was calculated by assigning a score for each natural community type’s state

rank and global rank (Appendix 1) and averaging the two scores. For both state and global ranks, higher scores were assigned to rarer types. The threat index was derived by calculating the average of a threat severity index and a treatment feasibility index. Threats incorporated into this index include invasive species infestation, anthropogenic disturbance, and herbivory. The threat severity index incorporates knowledge of impacts of threats to natural community types and site-specific information gained during surveys. Higher scores for the threat severity index correspond to increased degradation due to threats. The treatment feasibility index was derived by assigning a score to each natural community element occurrence based on the ease of addressing the threats recorded within that site. Higher scores for the treatment feasibility index correspond to a greater likelihood of successful threat abatement. The threat severity index and treatment feasibility index were assigned based on professional judgement and familiarity with species, systems, and ecological regions. Each index was scored on a scale of 0 to 5. For each natural community element occurrence, the sum of the scores for the ecological integrity index, rarity index, and threat index was calculated to sort the natural community element occurrences by their stewardship prioritization score (Figure 4). Higher scores indicate a higher priority for stewardship intervention. The stewardship prioritization for the natural community element occurrences is presented in the **Stewardship Prioritization Results** section.



**Figure 4.** The Stewardship Prioritization score is the sum of the Ecological Integrity Index, Rarity Index, and Threat Index. This prioritization scoring was derived to help focus finite resources for biodiversity stewardship.

## Survey Results

The following results section is organized alphabetically by natural community type. We provide detailed **Site Summaries** for each of the natural community element occurrences documented on Manitou Island. Nomenclature of plant species follows Michigan Flora (Voss and Reznicek 2012). Nine high-quality natural communities occur on Manitou Island representing nine different natural community types including: boreal forest, northern shrub thicket, northern wet meadow, poor conifer swamp, poor fen, volcanic bedrock glade, volcanic bedrock lakeshore, volcanic cobble shore, and volcanic lakeshore cliff. Table 1 lists the visited sites, their element occurrence ranks, and their acreage. Mapped natural community boundaries are provided for each natural community element occurrence in Figure 5.

The following site summaries detail floristic composition and structure, threats, and management recommendations for each of the nine natural community element occurrences visited in 2023 organized alphabetically by community type. We provide an overview of each natural community type adapted from MNFI's natural community classification

(Kost et al. 2007, Cohen et al. 2015, Cohen et al. 2020) and an accompanying ecoregional distribution map (Albert et al. 2008). For each site summary, we indicate if the site is an update of a previously identified element occurrence or a new element occurrence and provide the following information:

- a) site name
- b) natural community type
- c) global and state rank (see Appendix 1 for ranking criteria)
- d) current element occurrence rank
- e) size
- f) locational information
- g) digital photographs
- h) site description
- i) threat assessment
- j) management recommendations



Manitou Island volcanic lakeshore cliff. Photo by Jesse M. Lincoln.

**Table 1.** Natural community element occurrences (EOs) surveyed in 2023 on Manitou Island. EO rank abbreviations are as follows: A, excellent estimated viability; AB, excellent to good estimated viability; B, good estimated viability; and BC, good to fair estimated viability.

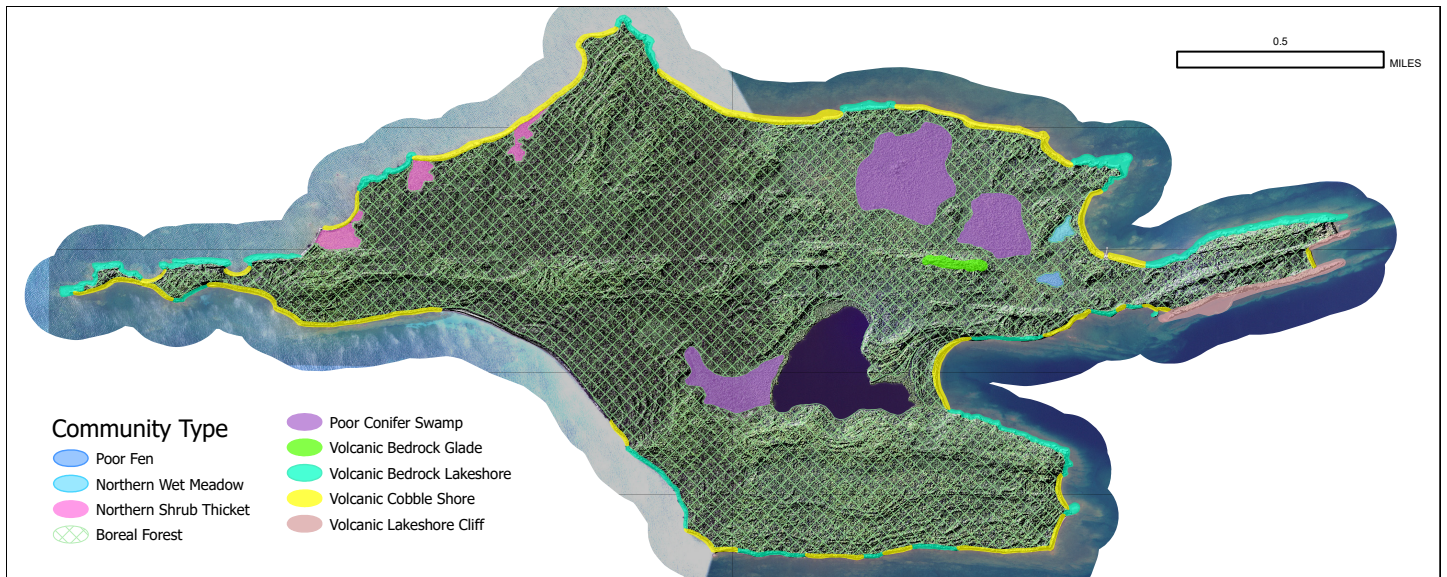
Community Type	EO ID	Acreege	EO Rank
Boreal Forest	27087	856	AB
Northern Shrub Thicket	27090	7.8	B
Northern Wet Meadow	27089	1.2	B
Poor Conifer Swamp	27091	52	B
Poor Fen	27088	0.9	B
Volcanic Bedrock Glade	27092	2.9	BC
Volcanic Bedrock Lakeshore	9280	24	A
Volcanic Cobble Shore	27093	28.5	A
Volcanic Lakeshore Cliff	12518	7.9	AB



Manitou Island boreal forest. Photos by Joshua G. Cohen (above) and Jesse M. Lincoln (below).







**Figure 5.** Natural community element occurrences on Manitou Island.

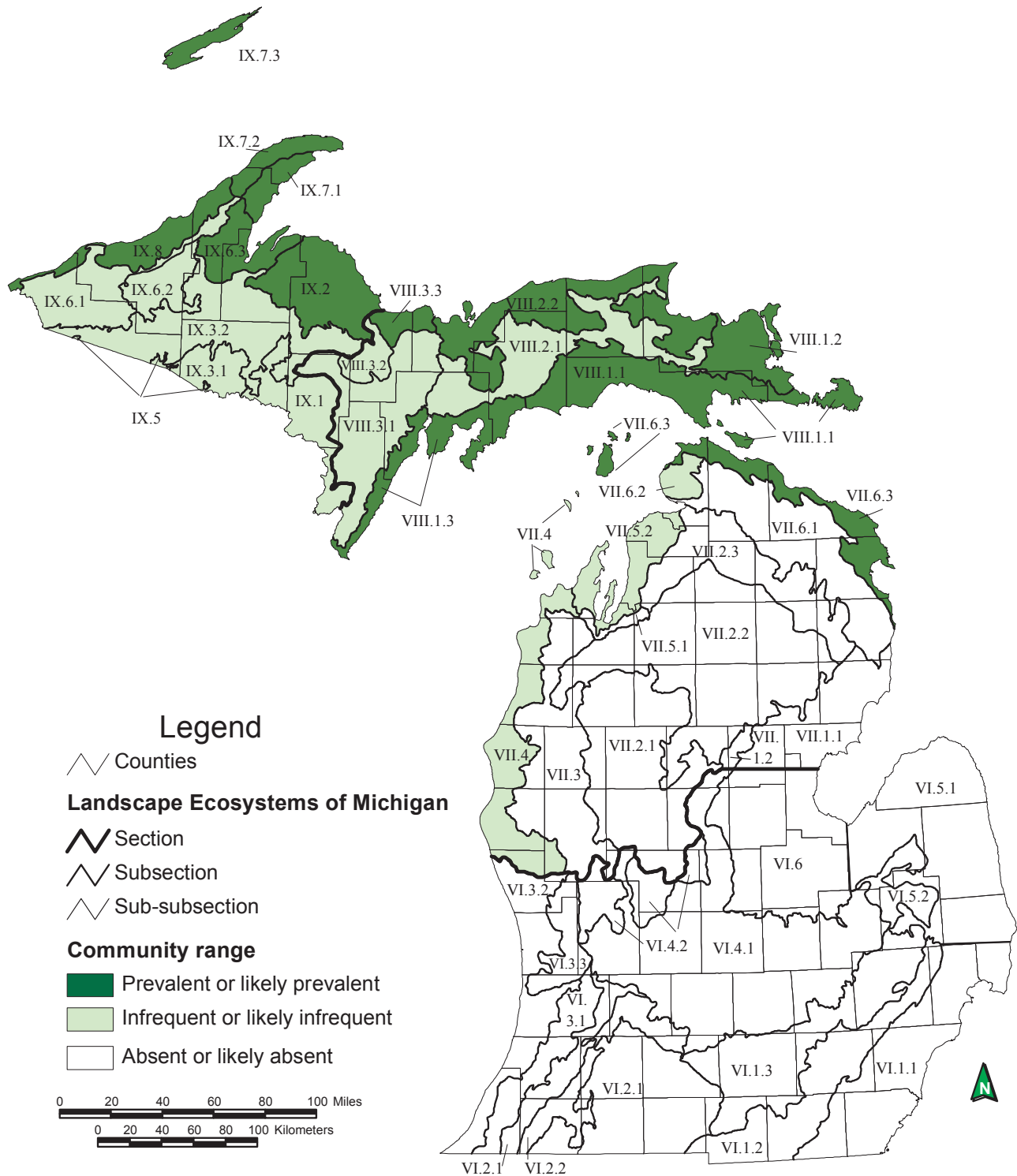


The Manitou Island volcanic bedrock lakeshore is primarily composed of Copper Hopper Conglomerates. Photo by Joshua G. Cohen.

## SITE SUMMARIES

### BOREAL FOREST

**Overview:** Boreal forest is a conifer or conifer-hardwood forest type occurring on moist to dry sites characterized by species dominant in the Canadian boreal forest. It typically occupies upland sites along shores of the Great Lakes, on islands in the Great Lakes, and locally inland. The community occurs north of the climatic tension zone primarily on sand dunes, glacial lakeplains, and thin soil over bedrock or cobble. Soils of sand and sandy loam are typically moderately acid to neutral, but heavier soils and more acid conditions are common. Proximity to the Great Lakes results in high levels of windthrow and climatic conditions characterized by low summer temperatures and high levels of humidity, snowfall, and summer fog and mist. Additional important forms of natural disturbance include fire and insect epidemics (Kost et al. 2007, Cohen et al. 2015).



**Map 1.** Distribution of boreal forest in Michigan (Albert et al. 2008).

## 1. Manitou Island

**Natural Community Type:** Boreal Forest

**Rank:** GU S3, uncertain globally and vulnerable within the state

**Element Occurrence Rank:** AB

**Size:** 856 acres

**Element Occurrence Identification Number:** 27087

**Site Description:** The interior of Manitou Island is dominated by uneven-aged boreal forest that is subject to frequent disturbance including windthrow, infrequent localized fire from lightning strike and anthropogenic ignition, beaver-felled trees, intense snowfall, and summer fog. Pervasive summer fog impacts all systems on Manitou Island and lichens are especially abundant. The east-west orientation of Manitou Island and its position in unprotected waters of Lake Superior result in the island experiencing frequent high winds across the island and high waves along the shorelines. Windthrow is prevalent across the island, generating many areas of open-canopied boreal forest with dense understories, particularly of yew (*Taxus canadensis*) and mountain maple (*Acer spicatum*). Several recently burned patches of boreal forest occur along the eastern end of the island, apparently the result of an anthropogenic fire in the fall of 2022. Both lightning strike and human ignition have caused local wildfires on Manitou Island. Canada geese were observed browsing the ground cover of recently burned areas in the eastern end of the island. Snowshoe hare browse was also noted in the ground cover and low shrub layer across the island. Beaver activity is concentrated around Perch Lake with beaver felling both understory and overstory trees within the boreal forest and contributing to the open canopy conditions locally. Beaver favor deciduous species and the combination of beaver activity and windthrow causes the formation of intense yew thickets with very little canopy.



Manitou Island boreal forest. Photo by Joshua G. Cohen.



The canopy of the boreal forest varies from closed to open and varies depending on the frequency and intensity of disturbance factors. Photos by Joshua G. Cohen (above) and Jesse M. Lincoln (below).





Manitou Island boreal forest delineated in yellow cross hatching on 2022 imagery.



Usnea lichen is prevalent throughout the Manitou Island boreal forest. Photo by Jesse M. Lincoln.

Shallow, rocky soils that cover the interior of the island are formed from locally derived glacial drift. The shallow soils of the boreal forest occur over a variety of substrate including volcanic cobble, volcanic bedrock, and sands. The majority of the boreal forest occurs on shallow soils over volcanic cobble or bedrock, which contributes to the high turnover rate across much of the island because volcanics provide a poor rooting substrate. The soils are shallow (typically 10-30 cm), acidic (pH 4.5-5.5), fine-textured, organics, loams, loamy sands, and sands overlying volcanic bedrock, cobble, and sands. Locally, boreal forest occurs on deep sands along the long sandy embayment along the south central portion of the island. Here soils are characterized by shallow (2-5 cm), acidic (pH 4.5) organics over fine-textured dune sands (pH 4.5-5.0). Along this sandy embayment, bigger and taller trees occur locally. Trees here likely live longer and can grow bigger because they have a more secure rooting substrate in the deep sands. White spruce (*Picea glauca*) are concentrated in this portion of boreal forest. One white spruce snag was measured at 90.4 cm in diameter and a 47.7 cm balsam fir (*Abies balsamea*) was estimated to be 25 meters tall.

Given the landscape position of the boreal forest on Manitou Island in Lake Superior and the prevalence of shallow soils, windthrow is ubiquitous. As a result, the boreal forest is characterized by high volumes of coarse woody debris including both snags and downed logs. The coarse woody debris load is composed primarily of small diameter and fast decomposing early-successional species, namely balsam fir and paper birch (*Betula papyrifera*). High turnover rates within this system results in open canopy, young canopy ages, complex vertical structure, and uneven-aged patches of boreal forest across the island. Numerous canopy dominants were cored across the boreal forest to help determine the age range of canopy trees. Estimated canopy ages ranged widely from 55 to 250 years and cored canopy trees included balsam fir, northern white-cedar (*Thuja occidentalis*), paper birch, quaking aspen (*Populus tremuloides*), and yellow birch (*Betula alleghaniensis*). A 49 cm northern white-cedar was cored and estimated to be over 250 years old (236 growth rings counted); a 56 cm northern white-cedar was cored and estimated to be over 200 years old (158 growth rings counted on a partial core due to rot); a 28.3 cm balsam fir was cored and estimated to be over 68 years old (58 growth rings counted); a 47.7 cm balsam fir was cored and estimated to be over 100 years old (90 growth rings counted); a 31 cm paper birch was cored and estimated to be over 55 years old (45 growth rings counted); a 25.8 cm quaking aspen was cored and estimated to be over 90 years old (55 growth rings counted on partial core due to rot); and a 34 cm yellow birch was cored and estimated to be over 63 years old (53 growth rings counted).

The complex geologic history and fluctuating lake levels create high levels of soil moisture variability across the island. There are crevasses in the bedrock that support small inclusions of poor conifer swamp. Areas close to the shoreline were historic embayments and now support northern shrub thicket. Zones adjacent to wetlands support concentrations of wetland species. In addition, the island has numerous cobble ridges and long linear bedrock ridges. This variability drives diversity across the boreal forest and there are small inclusions of poor conifer swamp, poor fen, northern shrub thicket, and volcanic bedrock glade.

Canopy composition of the boreal forest is highly variable with canopy coverage, structure, and composition correlated to the frequency of wind disturbance on the island. Canopy dominants throughout the boreal forest include balsam fir and paper birch. Shallow soils and frequent windthrow likely impart a competitive advantage to balsam fir and paper birch, which are the overwhelming dominants across the island's boreal forests. Additional canopy associates include northern white-cedar, mountain-ash (*Sorbus decora*), quaking aspen, mountain maple, and white spruce. Areas of boreal forest with deeper soils tend to exhibit an increased importance of deciduous species in the canopy. In localized portions of the island with more protection from windthrow, northern white-cedar and white spruce increase in importance. A lone supercanopy white pine (*Pinus strobus*) was observed along the margin of the boreal forest and the volcanic bedrock lakeshore along the northwestern shore of the island. Canopy coverage ranges dramatically but is generally 40 to 65% with zones associated with ridgelines having more open canopy (25-40%) where blowdown is more prevalent. Canopy trees typically range in diameter from 15 to 30 cm with scattered northern white-cedar, white spruce, and paper birch reaching from 50 to 90 cm. The lone white pine was 85.5 cm in diameter and has an eagle nest in the upper canopy. The understory layer is dense to impenetrable (50-90%) with yew and balsam fir locally dominant and additional species including mountain maple, mountain-ash, pin cherry (*Prunus pensylvanica*), red-osier (*Cornus sericea*), red elderberry (*Sambucus racemosa*), and round-leaved dogwood (*Cornus rugosa*). Squashberry (*Viburnum edule*, State Threatened) occurs locally, especially in the northwestern portion of the island near the volcanic bedrock lakeshore. Understory yew is locally dense and tall, reaching up to 2 meters tall. The prevalence of robust yew on Manitou Island indicates the lack of deer on the island. The dominance of yew in the understory and low shrub layer is likely limiting tree recruitment and ground cover diversity through light competition.



Squashberry (*Viburnum edule*, State Threatened) is locally common in the boreal forest along the northwestern portion of the island. Photos by Joshua G. Cohen.



The low shrub layer is patchy to dense (30-60%) with common species including yew, thimbleberry (*Rubus parviflorus*), Canadian fly honeysuckle (*Lonicera canadensis*), bush honeysuckle (*Diervilla lonicera*), pin cherry, red-osier, wild rose (*Rosa acicularis*), ninebark (*Physocarpus opulifolius*), and seedling mountain maple, mountain-ash, and balsam fir. The ground cover is sparse to patchy (10-40%) with characteristic species including twinflower (*Linnaea borealis*), bunchberry (*Cornus canadensis*), fireweed (*Chamerion angustifolium*), wild sarsaparilla (*Aralia nudicaulis*), Canada mayflower (*Maianthemum canadense*), bluebead-lily (*Clintonia borealis*), spinulose woodfern (*Dryopteris carthusiana*), northern wood-sorrel (*Oxalis acetosella*), star-flower (*Trientalis borealis*), creeping rattlesnake plantain (*Goodyera repens*), and cow parsnip (*Heracleum maximum*). Usnea lichen and feathermoss are abundant throughout the boreal forest.

Areas of recently burned boreal forest on the east end of the island are characterized by an open canopy (10-25%) with scattered balsam fir, quaking aspen, and paper birch. Understory species in the burned areas are patchy and infrequent and include mountain-ash, choke cherry (*Prunus virginiana*), mountain maple, and round-leaved dogwood. Bush honeysuckle, thimbleberry, yew, and bearberry (*Arctostaphylos uva-ursi*) are common in the low shrub layer. Common ground cover species include pearly everlasting (*Anaphalis margaritacea*), fireweed, wild sarsaparilla, and yarrow (*Achillea millefolium*). Non-native species prevalent in the burned areas include ox-eye daisy (*Leucanthemum vulgare*), field scorpion-grass (*Myosotis arvensis*), king devil (*Hieracium caespitosum*), and thyme-leaved sandwort (*Arenaria serpyllifolia*). Liverwort (*Marchantia polymorpha*) was recorded growing on bare mineral soil within the burnt boreal forest.

The Manitou Island boreal forest was surveyed August 21<sup>st</sup> through August 23<sup>rd</sup>, 2023. Forty-nine plant species were documented with 45 native species and 4 non-native species (Appendix 2.1). The total FQI was 29.4.

**Threats:** Species composition and structure are patterned by natural processes. Areas of recent fire have numerous weedy species growing on the exposed mineral soil. Non-native species prevalent in the burned areas include ox-eye daisy, field scorpion-grass, king devil, and thyme-leaved sandwort.

**Management Recommendations:** The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn) and to maintain a natural buffer surrounding the boreal forest. Invasive species are concentrated along the eastern portion of the island, particularly along trails, around the lighthouse, and near the dock where there are informal campsites. Monitoring and control efforts should be concentrated in these areas.



Boreal forest occurring inland from volcanic bedrock lakeshore along the northern shore of Manitou Island. Photo by Joshua G. Cohen.



