Natural Community Surveys of Rabbit Island Lake Superior

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Cover Photo: Rabbit Island sandstone bedrock lakeshore, Lake Superior. Photo by Joshua G. Cohen.

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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Surveys of Rabbit Island would not have been possible without the logistical support of the Keweenaw Bay Indian Community Natural Resources Department. We are especially grateful to Gene Mensch and Patrick LaPointe (pictured here) as well as Erin Johnston and Victoria Ripley. Photo by Joshua G. Cohen.

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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 However, within these unique geographies biodiversity data is limited or outdated, which hinders effective management and decision-making.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 Rabbit, Manitou, and Grand 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 Rabbit Island. For information on the natural community surveys conducted in 2023 on Grand Island and Manitou 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).

Rabbit Island sandstone lakeshore cliff. Photo by Joshua G. Cohen.

Rabbit Island occurs 4 miles east of the Keweenaw Peninsula in Lake Superior. Photos by the Rabbit Island Foundation.

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 Rabbit Island, also called Traverse Island.

Rabbit Island is located in Lake Superior about 4 miles east of the Keweenaw Peninsula on Jacobsville Sandstones (Figure 1). These relatively resistant sandstones are estimated to be the have been deposited approximately a billion years ago (Hodgin et al. 2022). The 91-acre island is just over 0.3 miles wide and 0.4 miles long and supports 1.7 miles of shoreline. The shoreline is primarily sandstone cobble shore but also includes stretches of sandstone bedrock lakeshore and sandstone lakeshore cliff. The interior of the island contains both boreal forest and mesic northern forest with boreal forest occurring on the lower terraces on shallow soils over sandstone bedrock and mesic northern forest primarily found on the upper terrace.

Rabbit Island is managed by the Rabbit Island Foundation as an artist's retreat. The Foundation's stated mission is to provide a platform to investigate, expand and challenge creative practices in a remote environment through the Rabbit Island Residency. By living and working on Rabbit Island residents engage directly with the landscape and respond to notions of conservation, ecology, sustainability, and resilience. A small artist's residence and camp occur on the northwestern portion of the island.

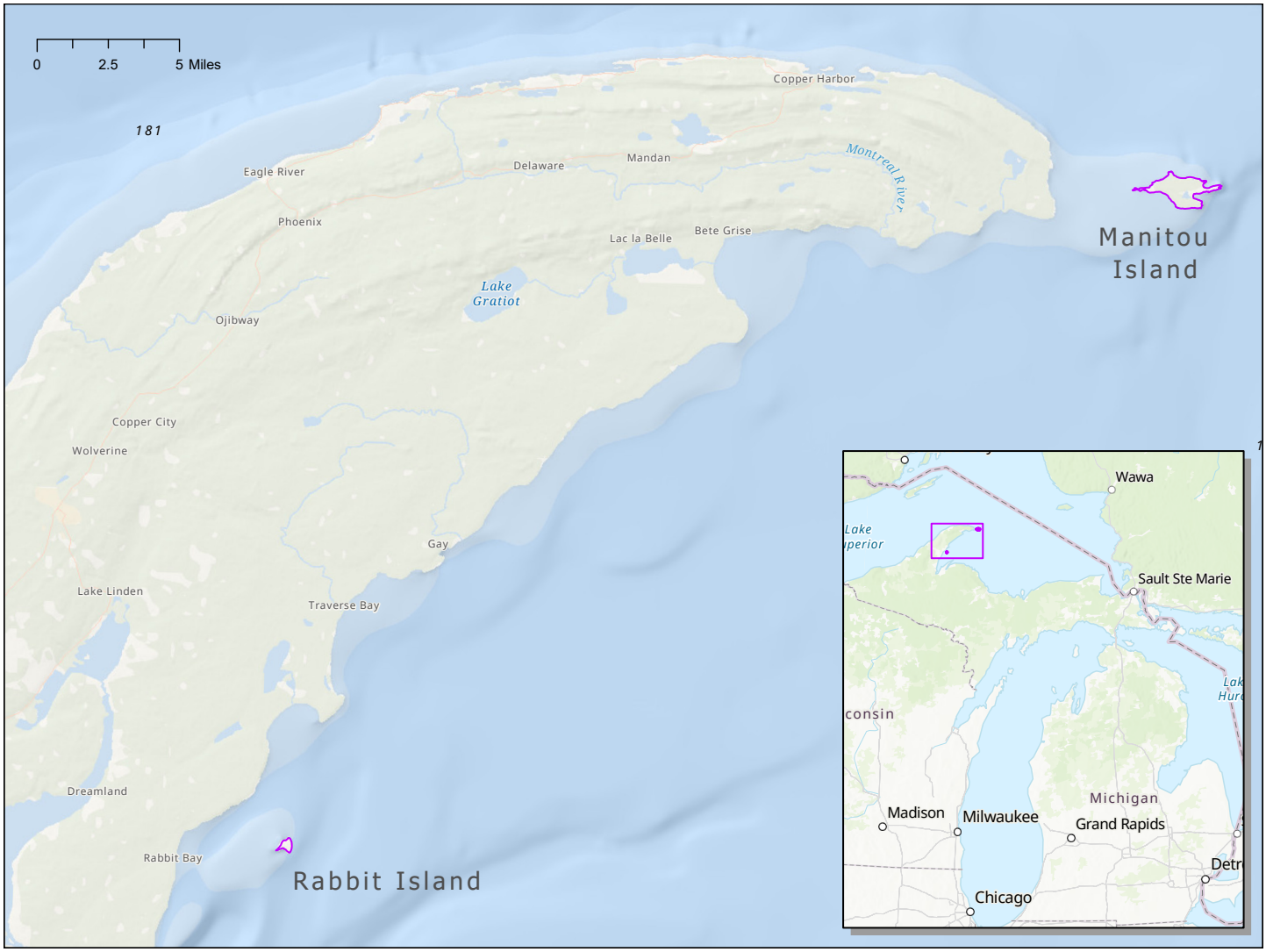


Figure 1. Map of Rabbit and Manitou Islands. Rabbit Island occurs just east of the Keweenaw Peninsula's Rabbit Bay.

Methods

Natural community surveys were conducted on Rabbit Island August 24th, 2023 on foot and by kayak. Prior to this survey effort, natural community surveys had not been conducted by MNFI staff on Rabbit Island.

Field Survey Prioritization

Prior to on-the-ground-surveys, MNFI ecologists conducted GIS analysis and aerial photo interpretation to delineate preliminary natural communities for Rabbit 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).

Rabbit Island boreal forest is characterized by an dense understory of yew (*Taxus canadensis*). Photo by Jesse M. Lincoln.