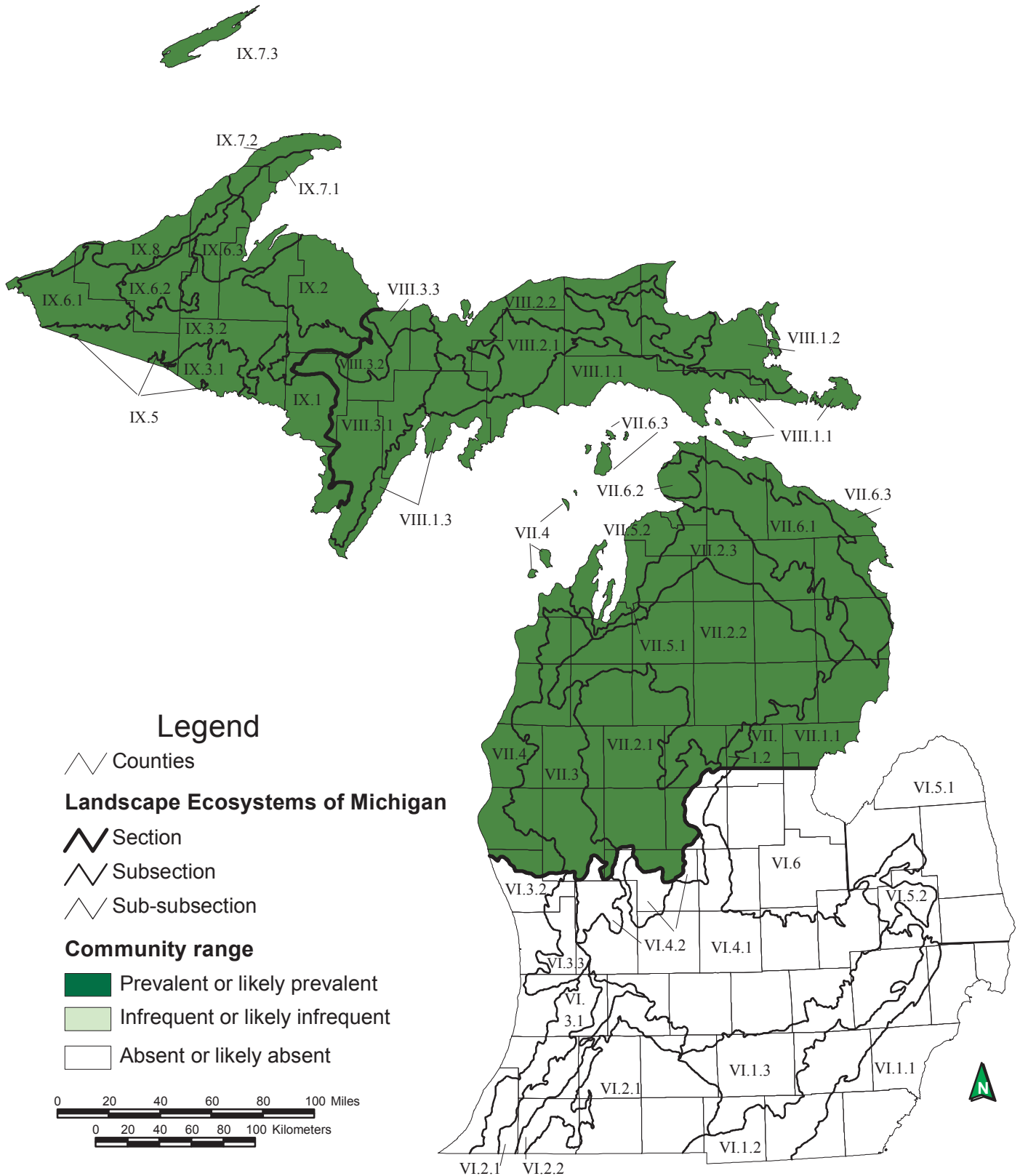


Boreal forest on the east end of Manitou Island has been impacted by recent wildfire. Photos by Jesse M. Lincoln (above) and Joshua G. Cohen (below).



## NORTHERN SHRUB THICKET

**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 tag alder (*Alnus incana*) (Kost et al. 2007, Cohen et al. 2015).



**Map 2.** Distribution of northern shrub thicket in Michigan (Albert et al. 2008).

## 2. Manitou Island

**Natural Community Type:** Northern Shrub Thicket

**Rank:** G4 S5, apparently secure globally and secure within the state

**Element Occurrence Rank:** B

**Size:** 7.8 acres

**Element Occurrence Identification Number:** 27090

**Site Description:** The Manitou Island northern shrub thicket is composed of four polygons along the northwestern portion of the island. The shrub thickets are dominated by dense tag alder (*Alnus incana*) and occur in small depressions behind low cobble ridges along the Lake Superior shoreline. These depressions were likely formerly small bays during historic higher water levels. Fluctuating water levels of the Great Lakes likely influence the hydrology of the shrub thickets. Scattered paper birch (*Betula papyrifera*) snags occur locally along the margins of the shrub thickets. The soils are typically shallow, ranging from 20 to 30 cm of slightly acidic peat (pH 6.5-6.8) overlying volcanic cobble and bedrock.

The northern shrub thicket is dominated by tag alder and red-osier (*Cornus sericea*) with dense tall shrub cover (60-80%). Sapling balsam fir (*Abies balsamea*) occur locally. The overstory is scattered (2-5%) with paper birch, black spruce (*Picea mariana*), and red maple (*Acer rubrum*). The low shrub layer is patchy (20-40%) with yew (*Taxus canadensis*), red-osier, and tag alder. Characteristic ground cover species include blue-joint (*Calamagrostis canadensis*), bladder sedge (*Carex intumescens*), rattlesnake grass (*Glyceria canadensis*), skunk-cabbage (*Symplocarpus foetidus*), spotted touch-me-not (*Impatiens capensis*), marsh-marigold (*Caltha palustris*), swamp-candles (*Lysimachia terrestris*), turtlehead (*Chelone glabra*), purple meadow-rue (*Thalictrum dasycarpum*), northern bugle weed (*Lycopus uniflorus*), wild mint (*Mentha canadensis*), wild blue flag (*Iris versicolor*), creeping-snowberry (*Gaultheria hispidula*), marsh bellflower (*Campanula*



Northern shrub thicket, Manitou Island. Photo by Joshua G. Cohen.

*aparinoides*), royal fern (*Osmunda regalis*), goldthread (*Coptis trifolia*), false mayflower (*Maianthemum trifolium*), and marsh skullcap (*Scutellaria galericulata*).

The Manitou Island northern shrub thicket was surveyed August 23<sup>rd</sup>, 2023. Forty-one native plant species were documented with no non-native species observed (Appendix 2.2). The total FQI was 31.4.

**Threats:** No threats were observed during the course of the survey. Species composition and structure are patterned by natural processes.

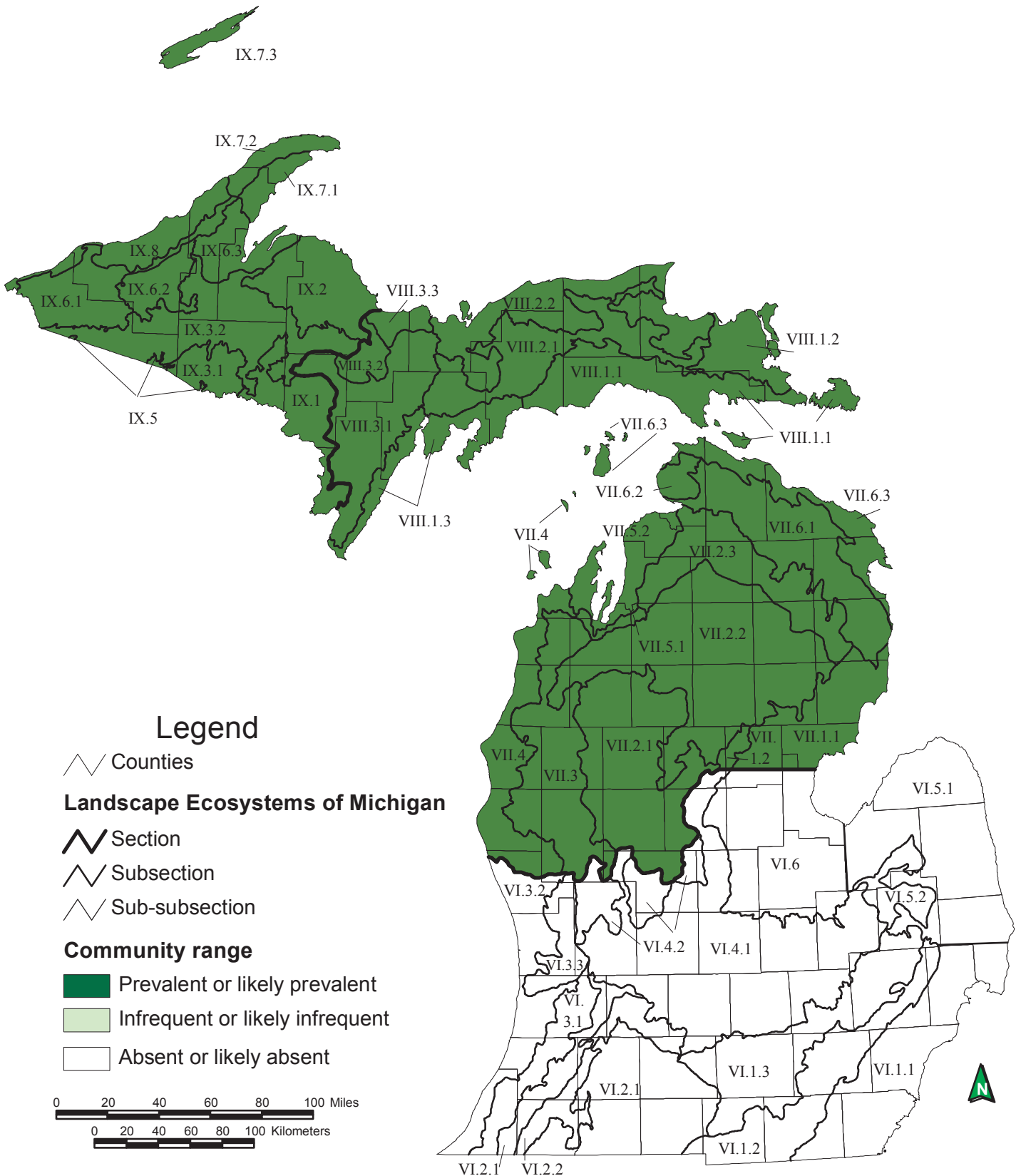
**Management Recommendations:** The main management recommendations are to allow natural processes to operate unhindered and to retain an intact buffer of natural communities surrounding the shrub thickets to minimize the threat of hydrological alteration.



Manitou Island northern shrub thicket delineated in yellow on 2022 imagery.

## NORTHERN WET MEADOW

**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 (Kost et al. 2007, Cohen et al. 2015).



**Map 3.** Distribution of northern wet meadow in Michigan (Albert et al. 2008).

### 3. Manitou Island

**Natural Community Type:** Northern Wet Meadow

**Rank:** G4G5 S4, apparently secure to secure globally and apparently secure within the state

**Element Occurrence Rank:** B

**Size:** 1.2 acres

**Element Occurrence Identification Number:** 27089

**Site Description:** The Manitou Island northern wet meadow occurs in a small depression in the northeastern portion of the island inland from volcanic cobble shore. Fluctuating water levels of the Great Lakes likely influence the hydrology of the wet meadow. The soils are of variable depth with shallower soils (50 cm) occurring along the wetland margin and deeper peats (>1 meter) in the interior of the meadow. The soils are saturated, slightly acidic peats (pH 6.0-6.5) that overly sandy clay (pH 7.5).

The northern wet meadow is graminoid dominated with sedges (*Carex lasiocarpa* and *C. vesicaria*), blue-joint (*Calamagrostis canadensis*), and rattlesnake grass (*Glyceria canadensis*). Herbaceous associates include marsh cinquefoil (*Comarum palustre*), buckbean (*Menyanthes trifoliata*), marsh bellflower (*Campanula aparinoides*), turtlehead (*Chelone glabra*), wild blue flag (*Iris versicolor*), water-parsnip (*Sium suave*), northern bugle weed (*Lycopus uniflorus*), marsh St. John's-wort (*Triadenum fraseri*), and swamp-candles (*Lysimachia terrestris*). Scattered trees and tall shrubs occur along the margin of the meadow and include northern white-cedar (*Thuja occidentalis*), black spruce (*Picea mariana*), tag alder (*Alnus incana*), and red-osier (*Cornus sericea*). Low shrubs occur infrequently in the meadow and include leatherleaf (*Chamaedaphne calyculata*), bog-rosemary (*Andromeda glaucophylla*), and bog willow (*Salix pedicellaris*).



Manitou Island northern wet meadow. Photo by Joshua G. Cohen.

The Manitou Island northern shrub thicket was surveyed August 22<sup>nd</sup>, 2023. Thirty-four native plant species were documented with no non-native species observed (Appendix 2.3). The total FQI was 35.6.

**Threats:** No threats were observed during the course of the survey. Species composition and structure are patterned by natural processes.

**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 meadow to minimize the threat of hydrological alteration.



Manitou Island northern wet meadow. Photos by Jesse M. Lincoln.



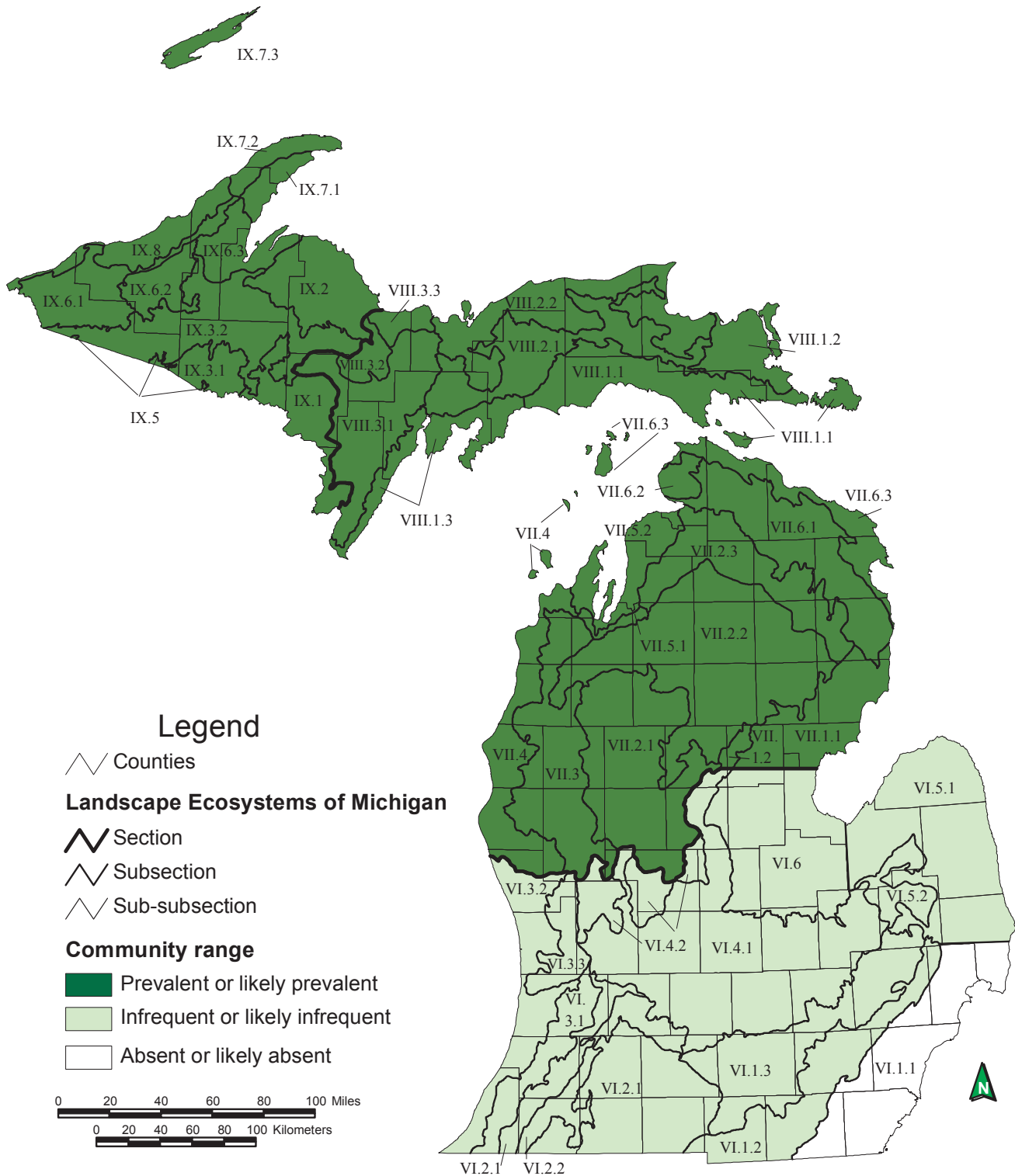


Manitou Island northern wet meadow delineated in yellow on 2022 imagery.



## POOR CONIFER SWAMP

**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 (Kost et al. 2007, Cohen et al. 2015).



**Map 4.** Distribution of poor conifer swamp in Michigan (Albert et al. 2008).

#### 4. Manitou Island

**Natural Community Type:** Poor Conifer Swamp

**Rank:** G4 S4, apparently secure globally and within the state

**Element Occurrence Rank:** B

**Size:** 52 acres

**Element Occurrence Identification Number:** 27091

**Site Description:** The Manitou Island poor conifer swamp is dominated by black spruce (*Picea mariana*) and composed of three distinct polygons with two polygons occurring in the north central portion of the island associated with low depressions and the third polygon occurring in a drainageway along the western end of Perch Lake. Accumulation of acidic peats in the depressions and drainageway have resulted in the development of acidic peatlands that support poor conifer swamp. The ecotone of the poor conifer swamp along the upland margin is slightly minerotrophic as the result of the localized influence of groundwater and northern white-cedar (*Thuja occidentalis*) is more prevalent in these areas. Other areas intergrade to northern shrub thicket where the canopy is sparse and there is extensive tag alder (*Alnus incana*).

Within the Perch Lake peatland, poor conifer swamp contains some pockets of poor fen and the margins are characterized by a narrow band of rich conifer swamp. Beaver activity is concentrated around Perch Lake with beaver felling paper birch (*Betula papyrifera*). The poor conifer swamp west of Perch Lake is characterized by greater than a meter of saturated, acidic (pH 4.5-5.5) peats that range from fibric to hemic to sapric. Fibric peats along the tops of sphagnum hummocks are strongly acidic (pH 4.5). Peats in the poor conifer swamp to the north of Perch Lake are characterized by shallower peats (20-40 cm deep) that range from fibric (pH 4.5) to hemic (pH 5.0) and overlie volcanic cobble and sandy gravel (pH 5.0-5.5). Small upland rises within this portion of the swamp have been paludified with sphagnum peats expanding horizontally over low cobble rises.

The poor conifer swamp west of Perch Lake is characterized by younger canopy black spruce compared to the poor conifer swamp to the north. West of Perch Lake, a 13.5 cm black spruce was cored and estimated to be over 44 years old (counted 34 growth rings), and a 15.6 cm black spruce was cored and estimated to be over 105 years old (counted 95 growth rings). North of Perch Lake, a 28.7 cm black spruce was cored and estimated to be over 144 years old (counted 133 growth rings). There is no evidence of cut stumps and the harsh growing conditions on Manitou Island likely limit the upper age of black spruce to under 200 years old.



Manitou Island poor conifer swamp. Photo by Jesse M. Lincoln.

The poor conifer swamp is characterized by a continuous carpet of sphagnum moss, a species-poor herbaceous layer (40-60%), a patchy to dense low shrub layer (30-70%), a scattered understory layer (10-15%), and a coniferous canopy. The canopy is dominated by black spruce with infrequent canopy associates including paper birch and tamarack (*Larix laricina*) and northern white-cedar occurring infrequently along the swamp margins. Canopy trees range from 10 to 30 cm diameter. Canopy coverage ranges widely from 30 to 75% with more open areas (30 to 50%) along the western margin of Perch Lake and more closed-canopy (50 to 75%) conditions in the swamp to the north of Perch Lake. The understory layer contains tag alder, mountain holly (*Ilex mucronata*), mountain-ash (*Sorbus decora*), and yew (*Taxus canadensis*) along with sapling black spruce, tamarack, and balsam fir (*Abies balsamea*). The low shrub layer is characterized by Labrador tea (*Rhododendron groenlandicum*), leatherleaf (*Chamaedaphne calyculata*), low sweet blueberry (*Vaccinium angustifolium*), yew, bog-laurel (*Kalmia polifolia*), and thimbleberry (*Rubus parviflorus*) with seedling black spruce. Characteristic ground cover species include goldthread (*Coptis trifolia*), false mayflower (*Maianthemum trifolium*), blue-joint (*Calamagrostis canadensis*), sedges (*Carex oligosperma*, *C. disperma*, *C. pauciflora*), creeping-snowberry (*Gaultheria hispidula*), star-flower (*Trientalis borealis*), pitcher-plant (*Sarracenia purpurea*), pinky lady-slipper (*Cypripedium acaule*), small cranberry (*Vaccinium oxycoccos*), and round-leaved sundew (*Drosera rotundifolia*). Sphagnum forms a continuous carpet throughout the swamp.

The Manitou Island poor conifer swamp was surveyed August 22<sup>nd</sup>, 2023. Twenty-six native plant species were documented with no non-native species observed (Appendix 2.4). The total FQI was 32.6.

**Threats:** No threats were observed during the course of the survey. Species composition and structure are patterned by natural processes.

**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 swamp to minimize the threat of hydrological alteration.



Two polygons of poor conifer swamp were documented in the north central portion of Manitou Island (outlined in yellow) and an addition polygon (not pictured) was mapped along the western shore of Perch Lake. Photo by Jesse M. Lincoln.



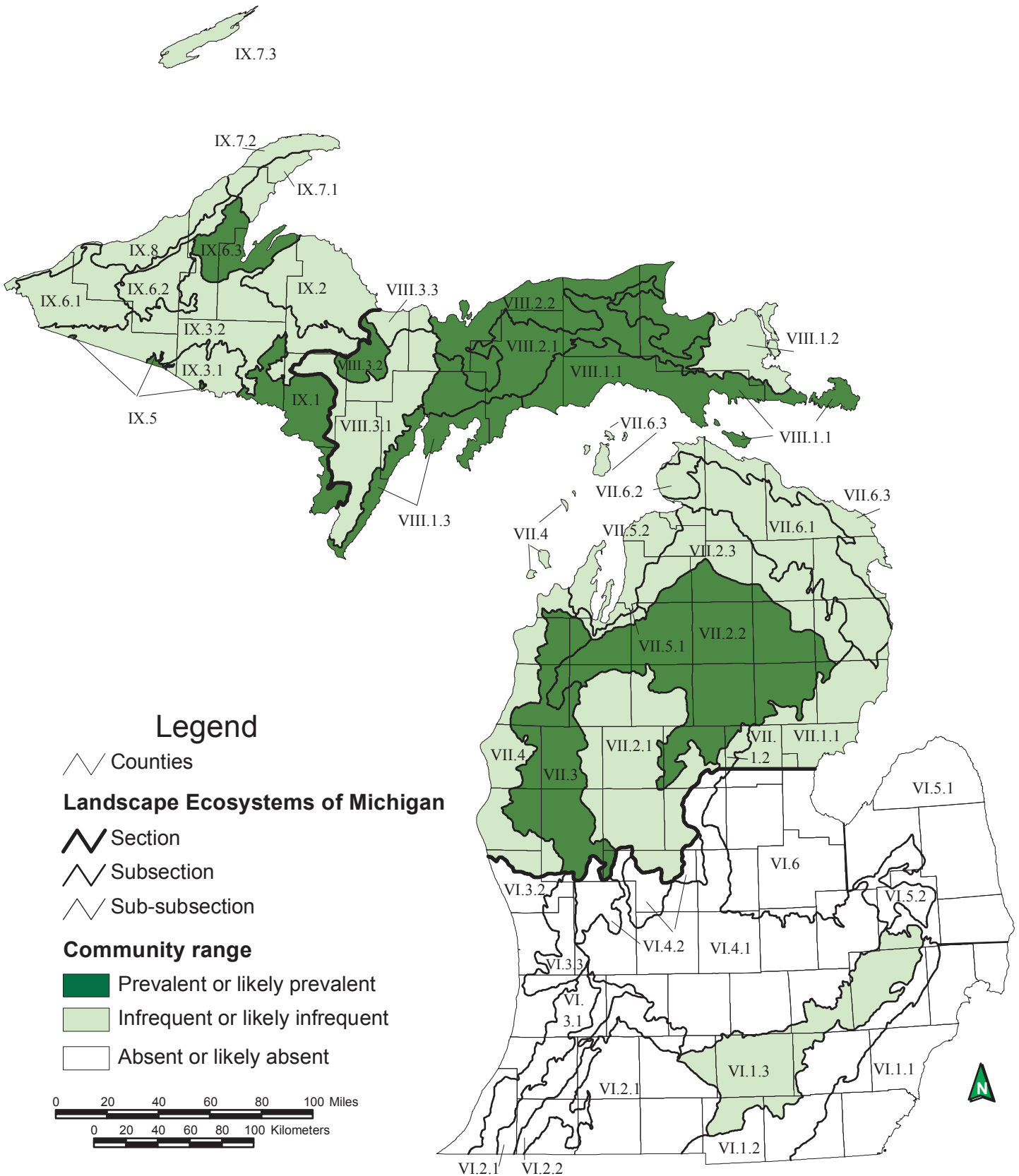
Manitou Island poor conifer swamp delineated in yellow on 2022 imagery.



Manitou Island poor conifer swamp. Photo by Jesse M. Lincoln.

## POOR FEN

**Overview:** Poor fen is a sedge-dominated wetland found on very strongly to strongly acid, saturated peat that is moderately influenced by groundwater. The community occurs north of the climatic tension zone in kettle depressions and in flat areas or mild depressions on glacial outwash and glacial lakeplain (Kost et al. 2007, Cohen et al. 2015).



## 5. Manitou Island

**Natural Community Type:** Poor Fen

**Rank:** G3 S3, vulnerable globally and within the state

**Element Occurrence Rank:** B

**Size:** 0.9 acres

**Element Occurrence Identification Number:** 27088

**Site Description:** The Manitou Island poor fen occurs in a small depression in the northeastern portion of the island. The poor fen is characterized by greater than a meter of saturated, slightly acidic (pH 6.5-6.8) peats that range from fibric to hemic. The fibric peats on the top of the sphagnum hummock are more acidic than the underlying hemic peats. Acidity decreases with increasing peat depth. Fine-scale gradients in soil composition and soil moisture associated within the sphagnum hummocks and hollows generate small-scale microhabitat within the fen and increase the overall species diversity. Snowshoe hare (*Lepus americanus*) browse is prevalent in the low shrub layer on the shrubs and tree seedlings, including tamarack (*Larix laricina*). Hare pellets were noted on the tops of the sphagnum hummocks. Intense hare browse pressure appears to be substantially contributing to the maintenance of the fen in an open state. Most saplings of tree species showed intense browse damage and it seems that very little can make it above the deep winter snowline. A 10.9 cm black spruce (*Picea mariana*) was cored and estimated to be over 140 years old (counted 130 growth rings).

The poor fen is floristically diverse and is characterized by scattered and stunted conifers, dense ericaceous shrubs, and tall sphagnum hummocks. Canopy coverage ranges from 5 to 10% with black spruce, tamarack, and northern white-cedar (*Thuja occidentalis*). Canopy trees range in diameter from 2 to 10 cm. The conifers and shrubs are concentrated on the low sphagnum hummocks. The tall shrub layer (10-20%) is dominated by sapling tamarack and black spruce as well as tag alder (*Alnus incana*) and red-osier (*Cornus sericea*). The low shrub layer is dense and diverse (40-70%)



Manitou Island poor fen. Photo by Joshua G. Cohen.



Manitou Island poor fen delineated in yellow on 2022 imagery.



Manitou Island poor fen. Photo by Jesse M. Lincoln.

with leatherleaf (*Chamaedaphne calyculata*), bog-rosemary (*Andromeda glaucophylla*), Labrador tea (*Rhododendron groenlandicum*), red-osier, yew (*Taxus canadensis*), and tag alder along with seedling black spruce and northern white-cedar. The ground cover (50-80%) is diverse with characteristic graminoids species including wiregrass sedge (*Carex lasiocarpa*), tufted bulrush (*Trichophorum cespitosum*), alpine bulrush (*T. alpinum*), livid sedge (*C. livida*), blue-joint (*Calamagrostis canadensis*), narrow-leaved reedgrass (*Calamagrostis stricta* ssp. *stricta*, State Threatened), and narrow-leaved cotton-grass (*Eriophorum angustifolium*). Forbs are also diverse and include dwarf raspberry (*Rubus pubescens*), creeping-snowberry (*Gaultheria hispidula*), bluebead-lily (*Clintonia borealis*), cranberries (*Vaccinium oxycoccos*, and *V. macrocarpon*), goldthread (*Coptis trifolia*), false asphodel (*Triantha glutinosa*), common bog arrow-grass (*Triglochin maritima*), bog goldenrod (*Solidago uliginosa*), twinflower (*Linnaea borealis*), bunchberry (*Cornus canadensis*), false mayflower (*Maianthemum trifolium*), pitcher-plant (*Sarracenia purpurea*), and marsh St. John's-wort (*Triadenum fraseri*). There were several orchid species within the fen including rose pogonia (*Pogonia ophioglossoides*), grass-pink (*Calopogon tuberosus*), tall white bog orchid (*Platanthera dilatata*), club-spur orchid (*P. clavellata*), and showy lady-slipper (*Cypripedium reginae*). There were also numerous ferns and fern allies, including marsh fern (*Thelypteris palustris*), royal fern (*Osmunda regalis*), stiff clubmoss (*Spinulum annotinum*), marsh horsetail (*Equisetum palustre*), and variegated scouring rush (*E. variegatum*). Burred horsehair lichen (*Bryoria furcellata*) was documented growing on the boles of black spruce trees.

The Manitou Island poor fen was surveyed August 22<sup>nd</sup>, 2023. Forty-seven native plant species were documented with no non-native species observed (Appendix 2.5). The total FQI was 46.6.

**Threats:** No non-native species were documented during the surveys. Snowshoe hare browse is prevalent on the shrubs and tree seedlings (including tamarack and spruce) in the low shrub layer. Hare browse pressure may be influencing the species composition and vegetation of the fen and maintaining the fen in an open state.

**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 fen to minimize the threat of hydrological alteration. Species composition and vegetative structure of the fen should be monitored over time to gauge the impact of snowshoe hare browse.

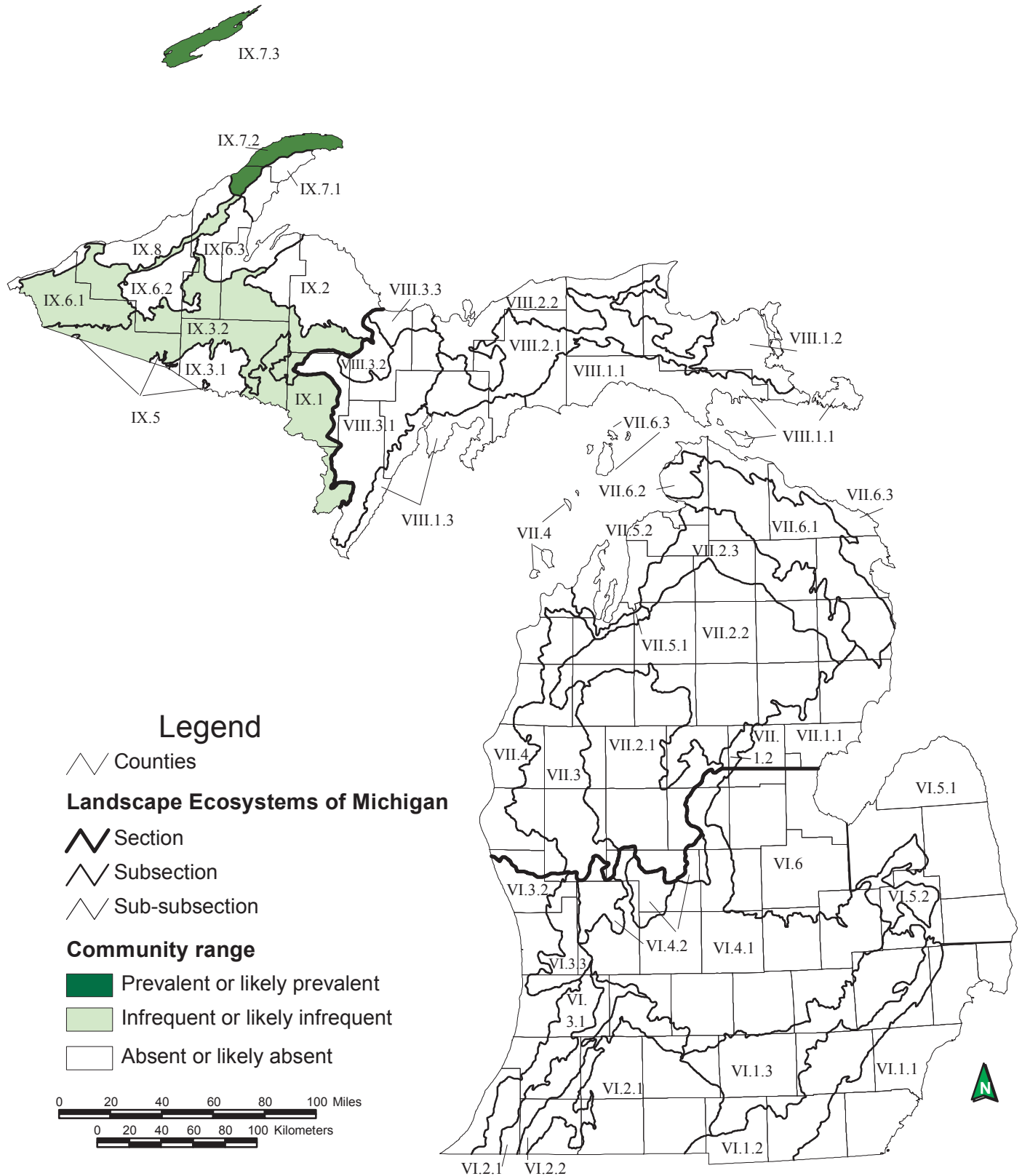


Poor fen (center right) and northern wet meadow (upper left) occur in small depressions in the northeastern portion of Manitou Island. Photo by Jesse M. Lincoln.



## VOLCANIC BEDROCK GLADE

**Overview:** Volcanic bedrock glade consists of an open forested or savanna community found where basaltic bedrock and conglomerates are exposed. The sparse vegetation consists of scattered open-grown trees, scattered shrubs or shrub thickets, and a partial turf of herbs, grasses, sedges, mosses, and lichens. The community occurs in the western Upper Peninsula on Isle Royale and the Keweenaw Peninsula, extending southwest into Houghton, Ontonagon, and Gogebic Counties (Kost et al. 2007, Cohen et al. 2015).



**Map 6.** Distribution of volcanic bedrock glade in Michigan (Albert et al. 2008).

## 6. Manitou Island

**Natural Community Type:** Volcanic Bedrock Glade

**Rank:** GU S2, uncertain globally and imperiled within the state

**Element Occurrence Rank:** BC

**Size:** 1.9 acres

**Element Occurrence Identification Number:** 27092

**Site Description:** The Manitou Island volcanic bedrock glade occurs along a conglomerate ridge in the interior of the island northeast of Perch Lake. This glade occurs an east-west running exposure of conglomerate bedrock of the Copper Harbor Conglomerates. Fire charred downed logs were noted within the glade and there were several top-killed shrubs. A fire appears to have occurred within the past 2 to 5 years based on shrub growth. The fire was presumably caused by lightning as there are no nearby trails or camp sites. Some organic soil has developed in pockets and cracks within the volcanic rock, but there are also large areas with no soil where lichens are the predominant vegetation. The soils are shallow (0-5 cm over bedrock), loose, unconsolidated organics mixed with acidic (pH 5.0-5.5) loams. Thin soils, cold winter temperatures, steady winds, and summer droughts make vegetation especially prone to desiccation. Blowdowns occur within the glade due to the high winds near Lake Superior and the thin rooting zone. Erosion, windthrow, desiccation, and fire are all important natural processes influencing volcanic bedrock glade communities. Fire may be especially important as the community assemblage was different than other sparsely canopied ridgelines within the matrix of boreal forest. In particular, bluegrass (*Poa saltuensis*), false melic (*Schizachne purpurascens*), and sedge (*Carex eburnea*) were not observed in other areas of the island. The open canopy is uneven-aged. A 19.6 cm balsam fir (*Abies balsamea*) was cored and estimated to be over 80 years old (counted 70 growth rings). A 10 cm pin cherry (*Prunus pensylvanica*) was cored and estimated to be over 44 years old (counted 34 growth rings). Open-canopied boreal forest surrounds the glade.



Manitou Island volcanic bedrock glade. Photo by Jesse M. Lincoln.



Manitou Island volcanic bedrock glade delineated in yellow on 2022 imagery.



Depicted in the central portion of this picture, the volcanic bedrock glade occurs along an east-west running exposure of conglomerate bedrock and is flanked by open-canopied boreal forest. Photo by Jesse M. Lincoln.



Manitou Island volcanic bedrock glade. Photos by Joshua G. Cohen.



The volcanic bedrock glade is characterized by dispersed open-grown trees, dense shrub thickets, and scattered openings that feature exposed bedrock and patchy forbs, grasses, sedges, mosses, and lichens. The overstory is open (5-15% canopy coverage) with balsam fir, mountain-ash (*Sorbus decora*), and pin cherry. Overstory trees range in diameter from 10 to 20 cm. The understory layer is patchy to dense (30 to 50%) and includes choke cherry (*Prunus virginiana*), serviceberry (*Amelanchier interior*), red-osier (*Cornus sericea*), red elderberry (*Sambucus racemosa*), wild red raspberry (*Rubus strigosus*), round-leaved dogwood (*Cornus rugosa*), and sapling mountain-ash, balsam fir, and pin cherry. Low shrubs form thickets around islands of overstory trees and tall shrubs and common low shrubs include bush honeysuckle (*Diervilla lonicera*), yew (*Taxus canadensis*), Canadian fly honeysuckle (*Lonicera canadensis*), thimbleberry (*Rubus parviflorus*), and wild rose (*Rosa acicularis*). The ground cover is locally abundant but generally patchy (10 to 50% coverage) and characteristic ground cover species include bluegrass (*Poa saltuensis*), sedges (*Carex eburnea*, *C. arctata*, and *C. umbellata*), twinflower (*Linnaea borealis*), false melic, ticklegrass (*Agrostis scabra*), bunchberry (*Cornus canadensis*), fringed false buckwheat (*Fallopia cilinodis*), big-leaved aster (*Eurybia macrophylla*), wild sarsaparilla (*Aralia nudicaulis*), Canada mayflower (*Maianthemum canadense*), wild-basil (*Clinopodium vulgare*), and king devil (*Hieracium caespitosum*). Expanded woodfern (*Dryopteris expansa*) and lady fern (*Athyrium filix-femina*) occur at the margins of the surrounding boreal forest. Non-native species are infrequent and the two species observed are field scorpion-grass (*Myosotis arvensis*) and king devil (*Hieracium caespitosum*).

The Manitou Island volcanic bedrock glade was surveyed August 22<sup>nd</sup>, 2023. Thirty-six plant species were documented with 34 native species and 2 non-native species (Appendix 2.6). The total FQI was 24.6.

**Threats:** Species composition and structure are patterned by natural processes. Non-native species are infrequent in the glade and include field scorpion-grass and king devil.

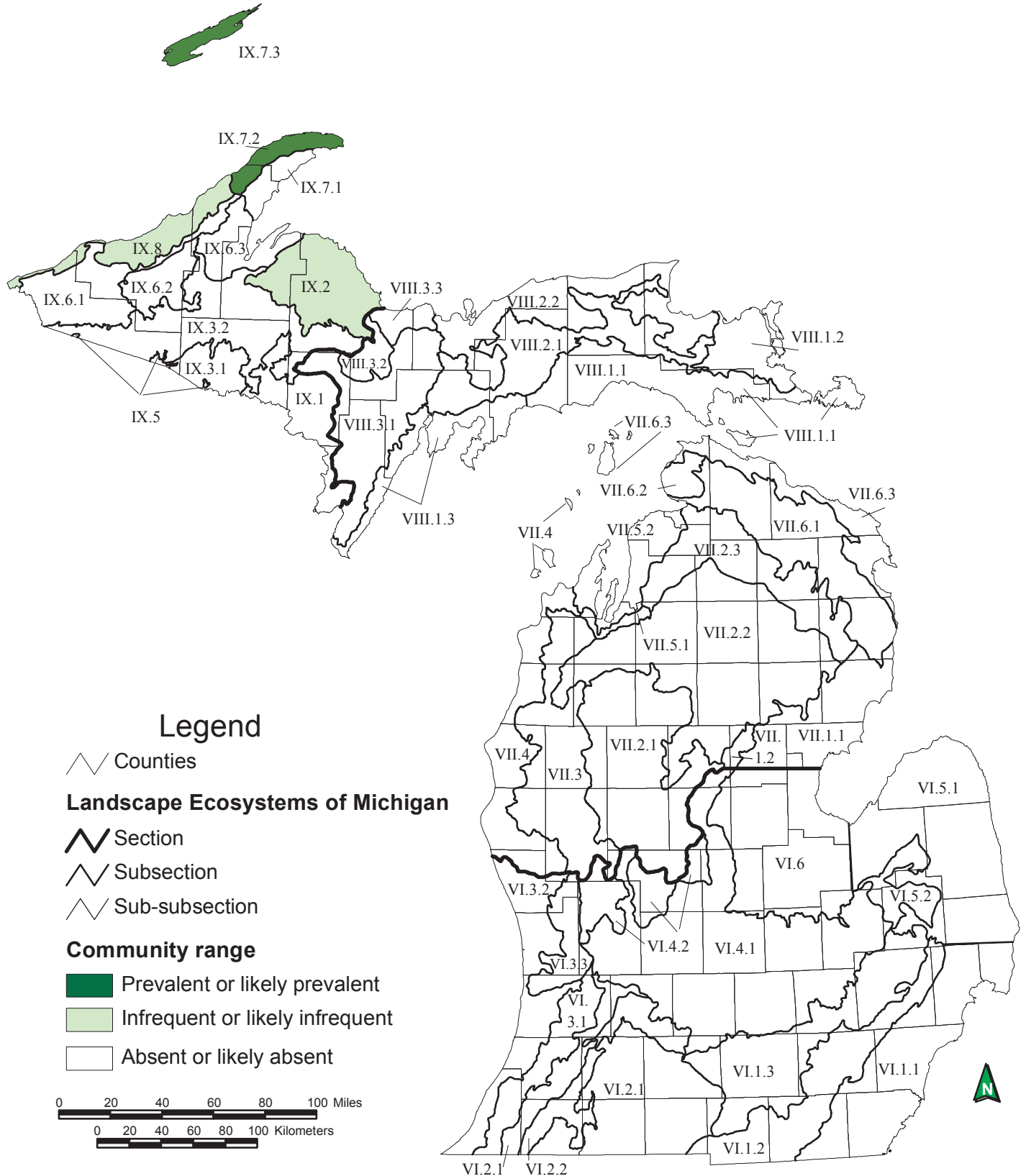
**Management Recommendations:** The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn) and to maintain a forested buffer surrounding the glade to prevent the increase of a weedy seed source. The glade should be monitored for invasive species.



Manitou Island volcanic bedrock glade. Photo by Jesse M. Lincoln.

## VOLCANIC BEDROCK LAKESHORE

**Overview:** Volcanic bedrock lakeshore is a sparsely vegetated community dominated by mosses and lichens, with a scattered coverage of vascular plants. The community is located primarily along the Lake Superior shoreline on the Keweenaw Peninsula and Isle Royale. This Great Lakes coastal plant community includes all types of volcanic bedrock, including basalt, conglomerate composed of volcanic rock, and rhyolite (Kost et al. 2007, Cohen et al. 2015).



**Map 7.** Distribution of volcanic bedrock lakeshore in Michigan (Albert et al. 2008).

## 7. Manitou Island

**Natural Community Type:** Volcanic Bedrock Lakeshore

**Rank:** G4G5 S2, apparently secure to secure globally and imperiled within the state

**Element Occurrence Rank:** A

**Size:** 24 acres

**Element Occurrence Identification Number:** 9280 (EO update)

**Site Description:** Moderately sloping volcanic bedrock lakeshore occurs along over three miles of Lake Superior shoreline on Manitou Island. Copper Harbor Conglomerates make up the majority of the Manitou Island shoreline (80%), but basaltic lava flows or Lake Shore Traps occur locally. The Lake Shore Traps mostly occur on Manitou Island's north shore. The majority of the shoreline of Manitou Island is characterized by volcanic bedrock lakeshore and volcanic cobble shore that intergrade. Volcanic lakeshore cliff is restricted to the southeastern portion of the island. The volcanic bedrock lakeshore is backed by open canopy boreal forest that is frequently impacted by Lake Superior storms and experiences high turnover of canopy trees.

The volcanic bedrock lakeshore ranges in width from 20 to 60 meters wide and several hundred meters long. Stretches of bedrock shoreline are interrupted by volcanic cobble shore and sand and gravel beach (especially along the southwestern shoreline). The multifaceted conglomerate is sparsely vegetated. Due to the lack of soil development because of frequent wave activity, the resistance of the bedrock and the lack of suitable sites for soil retention, the vegetation is sparse and concentrated along the upland margin above the wave-washed zone where it is restricted to cracks, crevices and depressions. Despite this, a surprising diversity of plant species persists along the bedrock shoreline due to multiple factors including the various rates of substrate decay; uneven exposure to wave and storm energy; protection along the



The volcanic bedrock lakeshore is sparsely vegetated and dominated by lichens with herbaceous plants and scattered tree and shrub cover restricted to the inland edge and cracks and crevices within the bedrock. Photo by Joshua G. Cohen.



Manitou Island volcanic bedrock lakeshore delineated in yellow on 2022 imagery.



Manitou Island volcanic bedrock lakeshore. Photo by Jesse M. Lincoln.



back slopes of bedrock; irregular configuration allowing pooling; moss and lichen development; and soil accumulation in cracks. Where the bedrock is more broken, there are more locations for soil and plant establishment. The wave-splashed zone ranges in width from 2 to 4 meters and is lacking vegetation. Near the water's edge, storm waves regularly scour the rock. During the winter, ice scours and abrades the rock even more violently. Freezing rain and mist coat both the rock and vegetation, and in combination with high winds, result in dwarf shrubs and stunted trees along the shore. Fog occurs on an almost daily basis in the summer, allowing plants more characteristic of cooler northern or high elevation habitats to survive beyond their normal range.

Volcanic bedrock lakeshore is subject to seasonal fluctuations in Great Lakes water levels, short-term changes due to seiches and storm surges, and long-term, multi-year lake level fluctuations. Storm waves and ice frequently disturb volcanic bedrock lakeshore, removing fine mineral sediments and organic soils. Winter storms scour vegetation from the volcanic bedrock lakeshore. Long-term cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of volcanic bedrock lakeshore, with vegetation and organic soils becoming established during low-water periods and reduced or eliminated during high-water periods. This site was surveyed in 2023, three years after five consecutive years of high Great Lakes water levels (from 2016 to 2020) resulting in the decrease in the extent of the volcanic bedrock lakeshore. High water levels and increased wave activity have likely reduced the overall cover of herbaceous species in the volcanic bedrock lakeshore. Horizontal bedrock coastal systems are more impacted by Great Lakes water level fluctuations compared to vertical bedrock systems such as volcanic lakeshore cliff.

Almost no soil development takes place on the volcanic conglomerates and basalts. The only places where plants are able to establish are in cracks, crevices, joints, vesicles, flats, and depressions in the bedrock, where small amounts of organic matter accumulate. Shallow organics mixed with sand (0-2 cm) occur locally along the volcanic bedrock lakeshore and range from circumneutral to alkaline (pH 7.0-7.2). Soil chemistry of the soils within the bedrock lakeshore is likely linked to the decomposition of the local organic material.



The wave-splashed zone of the volcanic bedrock lakeshore is devoid of vegetation. Photo by Joshua G. Cohen.



Basaltic lava flows or Lake Shore Traps occur locally on Manitou Island's north shore. Photos by Joshua G. Cohen.



The volcanic bedrock lakeshore is sparsely vegetated and dominated by non-vascular species with herbaceous plants (2-4%) and scattered tree and shrub cover (1-4%) restricted to the inland edge and cracks and crevices within the bedrock. A diverse array of lichens and mosses occurs on the exposed bedrock. One of the more common lichens is *Xantheria elegans*, an orange lichen whose presence is often associated with bird guano. Characteristic vascular plants include harebell (*Campanula rotundifolia*), wild strawberry (*Fragaria virginiana*), hair grass (*Deschampsia cespitosa*), Gillman's goldenrod (*Solidago simplex*), grass-leaved goldenrod (*Euthamia graminifolia*), fireweed (*Chamaenerion angustifolium*), dwarf raspberry (*Rubus pubescens*), birds-eye primrose (*Primula mistassinica*), northern bog violet (*Viola nephrophylla*), yarrow (*Achillea millefolium*), wild wormwood (*Artemisia campestris*), pearly everlasting (*Anaphalis margaritacea*), bluegrass (*Poa glauca*), and wild columbine (*Aquilegia canadensis*). Rare plants documented along this stretch of shoreline include alpine bistort (*Bistorta vivipara*, State Threatened), rock whitlow grass (*Draba arabisans*, State Special Concern), pale Indian paintbrush (*Castilleja septentrionalis*, State Threatened), alpine bluegrass (*Poa alpina*, State Threatened), squashberry (*Viburnum edule*, State Threatened), and downy oatgrass (*Trisetum spicatum*, State Special Concern).

Scattered and stunted trees (1-2%) include paper birch (*Betula papyrifera*), northern white-cedar (*Thuja occidentalis*), mountain-ash (*Sorbus decora*), and balsam fir (*Abies balsamea*). Trees range from 2 to 10 cm diameter and 1 to 5 m tall. Scattered tall shrubs and saplings (1-2%) are restricted to the upper margin and include red-osier (*Cornus sericea*), squashberry, balsam poplar (*Populus balsamifera*), balsam fir, mountain-ash, quaking aspen (*Populus tremuloides*), northern white-cedar, paper birch, and shinning willow (*Salix lucida*). The low shrub layer (2-4%) is characterized by bearberry (*Arctostaphylos uva-ursi*), soapberry (*Shepherdia canadensis*), ninebark (*Physocarpus opulifolius*), squashberry, wild rose (*Rosa blanda*), bush honeysuckle (*Diervilla lonicera*), shinning willow, sweet gale (*Myrica gale*), shadbush serviceberry (*Amelanchier spicata*), and seedling northern white-cedar, paper birch, and balsam poplar. Non-native species recorded within the volcanic bedrock lakeshore include ox-eye daisy (*Leucanthemum vulgare*), Canada bluegrass (*Poa compressa*), king devil (*Hieracium caespitosum*), common buttercup (*Ranunculus acris*), silvery cinquefoil (*Potentilla argentea*), and sweet William (*Dianthus barbatus*). As noted by Albert et al. (1997), the plant diversity along the conglomerate shoreline is greater than the stretches with basaltic bedrock.

The Manitou Island volcanic bedrock lakeshore was surveyed August 21<sup>st</sup> through August 23<sup>rd</sup>, 2023. Seventy-four plant species were documented with 68 native species and 6 non-native species (Appendix 2.7). The total FQI was 41.3.

**Threats:** Species composition and structure are patterned by natural processes. Foot traffic is limited, seasonal, and concentrated along the shoreline near the light house and near the boat dock. Non-native species recorded within the volcanic bedrock lakeshore include ox-eye daisy, Canada bluegrass, king devil, common buttercup, silvery cinquefoil, and sweet William.

**Management Recommendations:** The main management recommendations are to maintain a forested buffer surrounding the volcanic bedrock lakeshore, evaluate the control of invasive species, and monitor any control efforts. Efforts to control invasive species should be implemented with extreme care. Substantial risk for collateral damage exists since non-native species occur locally and the volcanic bedrock lakeshore supports several concentrations of rare species. Any control efforts should be executed by individuals trained on the identification of rare species and carefully monitored.



Manitou Island volcanic bedrock lakeshore. Photo by Jesse M. Lincoln.

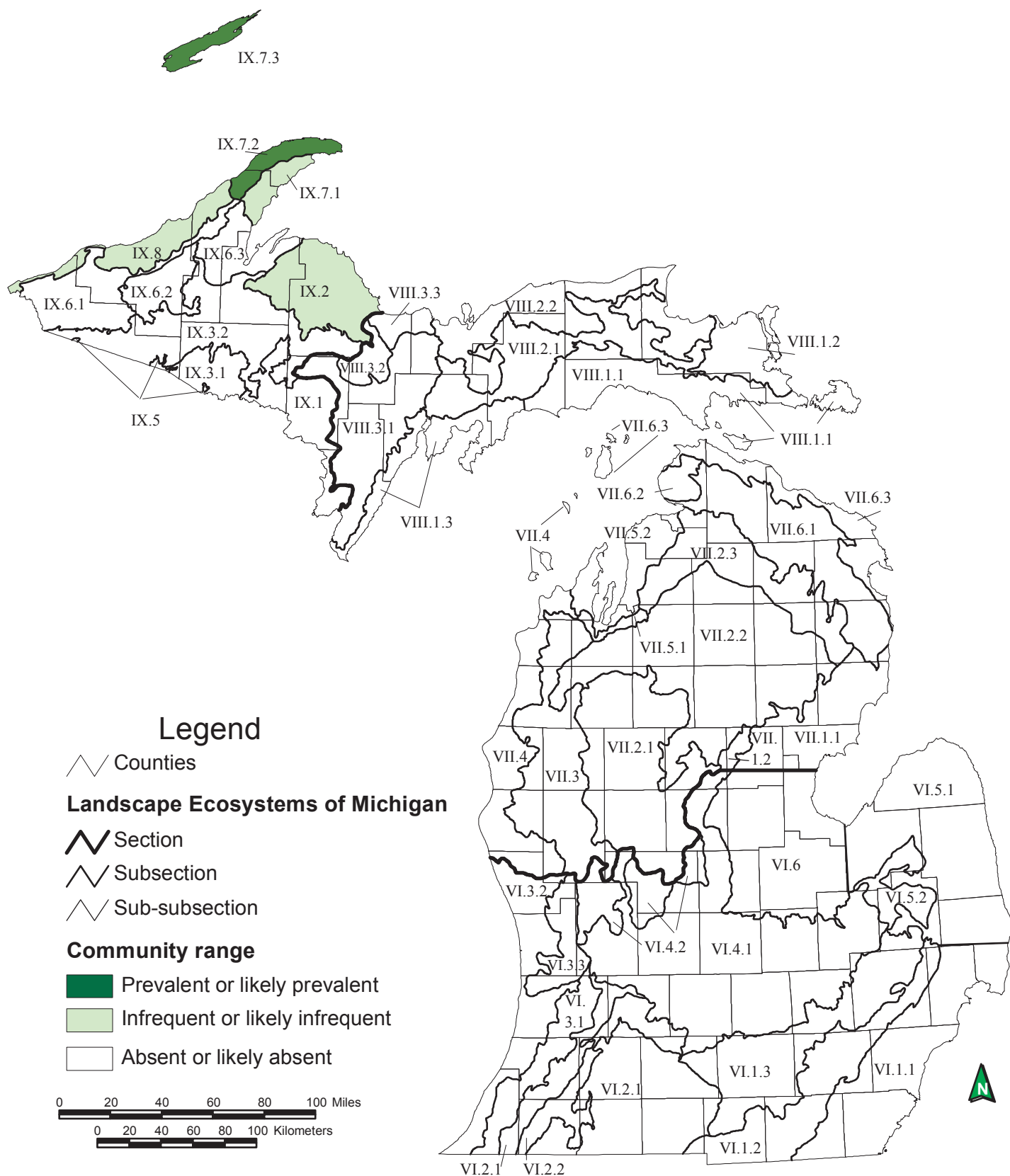


Numerous rare plants occur along this stretch of shoreline and include rock whitlow grass (*Draba arabisans*, State Special Concern) (above), alpine bistort (*Bistorta vivipara*, State Threatened) (lower left, lower stature plant), downy oatgrass (*Trisetum spicatum*, State Special Concern) (lower left, taller stature grass), and pale Indian paintbrush (*Castilleja septentrionalis*, State Threatened) (lower right). Photos by Jesse M. Lincoln.



## VOLCANIC COBBLE SHORE

**Overview:** Volcanic cobble shore occurs along Lake Superior, predominantly in coves and gently curving bays between rocky points. These mostly unvegetated shores are often terraced, with the highest cobble beach ridge typically supporting a shrub zone several meters above Lake Superior (Kost et al. 2007, Cohen et al. 2015).



**Map 8.** Distribution of volcanic cobble shore in Michigan (Albert et al. 2008).

## 8. Manitou Island

**Natural Community Type:** Volcanic Cobble Shore

**Rank:** G4G5 S2, apparently secure to secure globally and imperiled within the state

**Element Occurrence Rank:** A

**Size:** 29 acres

**Element Occurrence Identification Number:** 27093

**Site Description:** The Manitou Island volcanic cobble shore occurs along a 4.25-mile stretch of the Lake Superior shoreline around the island. The areas of cobble shore are typically narrow (2-5 meters wide) with some areas reaching up to 10 meters wide. The cobble shore is composed of cobbles from weathering, glacial erosion, and wave action breaking down the island's conglomerates. Soil development is minimal and is limited to the narrow spaces between the cobbles. Near the water's edge, storm waves regularly reorganize the cobble and erode the soil. During the winter, ice scours and abrades the rock and pushes the cobble into ridges up to 2 m tall. Freezing rain and mist coat both the rock and vegetation, and in combination with high winds, result in dwarf shrubs and stunted trees along the shore. This volcanic cobble shore is bordered by open-canopied boreal forest along its upland margin. This boreal forest is subject to frequent turnover of canopy trees from windthrow. Along the shoreline, the volcanic cobble shore intergrades with volcanic bedrock lakeshore and sand and gravel beach and locally with volcanic lakeshore cliff along the eastern end of the island. Coves and bays and high energy stretches of shoreline support volcanic cobble shore. The east-west orientation of Manitou Island and its position in unprotected waters of Lake Superior result in the island experiencing frequent high winds across the island and high waves along the shorelines.

The volcanic cobble shore is sparsely vegetated with a scattered coverage of vascular plants. Plant diversity is low due to wave and ice action and the lack of soil development. Vascular plants occur above the zone of active storm waves and ice scour. Wave action and ice scour are strongest near the lakeshore, producing a wave-washed zone that is almost



Manitou Island volcanic cobble shore. Photo by Joshua G. Cohen.



Manitou Island volcanic cobble shore delineated in yellow on 2022 imagery.



Manitou Island volcanic cobble shore. Photo by Jesse M. Lincoln.

devoid of vegetation. With greater distance above the lake, plant cover increases. On the high, dry rocks, scattered mosses, lichens, herbs, and woody plants occur locally. Herbs and woody plants are restricted to areas where there is limited soil development between cobbles and at the margin of the adjacent boreal forest.

Scattered tree saplings and tall shrubs (<1%) along the upper margin of the volcanic cobble shore include paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), northern white-cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), mountain-ash (*Sorbus decora*), red elderberry (*Sambucus racemosa*), mountain maple (*Acer spicatum*), red-osier (*Cornus sericea*), ninebark (*Physocarpus opulifolius*), and squashberry (*Viburnum edule*, State Threatened). Occasional low shrubs (1-2%) include soapberry (*Shepherdia canadensis*), ninebark, Canadian fly honeysuckle (*Lonicera canadensis*), choke cherry (*Prunus virginiana*), thimbleberry (*Rubus parviflorus*), wild rose (*Rosa acicularis*), bush honeysuckle (*Diervilla lonicera*), and wild red raspberry (*Rubus strigosus*). Characteristic ground cover species (<1%) include fireweed (*Chamaenerion angustifolium*), blue-joint (*Calamagrostis canadensis*), royal fern (*Osmunda regalis*), grass-leaved goldenrod (*Euthamia graminifolia*), harebell (*Campanula rotundifolia*), beach pea (*Lathyrus japonicus*), rough cinquefoil (*Potentilla norvegica*), and spotted touch-me-not (*Impatiens capensis*). Non-natives documented within the volcanic cobble shore include reed canary grass (*Phalaris arundinacea*) and mullein (*Verbascum thapsus*).

The Manitou Island volcanic cobble shore was surveyed August 21<sup>st</sup> through August 23<sup>rd</sup>, 2023. Thirty-two plant species were documented with 30 native species and 2 non-native species (Appendix 2.8). The total FQI was 22.1.

**Threats:** Species composition and structure are patterned by natural processes. Foot traffic is limited, seasonal, and concentrated along the shoreline near the light house and the boat dock. Non-native species recorded within the volcanic cobble shore include reed canary grass and mullein. Despite the remote nature of the island plastic trash, cigarette butts, and balloons were frequently found during the shoreline surveys. These can have negative impacts on migratory birds. There was a ruined sailboat stranded along the coastline. The Gladiator was observed during the 2023 surveys. Trash, including boat batteries, was strewn around the wreck.

**Management Recommendations:** The main management recommendations are to control invasive species, monitor these control efforts, and remove trash.

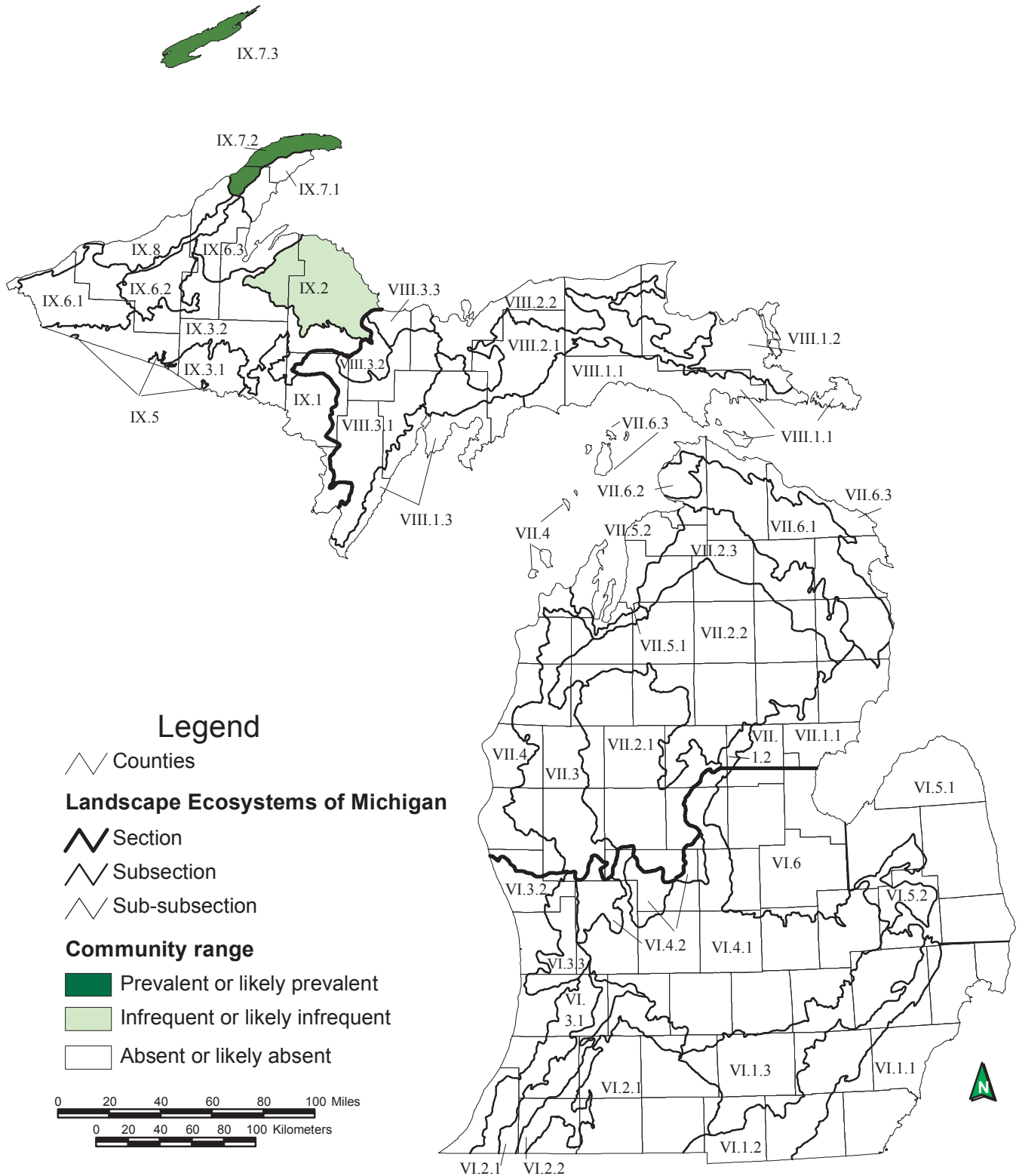


Volcanic cobble shore and volcanic bedrock lakeshore intergrade along the shoreline of Manitou Island. Photo by Joshua G. Cohen.



## VOLCANIC LAKESHORE CLIFF

**Overview:** Volcanic lakeshore cliff consists of vertical or near-vertical exposures of bedrock, which support less than 25% vascular plant coverage, although lichens, mosses, and liverworts are abundant on some rock surfaces. Volcanic lakeshore cliff ranges in height from 3 to 80 meters (10 to 260 ft) and occurs on Lake Superior along the Keweenaw Peninsula and along the northern shoreline of Isle Royale. Volcanic lakeshore cliff is characterized by high site moisture due to the proximity to Lake Superior and a stressed and unstable environment because of severe waves, wind, and winter ice. Volcanic lakeshore cliff is one of the rarest natural community types in Michigan with just four occurrence documented in the state (Kost et al. 2007, Cohen et al. 2015).



**Map 9.** Distribution of volcanic lakeshore cliff in Michigan (Albert et al. 2008).

## 9. Manitou Island

**Natural Community Type:** Volcanic Lakeshore Cliff

**Rank:** GU S1, uncertain globally and critically imperiled within the state

**Element Occurrence Rank:** AB

**Size:** 7.9 acres

**Element Occurrence Identification Number:** 12518 (EO update)

**Site Description:** Volcanic lakeshore cliff occurs along a half mile stretch of shoreline along the eastern end of Manitou Island and consists of vertical or near-vertical exposures of volcanic conglomerate bedrock of the Copper Harbor Conglomerate. The cliff ranges in height from 3 to 15 meters. There is little soil development on the steep rock face of the cliff. Some organic soil development occurs in crevices in the rock face and on the upper lip of the cliff. The shallow (<1 cm) organic soils from the upper lip are alkaline (pH 8.0).

The south-facing cliff is characterized by high site moisture due to the proximity to Lake Superior and a stressed and unstable environment because of severe waves, wind, and winter ice. The cliff is exposed to almost continual wave action from Lake Superior. During the winter, ice adds to the erosive environment along the shore, both for the cliff and the upland forest along the cliff edge. The wave-splash and ice-scour zone of the cliff is 1 to 3 meters up the cliff and is completely bare of vegetation. Lichens increase in abundance from the scour zone towards the top where there is a diversity of lichen species, many likely influenced by bird guano. Storm winds off Lake Superior uproot trees and erode soils. Windblown trees at the base of the cliff provide localized areas for soil accumulation. Thin soils, winter winds, full exposure, and summer droughts produce a desiccating environment for plants. The regularly occurring fog along the coast serves to somewhat mitigate these desiccating effects during the growing season. The volcanic lakeshore cliff is bordered inland by boreal forest, including a stretch that recently burned. Along the shoreline, volcanic lakeshore cliff is interspersed with areas of volcanic bedrock lakeshore and volcanic cobble shore. An 11 cm bonsai northern white-cedar (*Thuja occidentalis*) occurring along the margin of the cliff was cored and estimated to be over 62 years old. In addition, a 12 cm northern white-cedar was cored and estimated to be over 83 years old.

While mosses and lichens are common on the exposed cliff face, vascular plant cover is sparse, being generally restricted to the flat, exposed bedrock at the upper edge of the cliff (the lip), in cracks and joints in the cliff face, on ledges, and along the cliff base. The upper edge of the cliff is backed by boreal forest, with abundant windthrown trees resulting from strong lake winds. Vegetation is primarily restricted to the upper portion of the cliff face.



The lower portion of the volcanic lakeshore cliff is bare of vegetation due to wave splash and ice scour. Photo by Jesse M. Lincoln.



Manitou Island volcanic lakeshore cliff delineated in yellow on 2022 imagery.

Characteristic herbaceous species (2-4%) include harebell (*Campanula rotundifolia*), wormwood (*Artemisia campestris*), yarrow (*Achillea millefolium*), dwarf raspberry (*Rubus pubescens*), fragile fern (*Cystopteris tenuis*), woodland strawberry (*Fragaria vesca*), king devil (*Hieracium caespitosum*), hairy rock cress (*Arabis pycnocarpa*), wild-basil (*Clinopodium vulgare*), and wild columbine (*Aquilegia canadensis*). In addition, numerous rare species occur along the cliff and include downy oatgrass (*Trisetum spicatum*, State Special Concern), alpine bistort (*Bistorta vivipara*, State Threatened), and rock whitlow grass (*Draba arabisans*, State Special Concern).

The low shrub layer is locally dense at the top of the cliff with areas of continuous bearberry (*Arctostaphylos uva-ursi*) carpets. Elsewhere, low shrub coverage is sparse (1-2%) with bush honeysuckle (*Diervilla lonicera*), soapberry (*Shepherdia canadensis*), thimbleberry (*Rubus parviflorus*), wild rose (*Rosa acicularis*), red honeysuckle (*Lonicera dioica*), shadbush serviceberry (*Amelanchier spicata*), and seedling northern white-cedar, balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), and quaking aspen (*Populus tremuloides*).

Tall shrubs and tree saplings (1-2%) occurring along the upper lip include shadbush serviceberry, choke cherry (*Prunus virginiana*), northern white-cedar, and paper birch. Scattered canopy (<1%) northern white-cedar and paper birch occur along the cliff margin. An open-canopied stand of northern white-cedar, paper birch, mountain-ash (*Sorbus decora*), and balsam fir (*Abies balsamea*) form the coastal boreal forest along the edge of the cliff. Non-native species occur locally along the upper lip of the cliff, especially in the eastern portion towards the lighthouse. These include Canada bluegrass (*Poa compressa*), mullein (*Verbascum thapsus*), silvery cinquefoil (*Potentilla argentea*), white clover (*Trifolium repens*), red-seeded dandelion (*Taraxacum erythrospermum*), thyme-leaved sandwort (*Arenaria serpyllifolia*), king devil, field scorpion-grass (*Myosotis arvensis*), corn speedwell (*Veronica arvensis*), and ox-eye daisy (*Leucanthemum vulgare*).



Manitou Island volcanic lakeshore cliff. Photos by Joshua G. Cohen.



The Manitou Island lakeshore cliff was surveyed August 21<sup>st</sup>, 2023. Forty-five plant species were documented with 35 native species and 10 non-native species (Appendix 2.9). The total FQI was 21.5.

**Threats:** Species composition and structure are patterned by natural processes. The remote nature of Manitou Island limits anthropogenic disturbance to the island. Foot traffic is limited, seasonal, and concentrated along the shoreline near the light house and near the boat dock. Infrequent hikers explore portions of the upper lip of the cliff. Volcanic lakeshore cliff is a disturbance prone community and as such is extremely susceptible to invasive species, despite the remote nature of the island.

Impacts of clearing around the lighthouse have caused a localized dominance of invasive species in the eastern end of the cliffs especially. In addition, a pulse of non-native species occurs along the upper margin of the western end of the cliffs where boreal forest has recently burned. Non-native species documented along the upper margins of the cliff include Canada bluegrass, mullein, silvery cinquefoil, white clover, red-seeded dandelion, thyme-leaved sandwort, king devil, field scorpion-grass, corn speedwell, and ox-eye daisy.

**Management Recommendations:** The main management recommendations are to retain an intact buffer of natural communities surrounding the cliffs, evaluate the control of invasive species, and monitor any control efforts. Efforts to control invasive species should implemented with extreme care. Substantial risk for collateral damage exists since non-native species are locally dominant and the cliffs support several concentrations of rare species. Any control efforts should be executed by individuals trained on the identification of rare species and carefully monitored.



Harebell (*Campanula rotundifolia*) growing from a crevice in the vertical face of the volcanic lakeshore cliff. Photo by Joshua G. Cohen.

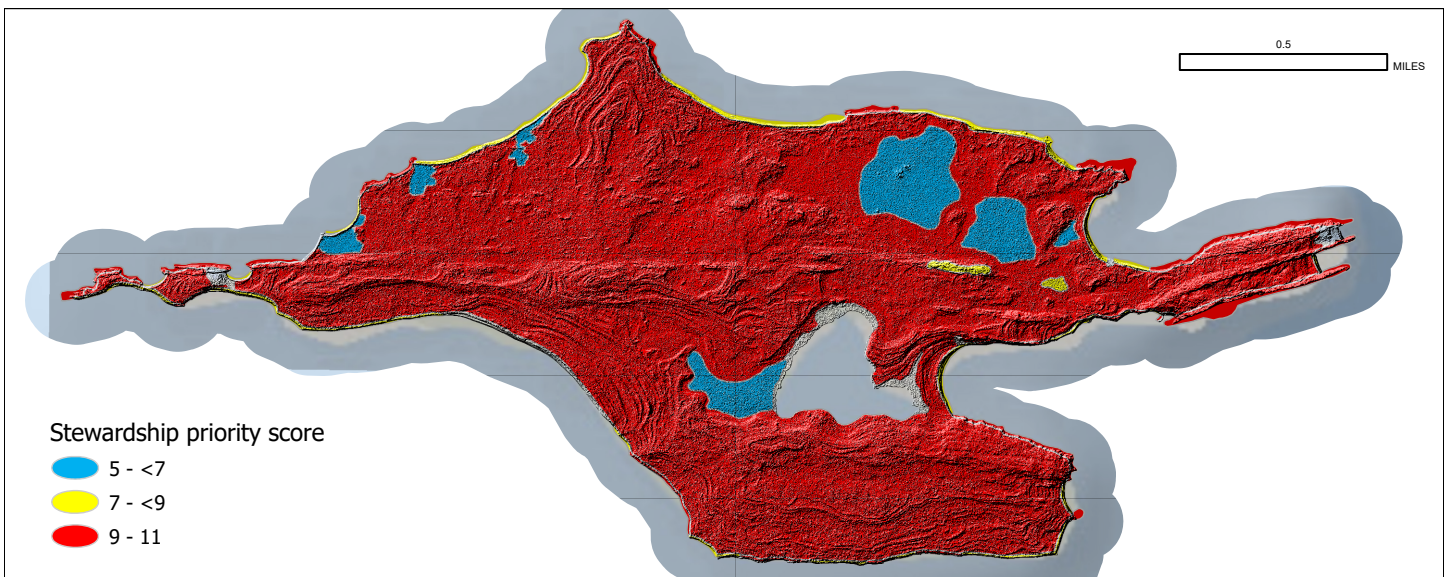
# Stewardship Prioritization Results

The stewardship prioritization scores for each natural community element occurrence from Manitou Island are presented in Table 2 and graphically displayed in Figure 6. We sorted the element occurrences by their stewardship prioritization scores and assigned them a high ( $\geq 9$ ; red), medium (7 and  $< 9$ ; yellow), or low ( $< 7$ ; blue) stewardship priority. The highest ranking natural community element occurrence for stewardship intervention on Manitou

Island is the volcanic lakeshore cliff. Volcanic lakeshore cliff is a Great Lakes endemic natural community type and this example is characterized by high native diversity and integrity threatened by localized non-native species infestations. Additional natural community element occurrences that ranked as the highest priority for stewardship included the volcanic bedrock lakeshore and the boreal forest.

**Table 2.** Stewardship prioritization for natural community element occurrences (EOs) on Manitou Island. EOs are sorted by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

EO ID	Natural Community	EO Rank	Ecological Integrity Index	Gobal Rank	Global Rank Score	State Rank	State Rank Score	Rarity Index	Threat Severity	Treatment Feasibility	Threat Index	Stewardship Priority Score
12518	Volcanic Lakeshore Cliff	AB	4.5	GU	-	S1	5	5	2	1	1.5	11
9280	Volcanic Bedrock Lakeshore	A	5	G4G5	1.5	S2	4	2.75	2	3	2.5	10.25
27087	Boreal Forest	AB	4.5	GU	-	S3	3	3	2	3	2.5	10
27093	Volcanic Cobble Shore	A	5	G4G5	1.5	S2	4	2.75	1	1	1	8.75
27092	Volcanic Bedrock Glade	BC	3.5	GU	-	S2	4	4	1	1	1	8.5
27088	Poor Fen	B	4	G3	3	S3	3	3	2	1	1.5	8.5
27091	Poor Conifer Swamp	B	4	G4	2	S4	2	2	-	-	0	6
27089	Northern Wet Meadow	B	4	G4G5	1.5	S4	2	1.75	-	-	0	5.75
27090	Northern Shrub Thicket	B	4	G4	2	S5	1	1.5	-	-	0	5.5



**Figure 6.** Stewardship prioritization for natural community element occurrences on Manitou Island. Element occurrences are displayed by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority. The volcanic lakeshore cliff, volcanic bedrock lakeshore, and boreal forest had the highest stewardship prioritization scores. We recommend focusing stewardship efforts in these natural communities and also targeting invasive species control along trails, around the lighthouse, and in recently burned boreal forest along the eastern end of the island.



Treating non-native species infestations along the volcanic lakeshore cliff and recently burned boreal forest are high stewardship priorities for Manitou Island. Photo by Jesse M. Lincoln.



The volcanic bedrock lakeshore on Manitou Island ranked as a high stewardship priority. This site represents a Great Lakes endemic natural community type and is characterized by high native biodiversity and integrity threatened by non-native species. Photo by Jesse M. Lincoln.

## Discussion

Manitou Island was first surveyed by MNFI ecologists in 1996 (Marr et al. 2009) and again in 2007 (Cohen et al. 2009). Both survey efforts focused on the shoreline ecosystems with the survey in 2007 being restricted to a boat due to weather conditions. The initial surveys resulted in the mapping of the volcanic bedrock lakeshore and the volcanic lakeshore cliff. The 2023 surveys updated these element occurrences and also documented seven additional new element occurrences. The 2023 surveys of Manitou Island represent MNFI's first surveys that targeted both the shoreline and interior of the island. The comparison of these past surveys to our current survey effort emphasizes the importance of continued evaluation of ecological assets and the benefit of refining mapping using current technologies and imagery. Furthermore, up-to-date surveys are requisite for evaluating current threats and informing biodiversity management.

The framework for stewardship prioritization presented in this report offers a method for targeting biodiversity management. This method could be refined to suit the specific and local needs of resource agencies. This stewardship prioritization could also be refined within broader ecological or political regions such as ecological subsection, county, or all islands across Lake Superior. In addition, other indices could be incorporated into the stewardship prioritization matrix. Additional indices to consider incorporating include indices that incorporate the presence of rare species, priority wildlife species, culturally significant sites, and the functionality of the landscape surrounding the site.

Manitou Island provides a critical learning environment where ecologists can study pattern and process to inform ecosystem management and conservation design. In the absence of shoreline development (e.g., breakwaters, jetties, and residences) dynamic coastal ecosystems on Manitou Island can change in spatial extent, floristic composition, and vegetative structure as the Great Lakes water levels fluctuate. The long-term conservation of Great Lakes coastal ecosystems depends on their capacity to change through time and space.

Across the Great Lakes region, natural habitats are declining due to habitat destruction and are eroding in ecological integrity due to habitat fragmentation. Threats associated with habitat fragmentation include invasive species infestation, deer herbivory, predation by mesopredators, and fire suppression. Great Lakes islands, especially uninhabited ones like Manitou Island, provide unique and essential refuges for native biodiversity. Though these islands face less pressure from habitat destruction and fragmentation, they are still susceptible to the threats prevalent on the mainland. Biodiversity stewardship actions within these isolated and less disturbed settings have a high likelihood of success if they are prompt and decisive. Implementation of stewardship efforts within these remote locations will need to be followed by monitoring to gauge the success of biodiversity management efforts and refine future stewardship prioritization efforts.



Manitou Island poor fen. Photo by Jesse M. Lincoln.



## Conclusion

Through this project we evaluated the ecological integrity of high-quality natural communities on Manitou Island. We updated 2 element occurrences (volcanic bedrock lakeshore and volcanic lakeshore cliff) and documented 7 new element occurrences (boreal forest, northern shrub thicket, northern wet meadow, poor conifer swamp, poor fen, volcanic bedrock glade, and volcanic cobble shore). The Manitou Island volcanic lakeshore cliff is one of four examples of the community type in Michigan. The site supports populations of three rare plant species and was last surveyed on foot in 1996. We observed serious infestations of non-native species along the top of the cliff, illustrating the importance of ongoing survey efforts on Great Lakes islands.

This report provides site-based assessments of these nine natural community element occurrences. Threats, management needs, and restoration opportunities specific

to each individual site have been discussed. The baseline information presented in the report provides resource managers with an ecological foundation for prescribing site-level biodiversity stewardship, monitoring these management activities, and implementing landscape-level biodiversity planning to prioritize management efforts. The framework for prioritizing stewardship and monitoring efforts across sites will help facilitate difficult decisions regarding the distribution of finite stewardship resources for site-based management. Based on our stewardship prioritization framework we recommend focusing invasive plant species control efforts on volcanic lakeshore cliff, volcanic bedrock lakeshore, and within the boreal forest at the eastern end of the island along trails, around the lighthouse, and near the dock. Finally, we emphasize the importance of long-term monitoring to help inform adaptive management and future stewardship priorities.



Manitou Island supports numerous Great Lakes endemic natural communities including volcanic bedrock lakeshore and volcanic lakeshore cliff. Biodiversity stewardship actions on Manitou Island have a high likelihood of success. We recommend prioritizing invasive species control within the island's volcanic bedrock lakeshore, volcanic lakeshore cliffs, and boreal forest. Photo by Joshua G. Cohen

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Volcanic lakeshore cliff and boreal forest occurring along the eastern end of Manitou Island. Photo by Jesse M. Lincoln.

# Appendix 1 - Global and State Element Ranking Criteria

## GLOBAL RANKS

- G1** = critically imperiled: at very high risk of extinction due to extreme rarity (often 5 or fewer occurrences), very steep declines, or other factors.
- G2** = imperiled: at high risk of extinction due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors.
- G3** = vulnerable: at moderate risk of extinction due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors.
- G4** = apparently secure: uncommon but not rare; some cause for long-term concern due to declines or other factors.
- G5** = secure: common; widespread.
- GNR** = Global rank not yet assessed. Unranked.
- GU** = currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
- GX** = eliminated: eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
- G?** = incomplete data.

## STATE RANKS

- S1** = critically imperiled in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state.
- S2** = imperiled in the state because of rarity due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state.
- S3** = vulnerable in the state due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
- S4** = uncommon but not rare; some cause for long-term concern due to declines or other factors.
- S5** = common and widespread in the state.
- SNR** = State rank not yet assessed. Unranked.
- SX** = community is presumed to be extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
- S?** = incomplete data.

## Appendix 2 - Floristic Quality Assessments

For each high-quality natural community, floristic data were compiled into the Universal Floristic Quality Assessment Calculator (Reznicek et al. 2014, Freyman et al. 2016) to determine the Floristic Quality Index (FQI) for each natural community element occurrence. The floristic quality assessment is derived from a mean coefficient of conservatism and floristic quality index. Each native species is assigned a coefficient of conservatism, a value of 0 to 10 based on probability of its occurrence in a natural versus degraded habitat. Species restricted to a specialized or undisturbed habitat are assigned a value of 10, implying the species has extremely strong fidelity to a specific habitat. Native species that are not particular or indicative of natural conditions are assigned a low value of 0 or 1. The coefficient of conservatism is determined by experts on the flora of a region, and so may vary for a given plant species from region to region. We employed a regionally appropriate FQA for Michigan (Reznicek et al. 2014). From the total list of plant species for an area, a mean C value is calculated and then multiplied by the square root of the total number of plant species to calculate the FQI. In addition, each species is assigned a coefficient of wetness (W) based on its affinity to wetland or upland habitat. Michigan sites with an FQI of 35 or greater possess sufficient conservatism and richness that they are considered floristically important from a statewide perspective (Herman et al. 2001). FQI scores greater than 50 indicate exceptional sites with extremely high conservation value (Herman et al. 2001).

For each high-quality natural community element occurrence, we generated a floristic quality assessment (FQA). The FQA includes a comprehensive list of the species documented in the element occurrence along with each species' C and W values. In addition, for each site we present the accompanying conservatism-based metrics, species richness, species wetness, physiognomy metrics, and duration metrics. Within the plant lists for each natural community element occurrence, non-native species have been highlighted in bold.

We used the Michigan FQA (Reznicek et al. 2014) and nomenclature within the species lists follows Michigan Flora (Voss and Reznicek 2012). We provide a crosswalk of Ojibwe names to scientific and common names in Appendix 3 for all plant species observed on Manitou Island that are listed in "Plants used by the Great Lakes Ojibwa" (Meeker et al. 1993).

## Appendix 2.1. Manitou Island Boreal Forest FQA

### Conservatism-Based Metrics:

Total Mean C:	4.2
Native Mean C:	4.6
Total FQI:	29.4
Native FQI:	30.9
Adjusted FQI:	44.1
% C value 0:	8.2
% C value 1-3:	26.5
% C value 4-6:	53.1
% C value 7-10:	12.2
Native Tree Mean C:	3.5
Native Shrub Mean C:	4.9
Native Herbaceous Mean C:	4.9

### Species Richness:

Total Species:	49	
Native Species:	45	91.80%
Non-native Species:	4	8.20%

### Species Wetness:

Mean Wetness:	0.8
Native Mean Wetness:	0.6

### Physiognomy Metrics:

Tree:	11	22.40%
Shrub:	15	30.60%
Vine:	0	0.00%
Forb:	20	40.80%
Grass:	0	0.00%
Sedge:	0	0.00%
Rush:	0	0%
Fern:	3	6.10%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	1	2.00%
Perennial:	47	95.90%
Biennial:	1	2.00%
Native Annual:	0	0.00%
Native Perennial:	45	91.80%
Native Biennial:	0	0.00%

## Appendix 2.1. Manitou Island Boreal Forest FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Acer spicatum</i>	mountain maple	ACESPI	native	5	3
<i>Achillea millefolium</i>	yarrow	ACHMIL	native	1	3
<i>Alnus incana; a. rugosa</i>	speckled alder	ALNINC	native	5	-3
<i>Anaphalis margaritacea</i>	pearly everlasting	ANAMAR	native	3	5
<i>Aralia nudicaulis</i>	wild sarsaparilla	ARANUD	native	5	3
<i>Arctostaphylos uva-ursi</i>	bearberry	ARCUVA	native	8	5
<b><i>Arenaria serpyllifolia</i></b>	<b>thyme-leaved sandwort</b>	<b>ARESER</b>	<b>non-native</b>	<b>0</b>	<b>0</b>
<i>Athyrium filix-femina</i>	lady fern	ATHFIL	native	4	0
<i>Betula alleghaniensis</i>	yellow birch	BETALL	native	7	0
<i>Betula papyrifera</i>	paper birch	BETPAP	native	2	3
<i>Chamerion angustifolium; epilobium a.</i>	fireweed	CHAANG	native	3	0
<i>Circaea alpina</i>	small enchanters-nightshade	CIRALP	native	4	-3
<i>Clintonia borealis</i>	bluebead-lily; corn-lily	CLIBOR	native	5	0
<i>Coptis trifolia</i>	goldthread	COPTRI	native	5	-3
<i>Cornus canadensis</i>	bunchberry	CORCAA	native	6	0
<i>Cornus rugosa</i>	round-leaved dogwood	CORRUG	native	6	5
<i>Cornus sericea; c. stolonifera</i>	red-osier	CORSER	native	2	-3
<i>Diervilla lonicera</i>	bush-honeysuckle	DIELON	native	4	5
<i>Dryopteris carthusiana</i>	spinulose woodfern	DRYCAR	native	5	-3
<i>Dryopteris expansa</i>	expanded woodfern	DRYEXP	native	9	0
<i>Galium tinctorium</i>	stiff bedstraw	GALTIN	native	5	-5
<i>Goodyera repens</i>	creeping rattlesnake plantain	GOOREP	native	9	0
<i>Heracleum maximum</i>	cow-parsnip	HERMAX	native	3	-3
<b><i>Hieracium caespitosum</i></b>	<b>king devil</b>	<b>HIECAE</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<b><i>Leucanthemum vulgare; chrysanthemum leucanthemum</i></b>	<b>ox-eye daisy</b>	<b>LEUVUL</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Linnaea borealis</i>	twinflower	LINBOR	native	6	0
<i>Lonicera canadensis</i>	canadian fly honeysuckle	LONCAN	native	5	3
<i>Maianthemum canadense</i>	canada mayflower	MAICAN	native	4	3
<b><i>Myosotis arvensis</i></b>	<b>field scorpion-grass</b>	<b>MYOARV</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Oxalis acetosella</i>	northern wood-sorrel	OXAACE	native	7	3
<i>Physocarpus opulifolius</i>	ninebark	PHYOPU	native	4	-3
<i>Picea glauca</i>	white spruce	PICGLA	native	3	3
<i>Pinus strobus</i>	white pine	PINSTR	native	3	3
<i>Populus tremuloides</i>	quaking aspen	POPTRE	native	1	0
<i>Prunus pensylvanica</i>	pin cherry	PRUPEN	native	3	3
<i>Prunus virginiana</i>	choke cherry	PRUVIR	native	2	3
<i>Ranunculus hispidus</i>	swamp buttercup	RANHIS	native	5	0
<i>Rosa acicularis</i>	wild rose	ROSACI	native	4	3
<i>Rubus parviflorus</i>	thimbleberry	RUBPAR	native	6	3
<i>Rubus pubescens</i>	dwarf raspberry	RUBPUB	native	4	-3
<i>Sambucus racemosa</i>	red-berried elder	SAMRAC	native	3	3
<i>Sorbus americana</i>	american mountain-ash	SORAME	native	4	0
<i>Sorbus decora</i>	mountain-ash	SORDEC	native	4	3
<i>Taxus canadensis</i>	yew	TAXCAN	native	5	3
<i>Thuja occidentalis</i>	arbor vitae	THUOCC	native	4	-3
<i>Trientalis borealis</i>	star-flower	TRIBOR	native	5	0
<i>Viburnum edule</i>	squashberry	VIBEDU	native	10	-3
<i>Viola macloskeyi</i>	smooth white violet	VIOMAC	native	6	-5

## Appendix 2.2. Manitou Island Northern Shrub Thicket FQA

### Conservatism-Based Metrics:

Total Mean C:	4.9
Native Mean C:	4.9
Total FQI:	31.4
Native FQI:	31.4
Adjusted FQI:	49
% C value 0:	0
% C value 1-3:	29.3
% C value 4-6:	51.2
% C value 7-10:	19.5
Native Tree Mean C:	3.2
Native Shrub Mean C:	4.8
Native Herbaceous Mean C:	5.2

### Species Richness:

Total Species:	41	
Native Species:	41	100.00%
Non-native Species:	0	0.00%

### Species Wetness:

Mean Wetness:	-3
Native Mean Wetness:	-3

### Physiognomy Metrics:

Tree:	5	12.20%
Shrub:	6	14.60%
Vine:	1	2.40%
Forb:	21	51.20%
Grass:	2	4.90%
Sedge:	3	7.30%
Rush:	0	0%
Fern:	3	7.30%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	1	2.40%
Perennial:	40	97.60%
Biennial:	0	0.00%
Native Annual:	1	2.40%
Native Perennial:	40	97.60%
Native Biennial:	0	0.00%



**Appendix 2.2.** Manitou Island Northern Shrub Thicket FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Acer rubrum</i>	red maple	ACERUB	native	1	0
<i>Alnus incana; a. rugosa</i>	speckled alder	ALNINC	native	5	-3
<i>Betula papyrifera</i>	paper birch	BETPAP	native	2	3
<i>Calamagrostis canadensis</i>	blue-joint	CALCAN	native	3	-5
<i>Caltha palustris</i>	marsh-marigold	CALPAR	native	6	-5
<i>Campanula aparinoides</i>	marsh bellflower	CAMAPA	native	7	-5
<i>Carex brunnescens</i>	sedge	CXBRUN	native	5	-3
<i>Carex intumescens</i>	sedge	CXINTU	native	3	-3
<i>Carex pseudo-cyperus</i>	sedge	CXPSEU	native	5	-5
<i>Chelone glabra</i>	turtlehead	CHEGLB	native	7	-5
<i>Coptis trifolia</i>	goldthread	COPTRI	native	5	-3
<i>Cornus sericea; c. stolonifera</i>	red-osier	CORSER	native	2	-3
<i>Galium asprellum</i>	rough bedstraw	GALASP	native	5	-5
<i>Galium trifidum</i>	small bedstraw	GALTRD	native	6	-3
<i>Gaultheria hispidula</i>	creeping-snowberry	GAUHIS	native	8	-3
<i>Glyceria canadensis</i>	rattlesnake grass	GLYCAN	native	8	-5
<i>Impatiens capensis</i>	spotted touch-me-not	IMPCAP	native	2	-3
<i>Iris versicolor</i>	wild blue flag	IRIVER	native	5	-5
<i>Lycopus americanus</i>	common water horehound	LYCAME	native	2	-5
<i>Lycopus uniflorus</i>	northern bugle weed	LYCUNI	native	2	-5
<i>Lysimachia terrestris</i>	swamp-candles	LYSTER	native	6	-5
<i>Maianthemum canadense</i>	canada mayflower	MAICAN	native	4	3
<i>Maianthemum trifolium; smilacina t.</i>	false mayflower	MAITRI	native	10	-5
<i>Mentha canadensis; m. arvensis</i>	wild mint	MENCAS	native	3	-3
<i>Menyanthes trifoliata</i>	buckbean	MENTRI	native	8	-5
<i>Osmunda regalis</i>	royal fern	OSMREG	native	5	-5
<i>Picea mariana</i>	black spruce	PICMAR	native	6	-3
<i>Platanthera dilatata; habenaria d.</i>	tall white bog orchid	PLADIL	native	10	-5
<i>Ranunculus hispidus</i>	swamp buttercup	RANHIS	native	5	0
<i>Ribes glandulosum</i>	skunk currant	RIBGLA	native	5	-3
<i>Rubus pubescens</i>	dwarf raspberry	RUBPUB	native	4	-3
<i>Rumex orbiculatus</i>	great water dock	RUMORB	native	9	-5
<i>Scutellaria galericulata</i>	marsh skullcap	SCUGAL	native	5	-5
<i>Sorbus decora</i>	mountain-ash	SORDEC	native	4	3
<i>Spinulum annotinum; lycopodium a.</i>	stiff clubmoss	SPIANN	native	5	0
<i>Symphotrichum puniceum; aster p.</i>	swamp aster	SYMPUN	native	5	-5
<i>Symplocarpus foetidus</i>	skunk-cabbage	SYMFOE	native	6	-5
<i>Taxus canadensis</i>	yew	TAXCAN	native	5	3
<i>Thalictrum dasycarpum</i>	purple meadow-rue	THADAS	native	3	-3
<i>Thelypteris palustris</i>	marsh fern	THEPAL	native	2	-3

## Appendix 2.3. Manitou Island Northern Wet Meadow FQA

### Conservatism-Based Metrics:

Total Mean C:	6.1
Native Mean C:	6.1
Total FQI:	35.6
Native FQI:	35.6
Adjusted FQI:	61
% C value 0:	0
% C value 1-3:	8.8
% C value 4-6:	50
% C value 7-10:	41.2
Native Tree Mean C:	5
Native Shrub Mean C:	6.1
Native Herbaceous Mean C:	6.2

### Species Richness:

Total Species:	34
Native Species:	34 100.00%
Non-native Species:	0 0.00%

### Species Wetness:

Mean Wetness:	-4.3
Native Mean Wetness:	-4.3

### Physiognomy Metrics:

Tree:	2	5.90%
Shrub:	8	23.50%
Vine:	0	0.00%
Forb:	19	55.90%
Grass:	2	5.90%
Sedge:	3	8.80%
Rush:	0	0%
Fern:	0	0.00%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	0	0.00%
Perennial:	34	100.00%
Biennial:	0	0.00%
Native Annual:	0	0.00%
Native Perennial:	34	100.00%
Native Biennial:	0	0.00%

### Appendix 2.3. Manitou Island Northern Wet Meadow FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Alnus incana; a. rugosa</i>	speckled alder	ALNINC	native	5	-3
<i>Andromeda glaucophylla</i>	bog-rosemary	ANDGLA	native	10	-5
<i>Calamagrostis canadensis</i>	blue-joint	CALCAN	native	3	-5
<i>Campanula aparinoides</i>	marsh bellflower	CAMAPA	native	7	-5
<i>Carex lasiocarpa</i>	sedge	CXLASI	native	8	-5
<i>Carex vesicaria</i>	sedge	CXVESI	native	7	-5
<i>Chamaedaphne calyculata</i>	leatherleaf	CHACAL	native	8	-5
<i>Chelone glabra</i>	turtlehead	CHEGLB	native	7	-5
<i>Cicuta bulbifera</i>	water hemlock	CICBUL	native	5	-5
<i>Comarum palustre; potentilla p.</i>	marsh cinquefoil	COMPAL	native	7	-5
<i>Cornus sericea; c. stolonifera</i>	red-osier	CORSER	native	2	-3
<i>Doellingeria umbellata; aster u.</i>	flat-topped white aster	DOEUMB	native	5	-3
<i>Eriophorum angustifolium</i>	narrow-leaved cotton-grass	ERIANG	native	10	-5
<i>Galium tinctorium</i>	stiff bedstraw	GALTIN	native	5	-5
<i>Glyceria canadensis</i>	rattlesnake grass	GLYCAN	native	8	-5
<i>Ilex mucronata; nemopanthus m.</i>	mountain holly	ILEMUC	native	7	-5
<i>Iris versicolor</i>	wild blue flag	IRIVER	native	5	-5
<i>Lycopus uniflorus</i>	northern bugle weed	LYCUNI	native	2	-5
<i>Lysimachia terrestris</i>	swamp-candles	LYSTER	native	6	-5
<i>Maianthemum canadense</i>	canada mayflower	MAICAN	native	4	3
<i>Maianthemum trifolium; smilacina t.</i>	false mayflower	MAITRI	native	10	-5
<i>Menyanthes trifoliata</i>	buckbean	MENTRI	native	8	-5
<i>Picea mariana</i>	black spruce	PICMAR	native	6	-3
<i>Platanthera dilatata; habenaria d.</i>	tall white bog orchid	PLADIL	native	10	-5
<i>Rosa palustris</i>	swamp rose	ROSPAL	native	5	-5
<i>Rubus pubescens</i>	dwarf raspberry	RUBPUB	native	4	-3
<i>Salix pedicellaris</i>	bog willow	SALPED	native	8	-5
<i>Scutellaria lateriflora</i>	mad-dog skullcap	SCULAT	native	5	-5
<i>Sium suave</i>	water-parsnip	SIUSUA	native	5	-5
<i>Symphotrichum puniceum; aster p.</i>	swamp aster	SYMPUN	native	5	-5
<i>Thuja occidentalis</i>	arbor vitae	THUOCC	native	4	-3
<i>Triadenum fraseri</i>	marsh st. johns-wort	TRIFRA	native	6	-5
<i>Trientalis borealis</i>	star-flower	TRIBOR	native	5	0
<i>Viola macloskeyi</i>	smooth white violet	VIOMAC	native	6	3

## Appendix 2.4. Manitou Island Poor Conifer Swamp FQA

### Conservatism-Based Metrics:

Total Mean C:	6.4
Native Mean C:	6.4
Total FQI:	32.6
Native FQI:	32.6
Adjusted FQI:	64
% C value 0:	0
% C value 1-3:	11.5
% C value 4-6:	46.2
% C value 7-10:	42.3
Native Tree Mean C:	4
Native Shrub Mean C:	6.9
Native Herbaceous Mean C:	7.4

### Species Richness:

Total Species:	26	
Native Species:	26	100.00%
Non-native Species:	0	0.00%

### Species Wetness:

Mean Wetness:	-2.5
Native Mean Wetness:	-2.5

### Physiognomy Metrics:

Tree:	6	23.10%
Shrub:	10	38.50%
Vine:	0	0.00%
Forb:	6	23.10%
Grass:	1	3.80%
Sedge:	3	11.50%
Rush:	0	0%
Fern:	0	0.00%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	0	0.00%
Perennial:	26	100.00%
Biennial:	0	0.00%
Native Annual:	0	0.00%
Native Perennial:	26	100.00%
Native Biennial:	0	0.00%

## Appendix 2.4. Manitou Island Poor Conifer Swamp FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Alnus incana</i> ; <i>a. rugosa</i>	speckled alder	ALNINC	native	5	-3
<i>Betula papyrifera</i>	paper birch	BETPAP	native	2	3
<i>Calamagrostis canadensis</i>	blue-joint	CALCAN	native	3	-5
<i>Carex disperma</i>	sedge	CXDISP	native	10	-5
<i>Carex oligosperma</i>	sedge	CXOLIS	native	10	-5
<i>Carex pauciflora</i>	sedge	CXPAUC	native	10	-5
<i>Chamaedaphne calyculata</i>	leatherleaf	CHACAL	native	8	-5
<i>Coptis trifolia</i>	goldthread	COPTRI	native	5	-3
<i>Cypripedium acaule</i>	pink lady-slipper; moccasin flower	CYPACA	native	5	-3
<i>Drosera rotundifolia</i>	round-leaved sundew	DROROT	native	6	-5
<i>Gaultheria hispidula</i>	creeping-snowberry	GAUHIS	native	8	-3
<i>Ilex mucronata</i> ; <i>nemopanthus m.</i>	mountain holly	ILEMUC	native	7	-5
<i>Kalmia polifolia</i>	bog-laurel	KALPOL	native	10	-5
<i>Larix laricina</i>	tamarack	LARLAR	native	5	-3
<i>Maianthemum trifolium</i> ; <i>smilacina t.</i>	false mayflower	MAITRI	native	10	-5
<i>Picea mariana</i>	black spruce	PICMAR	native	6	-3
<i>Rhododendron groenlandicum</i> ; <i>ledum g.</i>	labrador-tea	RHOGRO	native	8	-5
<i>Rubus parviflorus</i>	thimbleberry	RUBPAR	native	6	3
<i>Sarracenia purpurea</i>	pitcher-plant	SARPUR	native	10	-5
<i>Sorbus decora</i>	mountain-ash	SORDEC	native	4	3
<i>Taxus canadensis</i>	yew	TAXCAN	native	5	3
<i>Thuja occidentalis</i>	arbor vitae	THUOCC	native	4	-3
<i>Trientalis borealis</i>	star-flower	TRIBOR	native	5	0
<i>Vaccinium angustifolium</i>	low sweet blueberry	VACANG	native	4	3
<i>Vaccinium oxycoccos</i>	small cranberry	VACOXY	native	8	-5

## Appendix 2.5. Manitou Island Poor Fen FQA

### Conservatism-Based Metrics:

Total Mean C:	6.8
Native Mean C:	6.8
Total FQI:	46.6
Native FQI:	46.6
Adjusted FQI:	68
% C value 0:	0
% C value 1-3:	8.5
% C value 4-6:	42.6
% C value 7-10:	48.9
Native Tree Mean C:	4.5
Native Shrub Mean C:	6.5
Native Herbaceous Mean C:	7.2

### Species Richness:

Total Species:	47	
Native Species:	47	100.00%
Non-native Species:	0	0.00%

### Species Wetness:

Mean Wetness:	-3.3
Native Mean Wetness:	-3.3

### Physiognomy Metrics:

Tree:	4	8.50%
Shrub:	11	23.40%
Vine:	0	0.00%
Forb:	18	38.30%
Grass:	3	6.40%
Sedge:	6	12.80%
Rush:	0	0%
Fern:	5	10.60%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	0	0.00%
Perennial:	47	100.00%
Biennial:	0	0.00%
Native Annual:	0	0.00%
Native Perennial:	47	100.00%
Native Biennial:	0	0.00%

## Appendix 2.5. Manitou Island Poor Fen FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Agrostis scabra</i> ; <i>a. hyemalis</i>	ticklegrass	AGRSCA	native	4	0
<i>Alnus incana</i> ; <i>a. rugosa</i>	speckled alder	ALNINC	native	5	-3
<i>Andromeda glaucophylla</i>	bog-rosemary	ANDGLA	native	10	-5
<i>Calamagrostis canadensis</i>	blue-joint	CALCAN	native	3	-5
<i>Calamagrostis stricta</i> ; <i>c. inexpansa</i> ; <i>c. lacustris</i>	narrow-leaved reedgrass	CALSTR	native	10	-3
<i>Calopogon tuberosus</i>	grass-pink	CALTUB	native	9	-5
<i>Carex lasiocarpa</i>	sedge	CXLASI	native	8	-5
<i>Carex leptalea</i>	sedge	CXLEPA	native	5	-5
<i>Carex livida</i>	sedge	CXLIVI	native	10	-5
<i>Chamaedaphne calyculata</i>	leatherleaf	CHACAL	native	8	-5
<i>Clintonia borealis</i>	bluebead-lily; corn-lily	CLIBOR	native	5	0
<i>Coptis trifolia</i>	goldthread	COPTRI	native	5	-3
<i>Cornus canadensis</i>	bunchberry	CORCAA	native	6	0
<i>Cornus sericea</i> ; <i>c. stolonifera</i>	red-osier	CORSER	native	2	-3
<i>Cypripedium reginae</i>	showy or queens lady-slipper	CYPREG	native	9	-3
<i>Doellingeria umbellata</i> ; <i>aster u.</i>	flat-topped white aster	DOEUMB	native	5	-3
<i>Equisetum palustre</i>	marsh horsetail	EQUPAL	native	8	-3
<i>Equisetum variegatum</i>	variegated scouring rush	EQUVAR	native	6	-3
<i>Eriophorum angustifolium</i>	narrow-leaved cotton-grass	ERIANG	native	10	-5
<i>Gaultheria hispidula</i>	creeping-snowberry	GAUHIS	native	8	-3
<i>Larix laricina</i>	tamarack	LARLAR	native	5	-3
<i>Linnaea borealis</i>	twinline	LINBOR	native	6	0
<i>Maianthemum trifolium</i> ; <i>smilacina t.</i>	false mayflower	MAITRI	native	10	-5
<i>Menyanthes trifoliata</i>	buckbean	MENTRI	native	8	-5
<i>Osmunda regalis</i>	royal fern	OSMREG	native	5	-5
<i>Picea mariana</i>	black spruce	PICMAR	native	6	-3
<i>Platanthera clavellata</i> ; <i>habenaria c.</i>	small green wood orchid	PLACLA	native	6	-3
<i>Platanthera dilatata</i> ; <i>habenaria d.</i>	tall white bog orchid	PLADIL	native	10	-5
<i>Pogonia ophioglossoides</i>	rose pogonia	POGOPH	native	10	-5
<i>Pyrola americana</i> ; <i>p. rotundifolia</i>	round-leaved pyrola	PYRAME	native	7	0
<i>Rhododendron groenlandicum</i> ; <i>ledum g.</i>	labrador-tea	RHOGRO	native	8	-5
<i>Rubus pubescens</i>	dwarf raspberry	RUBPUB	native	4	-3
<i>Sarracenia purpurea</i>	pitcher-plant	SARPUR	native	10	-5
<i>Solidago uliginosa</i>	bog goldenrod	SOLULI	native	4	-5
<i>Spinulum annotinum</i> ; <i>lycopodium a.</i>	stiff clubmoss	SPIANN	native	5	0
<i>Taxus canadensis</i>	yew	TAXCAN	native	5	3
<i>Thelypteris palustris</i>	marsh fern	THEPAL	native	2	-3
<i>Thuja occidentalis</i>	arbor vitae	THUOCC	native	4	-3
<i>Triadenum fraseri</i>	marsh st. johns-wort	TRIFRA	native	6	-5
<i>Triantha glutinosa</i> ; <i>tofieldia g.</i>	false asphodel	TRIGLU	native	10	-5
<i>Trichophorum alpinum</i> ; <i>scirpus hudsonianus</i>	bulrush	TRIALP	native	10	-5
<i>Trichophorum cespitosum</i> ; <i>scirpus c.</i>	bulrush	TRICES	native	10	-5
<i>Trientalis borealis</i>	star-flower	TRIBOR	native	5	0
<i>Triglochin maritima</i>	common bog arrow-grass	TRIMAR	native	8	-5
<i>Vaccinium macrocarpon</i>	large cranberry	VACMAC	native	8	-5
<i>Vaccinium oxycoccos</i>	small cranberry	VACOXY	native	8	-5

## Appendix 2.6. Manitou Island Volcanic Bedrock Glade FQA

### Conservatism-Based Metrics:

Total Mean C:	4.1
Native Mean C:	4.3
Total FQI:	24.6
Native FQI:	25.1
Adjusted FQI:	41.8
% C value 0:	5.6
% C value 1-3:	30.6
% C value 4-6:	55.6
% C value 7-10:	8.3
Native Tree Mean C:	3.4
Native Shrub Mean C:	4.1
Native Herbaceous Mean C:	4.8

### Species Richness:

Total Species:	36	
Native Species:	34	94.40%
Non-native Species:	2	5.60%

### Species Wetness:

Mean Wetness:	2.7
Native Mean Wetness:	2.6

### Physiognomy Metrics:

Tree:	5	13.90%
Shrub:	13	36.10%
Vine:	1	2.80%
Forb:	9	25.00%
Grass:	3	8.30%
Sedge:	3	8.30%
Rush:	0	0%
Fern:	2	5.60%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	0	0.00%
Perennial:	35	97.20%
Biennial:	1	2.80%
Native Annual:	0	0.00%
Native Perennial:	34	94.40%
Native Biennial:	0	0.00%



**Appendix 2.6.** Manitou Island Volcanic Bedrock Glade FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Acer spicatum</i>	mountain maple	ACESPI	native	5	3
<i>Actaea pachypoda</i>	dolls-eyes	ACTPAC	native	7	5
<i>Agrostis scabra; a. hyemalis</i>	ticklegrass	AGRSCA	native	4	0
<i>Amelanchier interior</i>	serviceberry	AMEINT	native	4	5
<i>Amelanchier spicata</i>	shadbush serviceberry	AMESPI	native	4	3
<i>Aralia nudicaulis</i>	wild sarsaparilla	ARANUD	native	5	3
<i>Athyrium filix-femina</i>	lady fern	ATHFIL	native	4	0
<i>Betula papyrifera</i>	paper birch	BETPAP	native	2	3
<i>Carex arctata</i>	sedge	CXARTT	native	3	5
<i>Carex eburnea</i>	sedge	CXEBUR	native	7	3
<i>Carex umbellata</i>	sedge	CXUMBE	native	5	5
<i>Clinopodium vulgare</i>	wild-basil	CLIVUL	native	3	5
<i>Cornus canadensis</i>	bunchberry	CORCAA	native	6	0
<i>Cornus rugosa</i>	round-leaved dogwood	CORRUG	native	6	5
<i>Cornus sericea; c. stolonifera</i>	red-osier	CORSER	native	2	-3
<i>Diervilla lonicera</i>	bush-honeysuckle	DIELON	native	4	5
<i>Dryopteris expansa</i>	expanded woodfern	DRYEXP	native	9	0
<i>Epilobium ciliatum</i>	willow-herb	EPICIL	native	3	-3
<i>Eurybia macrophylla; aster m.</i>	big-leaved aster	EURMAC	native	4	5
<i>Fallopia cilinodis; polygonum c.</i>	fringed false buckwheat	FALCIL	native	3	5
<b><i>Hieracium caespitosum</i></b>	<b>king devil</b>	<b>HIECAE</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Linnaea borealis</i>	twinflower	LINBOR	native	6	0
<i>Lonicera canadensis</i>	canadian fly honeysuckle	LONCAN	native	5	3
<i>Maianthemum canadense</i>	canada mayflower	MAICAN	native	4	3
<b><i>Myosotis arvensis</i></b>	<b>field scorpion-grass</b>	<b>MYOARV</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Poa saltuensis</i>	bluegrass	POASAL	native	5	5
<i>Prunus pensylvanica</i>	pin cherry	PRUPEN	native	3	3
<i>Prunus virginiana</i>	choke cherry	PRUVIR	native	2	3
<i>Rosa acicularis</i>	wild rose	ROSACI	native	4	3
<i>Rubus parviflorus</i>	thimbleberry	RUBPAR	native	6	3
<i>Rubus strigosus</i>	wild red raspberry	RUBSTR	native	2	0
<i>Sambucus racemosa</i>	red-berried elder	SAMRAC	native	3	3
<i>Schizachne purpurascens</i>	false melic	SCHPUP	native	5	3
<i>Sorbus decora</i>	mountain-ash	SORDEC	native	4	3
<i>Taxus canadensis</i>	yew	TAXCAN	native	5	3

## Appendix 2.7. Manitou Island Volcanic Bedrock Lakeshore FQA

### Conservatism-Based Metrics:

Total Mean C:	4.8
Native Mean C:	5.2
Total FQI:	41.3
Native FQI:	42.9
Adjusted FQI:	49.8
% C value 0:	9.5
% C value 1-3:	28.4
% C value 4-6:	35.1
% C value 7-10:	27
Native Tree Mean C:	3.1
Native Shrub Mean C:	4.7
Native Herbaceous Mean C:	5.8

### Species Richness:

Total Species:	74	
Native Species:	68	91.90%
Non-native Species:	6	8.10%

### Species Wetness:

Mean Wetness:	0.8
Native Mean Wetness:	0.5

### Physiognomy Metrics:

Tree:	8	10.80%
Shrub:	16	21.60%
Vine:	0	0.00%
Forb:	36	48.60%
Grass:	7	9.50%
Sedge:	3	4.10%
Rush:	0	0%
Fern:	4	5.40%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	1	1.40%
Perennial:	71	95.90%
Biennial:	2	2.70%
Native Annual:	1	1.40%
Native Perennial:	65	87.80%
Native Biennial:	2	2.70%

## Appendix 2.7. Manitou Island Volcanic Bedrock Lakeshore FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Acer spicatum</i>	mountain maple	ACESPI	native	5	3
<i>Achillea millefolium</i>	yarrow	ACHMIL	native	1	3
<i>Agrostis scabra; a. hyemalis</i>	tickleggrass	AGRSCA	native	4	0
<i>Amelanchier spicata</i>	shadbush serviceberry	AMESPI	native	4	3
<i>Anaphalis margaritacea</i>	pearly everlasting	ANAMAR	native	3	5
<i>Aquilegia canadensis</i>	wild columbine	AQUCAN	native	5	3
<i>Arabis pycnocarpa; a. hirsuta</i>	hairy rock cress	ARAPYC	native	6	3
<i>Aralia nudicaulis</i>	wild sarsaparilla	ARANUD	native	5	3
<i>Arctostaphylos uva-ursi</i>	bearberry	ARCUVA	native	8	5
<i>Artemisia campestris</i>	wormwood	ARTCAM	native	5	5
<i>Betula papyrifera</i>	paper birch	BETPAP	native	2	3
<i>Bistorta vivipara; polygonum v.</i>	alpine bistort	BISVIV	native	10	-3
<i>Calamagrostis canadensis</i>	blue-joint	CALCAN	native	3	-5
<i>Campanula rotundifolia</i>	harebell	CAMROT	native	6	3
<i>Carex brunnescens</i>	sedge	CXBRUN	native	5	-3
<i>Carex livida</i>	sedge	CXLIVI	native	10	-5
<i>Carex umbellata</i>	sedge	CXUMBE	native	5	5
<i>Castilleja septentrionalis</i>	northern paintbrush	CASSEP	native	10	0
<i>Chamerion angustifolium; epilobium a.</i>	fireweed	CHAANG	native	3	0
<i>Cornus canadensis</i>	bunchberry	CORCAA	native	6	0
<i>Cornus rugosa</i>	round-leaved dogwood	CORRUG	native	6	5
<i>Cornus sericea; c. stolonifera</i>	red-osier	CORSER	native	2	-3
<i>Deschampsia cespitosa</i>	hair grass	DESCES	native	9	-3
<b><i>Dianthus barbatus</i></b>	<b>sweet william</b>	<b>DIABAR</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Diervilla lonicera</i>	bush-honeysuckle	DIELON	native	4	5
<i>Draba arabisans</i>	rock whitlow-grass	DRAARA	native	10	5
<i>Drymocallis arguta; potentilla a.</i>	tall or prairie cinquefoil	DRYARG	native	8	3
<i>Epilobium ciliatum</i>	willow-herb	EPICIL	native	3	-3
<i>Equisetum arvense</i>	common horsetail	EQUARV	native	0	0
<i>Euthamia graminifolia</i>	grass-leaved goldenrod	EUTGRA	native	3	0
<i>Fragaria vesca</i>	woodland strawberry	FRAVES	native	2	3
<i>Fragaria virginiana</i>	wild strawberry	FRAVIR	native	2	3
<i>Galium triflorum</i>	fragrant bedstraw	GALTRR	native	4	3
<i>Halenia deflexa</i>	spurred gentian	HALDEF	native	7	0
<b><i>Hieracium caespitosum</i></b>	<b>king devil</b>	<b>HIECAE</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Iris versicolor</i>	wild blue flag	IRIVER	native	5	-5
<b><i>Leucanthemum vulgare; chrysanthemum leucanthemum</i></b>	<b>ox-eye daisy</b>	<b>LEUVUL</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Linnaea borealis</i>	twinflower	LINBOR	native	6	0
<i>Lycopus americanus</i>	common water horehound	LYCAME	native	2	-5
<i>Maianthemum canadense</i>	canada mayflower	MAICAN	native	4	3
<i>Mitella nuda</i>	naked miterwort	MITNUD	native	8	-3
<i>Myrica gale</i>	sweet gale	MYRGAL	native	6	-5
<i>Onoclea sensibilis</i>	sensitive fern	ONOSEN	native	2	-3
<i>Packera paupercula; senecio p.; senecio plattensis</i>	balsam ragwort	PACPAU	native	3	0

Appendix 2.7. Manitou Island Volcanic Bedrock Lakeshore FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Physocarpus opulifolius</i>	ninebark	PHYOPU	native	4	-3
<i>Poa alpina</i>	alpine bluegrass	POAALP	native	10	3
<b><i>Poa compressa</i></b>	<b>canada bluegrass</b>	<b>POACOM</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Poa glauca</i>	bluegrass	POAGLA	native	10	5
<i>Polypodium virginianum</i>	common polypody	POLVIR	native	8	5
<i>Populus balsamifera</i>	balsam poplar	POPBAL	native	2	-3
<i>Populus tremuloides</i>	quaking aspen	POPTRE	native	1	0
<b><i>Potentilla argentea</i></b>	<b>silvery cinquefoil</b>	<b>POTARG</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Primula mistassinica</i>	birds-eye primrose	PRIMIS	native	10	-3
<i>Prunus virginiana</i>	choke cherry	PRUVIR	native	2	3
<b><i>Ranunculus acris</i></b>	<b>tall or common buttercup</b>	<b>RANACR</b>	<b>non-native</b>	<b>0</b>	<b>0</b>
<i>Rosa blanda</i>	wild rose	ROSBLA	native	3	3
<i>Rubus pubescens</i>	dwarf raspberry	RUBPUB	native	4	-3
<i>Rubus strigosus</i>	wild red raspberry	RUBSTR	native	2	0
<i>Salix humilis</i>	prairie willow	SALHUM	native	4	3
<i>Salix lucida</i>	shining willow	SALLUC	native	3	-3
<i>Shepherdia canadensis</i>	soapberry	SHECAN	native	7	5
<i>Sibbaldiopsis tridentata; potentilla t.</i>	three-toothed cinquefoil	SIBTRI	native	10	3
<i>Sisyrinchium montanum</i>	mountain blue-eyed-grass	SISMON	native	4	0
<i>Solidago simplex</i>	gillmans goldenrod	SOLSIM	native	10	3
<i>Sorbus americana</i>	american mountain-ash	SORAME	native	4	0
<i>Sorbus decora</i>	mountain-ash	SORDEC	native	4	3
<i>Streptopus lanceolatus; s. roseus</i>	rose twisted-stalk	STRLAN	native	5	3
<i>Thelypteris palustris</i>	marsh fern	THEPAL	native	2	-3
<i>Thuja occidentalis</i>	arbor vitae	THUOCC	native	4	-3
<i>Trisetum spicatum</i>	downy oatgrass	TRISPI	native	10	0
<i>Viburnum edule</i>	squashberry	VIBEDU	native	10	-3
<i>Viola nephrophylla</i>	northern bog violet	VIONEP	native	8	-3
<i>Xyris montana</i>	yellow-eyed-grass	XYRMON	native	10	-5

## Appendix 2.8. Manitou Island Volcanic Cobble Shore FQA

### Conservatism-Based Metrics:

Total Mean C:	3.9
Native Mean C:	4.1
Total FQI:	22.1
Native FQI:	22.8
Adjusted FQI:	40.4
% C value 0:	9.4
% C value 1-3:	37.5
% C value 4-6:	43.8
% C value 7-10:	9.4
Native Tree Mean C:	3.3
Native Shrub Mean C:	4.5
Native Herbaceous Mean C:	4

### Species Richness:

Total Species:	32	
Native Species:	30	96.90%
Non-native Species:	2	3.10%

### Species Wetness:

Mean Wetness:	0.5
Native Mean Wetness:	0.4

### Physiognomy Metrics:

Tree:	6	18.80%
Shrub:	13	40.60%
Vine:	2	6.30%
Forb:	8	25.00%
Grass:	2	6.30%
Sedge:	0	0.00%
Rush:	0	0%
Fern:	1	3.10%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	2	6.30%
Perennial:	29	90.60%
Biennial:	1	3.10%
Native Annual:	2	6.30%
Native Perennial:	29	90.60%
Native Biennial:	0	0.00%

## Appendix 2.8. Manitou Island Volcanic Cobble Shore FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Acer spicatum</i>	mountain maple	ACESPI	native	5	3
<i>Aralia nudicaulis</i>	wild sarsaparilla	ARANUD	native	5	3
<i>Betula papyrifera</i>	paper birch	BETPAP	native	2	3
<i>Calamagrostis canadensis</i>	blue-joint	CALCAN	native	3	-5
<i>Campanula rotundifolia</i>	harebell	CAMROT	native	6	3
<i>Chamerion angustifolium; epilobium a.</i>	fireweed	CHAANG	native	3	0
<i>Cornus canadensis</i>	bunchberry	CORCAA	native	6	0
<i>Cornus sericea; c. stolonifera</i>	red-osier	CORSER	native	2	-3
<i>Diervilla lonicera</i>	bush-honeysuckle	DIELON	native	4	5
<i>Euthamia graminifolia</i>	grass-leaved goldenrod	EUTGRA	native	3	0
<i>Impatiens capensis</i>	spotted touch-me-not	IMPCAP	native	2	-3
<i>Lathyrus japonicus</i>	beach pea	LATJAP	native	10	3
<i>Linnaea borealis</i>	twinflower	LINBOR	native	6	0
<i>Lonicera canadensis</i>	canadian fly honeysuckle	LONCAN	native	5	3
<i>Lonicera dioica</i>	red honeysuckle	LONDIO	native	5	3
<i>Osmunda regalis</i>	royal fern	OSMREG	native	5	-5
<b><i>Phalaris arundinacea</i></b>	<b>reed canary grass</b>	<b>PHAARU</b>	<b>non-native</b>	<b>0</b>	<b>-3</b>
<i>Physocarpus opulifolius</i>	ninebark	PHYOPU	native	4	-3
<i>Populus balsamifera</i>	balsam poplar	POPBAL	native	2	-3
<i>Potentilla norvegica</i>	rough cinquefoil	POTNOR	native	0	0
<i>Prunus virginiana</i>	choke cherry	PRUVIR	native	2	3
<i>Rosa acicularis</i>	wild rose	ROSACI	native	4	3
<i>Rubus parviflorus</i>	thimbleberry	RUBPAR	native	6	3
<i>Rubus strigosus</i>	wild red raspberry	RUBSTR	native	2	0
<i>Sambucus canadensis</i>	elderberry	SAMCAN	native	3	-3
<i>Sambucus racemosa</i>	red-berried elder	SAMRAC	native	3	3
<i>Shepherdia canadensis</i>	soapberry	SHECAN	native	7	5
<i>Sorbus decora</i>	mountain-ash	SORDEC	native	4	3
<i>Thuja occidentalis</i>	arbor vitae	THUOCC	native	4	-3
<b><i>Verbascum thapsus</i></b>	<b>common mullein</b>	<b>VERTHA</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Viburnum edule</i>	squashberry	VIBEDU	native	10	-3

## Appendix 2.9. Manitou Island Volcanic Lakeshore Cliff FQA

### Conservatism-Based Metrics:

Total Mean C:	3.2
Native Mean C:	4.1
Total FQI:	21.5
Native FQI:	24.3
Adjusted FQI:	36.2
% C value 0:	26.7
% C value 1-3:	28.9
% C value 4-6:	33.3
% C value 7-10:	11.1
Native Tree Mean C:	2.7
Native Shrub Mean C:	4.7
Native Herbaceous Mean C:	4.4

### Species Richness:

Total Species:	45	
Native Species:	35	77.80%
Non-native Species:	10	22.20%

### Species Wetness:

Mean Wetness:	2.4
Native Mean Wetness:	2.1

### Physiognomy Metrics:

Tree:	7	15.60%
Shrub:	9	20.00%
Vine:	1	2.20%
Forb:	24	53.30%
Grass:	3	6.70%
Sedge:	0	0.00%
Rush:	0	0%
Fern:	1	2.20%
Bryophyte:	0	0%

### Duration Metrics:

Annual:	4	8.90%
Perennial:	37	82.20%
Biennial:	4	8.90%
Native Annual:	2	4.40%
Native Perennial:	31	68.90%
Native Biennial:	2	4.40%

Appendix 2.9. Manitou Island Volcanic Lakeshore Cliff FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
<i>Abies balsamea</i>	balsam fir	ABIBAL	native	3	0
<i>Achillea millefolium</i>	yarrow	ACHMIL	native	1	3
<i>Agrostis scabra; a. hyemalis</i>	tickleggrass	AGRSCA	native	4	0
<i>Amelanchier spicata</i>	shadbush serviceberry	AMESPI	native	4	3
<i>Aquilegia canadensis</i>	wild columbine	AQUCAN	native	5	3
<i>Arabis pycnocarpa; a. hirsuta</i>	hairy rock cress	ARAPYC	native	6	3
<i>Aralia nudicaulis</i>	wild sarsaparilla	ARANUD	native	5	3
<i>Arctostaphylos uva-ursi</i>	bearberry	ARCUVA	native	8	5
<b><i>Arenaria serpyllifolia</i></b>	<b>thyme-leaved sandwort</b>	<b>ARESER</b>	<b>non-native</b>	<b>0</b>	<b>0</b>
<i>Artemisia campestris</i>	wormwood	ARTCAM	native	5	5
<i>Betula papyrifera</i>	paper birch	BETPAP	native	2	3
<i>Bistorta vivipara; polygonum v.</i>	alpine bistort	BISVIV	native	10	-3
<i>Campanula rotundifolia</i>	harebell	CAMROT	native	6	3
<i>Chamerion angustifolium; epilobium a.</i>	fireweed	CHAANG	native	3	0
<i>Clinopodium vulgare</i>	wild-basil	CLIVUL	native	3	5
<i>Conyza canadensis</i>	horseweed	CONCAN	native	0	3
<i>Cystopteris tenuis</i>	fragile fern	CYSTEN	native	5	5
<i>Diervilla lonicera</i>	bush-honeysuckle	DIELON	native	4	5
<i>Draba arabisans</i>	rock whitlow-grass	DRAARA	native	10	5
<i>Fragaria vesca</i>	woodland strawberry	FRAVES	native	2	3
<b><i>Hieracium caespitosum</i></b>	<b>king devil</b>	<b>HIECAE</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<b><i>Leucanthemum vulgare; chrysanthemum leucanthemum</i></b>	<b>ox-eye daisy</b>	<b>LEUVUL</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Lonicera dioica</i>	red honeysuckle	LONDIO	native	5	3
<b><i>Myosotis arvensis</i></b>	<b>field scorpion-grass</b>	<b>MYOARV</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Picea glauca</i>	white spruce	PICGLA	native	3	3
<b><i>Poa compressa</i></b>	<b>canada bluegrass</b>	<b>POACOM</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Populus balsamifera</i>	balsam poplar	POPBAL	native	2	-3
<i>Populus tremuloides</i>	quaking aspen	POPTRE	native	1	0
<b><i>Potentilla argentea</i></b>	<b>silvery cinquefoil</b>	<b>POTARG</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Potentilla norvegica</i>	rough cinquefoil	POTNOR	native	0	0
<i>Prunus virginiana</i>	choke cherry	PRUVIR	native	2	3
<i>Rosa acicularis</i>	wild rose	ROSACI	native	4	3
<i>Rosa blanda</i>	wild rose	ROSBLA	native	3	3
<i>Rubus parviflorus</i>	thimbleberry	RUBPAR	native	6	3
<i>Rubus pubescens</i>	dwarf raspberry	RUBPUB	native	4	-3
<i>Shepherdia canadensis</i>	soapberry	SHECAN	native	7	5
<i>Solidago canadensis</i>	canada goldenrod	SOLCAN	native	1	3
<i>Sorbus decora</i>	mountain-ash	SORDEC	native	4	3
<b><i>Taraxacum erythrospermum</i></b>	<b>red-seeded dandelion</b>	<b>TARERY</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<i>Thuja occidentalis</i>	arbor vitae	THUOCC	native	4	-3
<b><i>Trifolium repens</i></b>	<b>white clover</b>	<b>TRIREP</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Trisetum spicatum</i>	downy oatgrass	TRISPI	native	10	0
<b><i>Verbascum thapsus</i></b>	<b>common mullein</b>	<b>VERTHA</b>	<b>non-native</b>	<b>0</b>	<b>5</b>
<b><i>Veronica arvensis</i></b>	<b>corn speedwell</b>	<b>VERARV</b>	<b>non-native</b>	<b>0</b>	<b>3</b>
<i>Viola labradorica; v. conspersa</i>	dog violet	VIOLAB	native	3	0



## Appendix 3 - Ojibwe Names for Plants Observed on Manitou Island

This appendix includes a crosswalk between Ojibwe names, scientific names, and common English names for all plant species observed on Manitou Island that are listed in “Plants used by the Great Lakes Ojibwa” (Meeker et al. 1993). Within the crosswalk, when multiple Ojibwe names are known for the same plant, the Ojibwe names are separated by a semi-colon. Many names were originally documented by non-Ojibwe speakers and the spellings of some of the names were not restored by Ojibwe speakers so are reproduced here phonetically. We indicate whether or not a plant has been restored. Note that we do not reproduce accents (diacritical marks) for names included only under a phonetic name in Meeker et al. (1993) and this may affect pronunciation (for example, some “s” = “zh”). Multiple scientific names separated by semi-colons indicate closely related species we have crosswalked to a single Ojibwe name. The first scientific name listed is the species listed in Meeker et al. (1993). If Meeker et al. (1993) lists a synonym or only includes a closely related species, then the scientific name used in Meeker et al. (1993) is listed in parentheses (\*different but closely related species). Page numbers within the crosswalk indicate the page in Meeker et al. (1993) where the plant is referenced.

### Appendix 3. Crosswalk between Ojibwe names and scientific and English names

Ojibwe Name	Restored	Page	Scientific Name	English Name
(g)odotaagaans	Yes	318	<i>Clintonia borealis</i>	bluebead-lily; corn-lily
(g)odotaagaans; ?ziiginise; ziiginish€	Yes	35	<i>Campanula aparanoïdes</i> (*C. rotundifolia)	marsh bellflower
(g)odotaagaans; ?ziiginise; ziiginish€	Yes	35	<i>Campanula rotundifolia</i>	harebell
?bebaamaabiig; okaaadaak; waaboozojibik	Yes	235	<i>Aralia nudicaulis</i>	wild sarsaparilla
?wenabozhoo nookomis wiinizisan; ?nenzbozh ookomisan miinizisan	Yes	159	<i>Castilleja septentrionalis</i> (*C. coccinea)	northern paintbrush
a 'nana ' ganuck	No	344	<i>Onoclea sensibilis</i>	sensitive fern
a 'sawan; ana ' ganuck; nokomi ' skinun	No	238	<i>Athyrium filix-femina</i>	lady fern
aandegobagoons; namepin; namewashkoons	Yes	343	<i>Mentha canadensis</i> (M. arvensis)	field mint
aandegopin	Yes	174	<i>Lycopus americanus; Lycopus uniflorus</i> (*L. asper)	common water horehound
aditeminagaanwanzh (plant); atiteminagaawanzh (plant); aditemin (berry); atitemin (berry)	Yes	267	<i>Viburnum edule</i> (*V. lentago)	squashberry
aginiiminagaawanzh	Yes	225	<i>Rosa blanda</i>	wild rose
aginiiminagaawanzh	Yes	225	<i>Rosa palustris</i> (*R. blanda)	swamp rose
agobizowin	Yes	377	<i>Cypripedium reginae</i>	showy or queens lady-slipper
agongosimin, -an, -ag	Yes	326	<i>Maianthemum canadense</i>	canada mayflower
agongosimin, -an, -ag	Yes	326	<i>Maianthemum trifolium</i> (M. canadense)	false mayflower
agwingosibag; agongosibag	Yes	334	<i>Streptopus lanceolatus; s. roseus</i>	rose twisted-stalk
ah-o-je-mahg (adjimag)	No	333	<i>Sorbus americana; Sorbus decora</i>	mountain-ash
ajidamoowaanow; giiziso-mashkiki	Yes	349	<i>Solidago canadensis; S. altissima</i>	canada goldenrod
ajidamoowaanow; giiziso-mashkiki	Yes	349	<i>Solidago spp.</i> (*S. canadensis)	goldenrods
ajidamoowaanow; waabigwan	Yes	93	<i>Achillea millefolium</i>	yarrow
ana ' ganuck	No	378	<i>Dryopteris carthusiana; D. expansa</i> (*D. cristata)	spinulose woodfern
anagone ' wuck	No	166	<i>Glyceria canadensis</i>	rattlesnake grass
aniibimin	Yes	204	<i>Vaccinium macrocarpon</i>	large cranberry
aninaandag, -oog; ininaandag, -oog; bigiwaandag, -oog; zhinbog, --g; zhingobaaandag, -oog; zhingob bigiwaandag	Yes	313	<i>Abies balsamea</i>	balsam fir
apaakozigan; miskwaabiimag	Yes	18	<i>Arctostaphylos uva-ursi</i>	bearberry
asa/isaweminagaawanzh (plant); asa/isawemin (berry)	Yes	256	<i>Prunus virginiana</i>	choke cherry
azaadi(i); azaadiins	Yes	253	<i>Populus tremuloides</i>	quaking aspen
azaadi(i); maanazaadi(i)	Yes	328	<i>Populus balsamifera</i>	balsam poplar
bawa'iminaan; gozigwaakomin, -ag	Yes	329	<i>Prunus pennsylvanica</i>	pin cherry
bebezhigooganshii-mashkiki	Yes	172	<i>Lathyrus japonicus</i> (*L. palustris)	beach pea

### Appendix 3. Crosswalk between Ojibwe names and scientific and English names (continued)

Ojibwe Name	Restored	Page	Scientific Name	English Name
bibigwemin; bibigweman; bibigwewanashk	Yes	258	<i>Sambucus canadensis</i>	elderberry
bibigwewanashk, -oon	Yes	167	<i>Heracleum maximum (H. lanatum)</i>	cow-parsnip
bine ' mikci	No	187	<i>Andromeda glaucophyllia</i>	bog-rosemary
bine(wi)bag	Yes	223	<i>Pyrola americana (P. rotundifolia)</i>	round-leaved pyrola
bine(wi)bag; gidagi-bineobag; mashkiigojiibik	Yes	199	<i>Comarum palustre (Potentilla palustris)</i>	marsh cinquefoil
biwee ' ckinuk; mesadi ' wackons	No	193	<i>Eriophorum angustifolium, E. tenellum, E. viridi-carinatum (*E. vaginatum)</i>	cotton-grasses
doodooshaaboojiibik; mindimooyenh	Yes	134	<i>Taraxacum erythrospermum (*T. officinale)</i>	red-seeded dandelion
gaagaagiwanzh; zesegaandag; zhingob; zhingob gaawaandag	Yes	382	<i>Picea mariana</i>	black spruce
gaawaandag; gaawaandagwaatig; mina'ig; wadab; zesegaandag	Yes	327	<i>Picea glauca</i>	white spruce
gichi-ode'iminijiibik	Yes	25	<i>Dryocallis arguta (Potentilla a.)</i>	tall or prairie cinquefoil
gichi-ode'iminijiibik	Yes	25	<i>Potentilla argentea (*P. arguta)</i>	silvery cinquefoil
gichi-ode'iminijiibik	Yes	49	<i>Potentilla norvegica</i>	rough cinquefoil
giizhik, -ag; gizhikens, -ag; giizhikenh	Yes	387	<i>Thuja occidentalis</i>	arbor vitae
ginoozhewashk; ozawijiibik; zhiiwibag	Yes	127	<i>Rumex orbiculata (*R. crispus)</i>	great water dock
gozgwawaakominagaawanzh (plant); gozigwaakomin, -ag (berry); ozagadigom; zazigaakominagaawamzh	Yes	231	<i>Amelanchier interior; A. spicata (*A. laevis)</i>	serviceberries
jasibonskok; aiankosing; gezibnusk; giji ' binusk	No	107	<i>Equisetum arvense</i>	common horsetail
jasibonskok; aiankosing; gezibnusk; giji ' binusk	No	107	<i>Equisetum palustre (*E. arvense)</i>	marsh horsetail
jasibonskok; aiankosing; gezibnusk; giji ' binusk	No	107	<i>Equisetum variegatum (*E. arvense)</i>	common horsetail
kokbenognik keya; sasgob-mins	No	54	<i>Salix spp. (*Salix exigua)</i>	willows
makizin	Yes	376	<i>Cypripedium acaule (*C. calceolus)</i>	pink lady-slipper
mashkiigiminagaawanzh (plant); mashkiigimin (berry)	Yes	205	<i>Vaccinium oxycoccos</i>	small cranberry
mashkiigobag; mashkiikaang niibish; waabashkikiibag	Yes	196	<i>Rhododendron groenlandicum (Ledum g.)</i>	labrador-tea
mashkiigwaatig	Yes	381	<i>Larix laricina</i>	tamarack
maskwi ' widzhi ' wiko ' kok	No	312	<i>Viola macloskeyi; V. nephrophylla (*V. canadensi)</i>	violets
mickiminu ' nimic	No	198	<i>Ilex mucronata (Nemopanthus mucronatus)</i>	mountain holly
migiziibag; migiziwibag; naemgosibag	Yes	237	<i>Eurybia macrophylla (Aster macrophyllus)</i>	big-leaved aster

### Appendix 3. Crosswalk between Ojibwe names and scientific and English names (continued)

Ojibwe Name	Restored	Page	Scientific Name	English Name
miinagaawanzh (plant); miin, -an (berry)	Yes	227	<i>Vaccinium angustifolium</i>	low sweet blueberry
miskominagaawanzh; miskwiminagaawanzh; miskomin, -ag; miskimin, -ag	Yes	125	<i>Rubus parviflorus</i> (* <i>R. strigosus</i> )	timbleberry
miskominagaawanzh; miskwiminagaawanzh; miskomin, -ag; miskimin, -ag	Yes	125	<i>Rubus strigosus</i> ( <i>R. idaeus</i> )	wild red raspberry
miskoobimizh; miskwaabiimizh	Yes	340	<i>Cornus rugosa</i> (* <i>C. sericea</i> )	round-leaved dogwood
miskoobimizh; miskwaabiimizh	Yes	340	<i>Cornus sericea</i>	red-osier
miskwazi-wusk	No	47	<i>Physocarpus opulifolius</i>	Rosaceae
misodjidamo	Yes	17	<i>Arabis pycnocarpa</i> (* <i>Arabis glabra</i> )	hairy rock cress
misudidjeebik	No	234	<i>Aquilegia canadensis</i>	wild columbine
moosewijiibik	Yes	34	<i>Artemisia campestris</i>	wormwood
nabagashk; wiikenh; zhaabozigan	Yes	170	<i>Iris versicolor</i>	wild blue flag
naubishkaukoot	No	129	<i>Sisyrinchium montanum</i>	mountain blue-eyed-grass
nawo 'buguk; wunukibugauh	No	336	<i>Trientalis borealis</i>	star-flower
ne 'bagandag '; pebamabid-singup	No	335	<i>Taxus canadensis</i>	yew
neezhodaeyun	No	325	<i>Linnaea borealis</i>	twinflower
ode'immin	Yes	379	<i>Fragaria vesca</i>	woodland strawberry
ode'immin, -an; ode'imminijiibik	Yes	109	<i>Fragaria virginiana</i>	wild strawberry
ode'imminijiibik; zhakaagomin; zhaashaagomin; zhaashaagominens	Yes	319	<i>Cornus canadensis</i>	bunchberry
oginiiminagaawanzh	Yes	82	<i>Rosa acicularis</i>	wild rose
ogitebag	Yes	158	<i>Caltha palustris</i>	marsh-marigold
ojiibwe ' owe ' cuwun	No	165	<i>Galium trifidum</i>	small bedstraw
omakakiwidaasan; omakaiiwidaas	Yes	202	<i>Sarracenia purpurea</i>	pitcher plant
ozaawaajiibik; ozaawijiibik	Yes	375	<i>Coptis trifolia</i>	goldthread
ozaawashkojiibik	Yes	360	<i>Impatiens capensis</i>	spotted touch-me-not
ozhaashijiibik; ozhaashijiibikens; zhooshkijiibik	Yes	106	<i>Chamerion angustifolium</i> ( <i>Epilobium</i> a.)	fireweed
oziisigobimizh	Yes	55	<i>Salix lucida</i>	shinning willow
oziisigobimizh	Yes	386	<i>Salix pedicellaris</i>	bog willow
papshkisiganak; papskatckisi ' gana 'tig	No	305	<i>Sambucus racemosa</i>	red-berried elder
sabankuk	No	215	<i>Lonicera dioica</i>	red honeysuckle
skizgu-min	No	331	<i>Rubus pubescens</i>	dwarf raspberry
tcatcabonu ' ksik; zheebaunkudohnse	No	182	<i>Scutellaria galericulata</i>	marsh skullcap
tcatcabonu ' ksik; zheebaunkudohnse	No	182	<i>Scutellaria lateriflora</i> (* <i>S. galericulata</i> )	mad-dog skullcap
wa 'sawasni 'mike	No	175	<i>Myrica gale</i>	sweet gale
waabashkikiibag; mashkiigobagoons	Yes	191	<i>Chamaedaphne calyculata</i>	leatherleaf
waabigwan	Yes	104	<i>Conyza canadensis</i>	horseweed
waabigwan; baasibagak	Yes	14	<i>Anaphalis margaritacea</i>	pearly everlasting

### Appendix 3. Crosswalk between Ojibwe names and scientific and English names (continued)

Ojibwe Name	Restored	Page	Scientific Name	English Name
waabigwan; memisku 'nakuk	No	20	<i>Hieracium caespitosum</i> , <i>H. murorum</i> (* <i>H. kalmii</i> )	hawkweeds
waaboozobagoons; waaboozobanzh	Yes	42	<i>Gaultheria hispidula</i>	creeping-snowberry
waaboozoiibik	Yes	330	<i>Ribes glandulosum</i>	skunk currant
waboskiki 'minun	No	164	<i>Galium asprellum</i> , <i>Galium triflorum</i> (* <i>G. tinctorium</i> )	bedstraws
waboskiki 'minun	No	164	<i>Galium tinctorium</i>	fragrant bedstraw
wadoop, -iin	Yes	339	<i>Alnus incana</i>	speckled alder
wane 'migons	No	347	<i>Sium suave</i>	water-parsnip
wanukons'; apagwasi 'gons; abagwasi 'gans	No	160	<i>Cicuta bulbifera</i> (* <i>C. maculata</i> )	water hemlock
wapkadak; weekizigun	Yes	271	<i>Actaea pachypoda</i> ( <i>A. alba</i> )	dolls-eyes
wawiaeneegaeguhns	No	192	<i>Drosera rotundifolia</i>	round-leaved sundew
wewai 'bugug	Yes	338	<i>Viola labradorica</i> ( <i>V. conspersa</i> )	dog violet
wezaawaaskoneg	Yes	41	<i>Euthamia graminifolia</i>	flat-topped goldenrod
wezauskwagmik; osawa 'skanet	No	245	<i>Diervilla lonicera</i>	bush-honeysuckle
wiigwaas, -an, -ag; wiigwaasaatig; wiigwaasi-mitig; wiigwaasimizh	Yes	239	<i>Betula papyrifera</i>	paper birch
wiinziikens	Yes	157	<i>Symphotrichum puniceum</i> ; <i>S. firmum</i> ( <i>Aster puniceus</i> )	swamp aster
wiinizik	Yes	277	<i>Betula alleghaniensis</i>	yellow birch
zeewunubugushk	No	298	<i>Oxalis acetosella</i>	northern wood-sorrel
zhaashaagobiimag	Yes	315	<i>Acer spicatum</i>	mountain maple
zhigaagobag	Yes	371	<i>Symplocarpus foetidus</i>	skunk-cabbage
zhiishiiginewanzh, iig; zhiishiigimiiwanzh, -iig	Yes	229	<i>Acer rubrum</i>	red maple
zhingwaak	Yes	220	<i>Pinus strobus</i>	white pine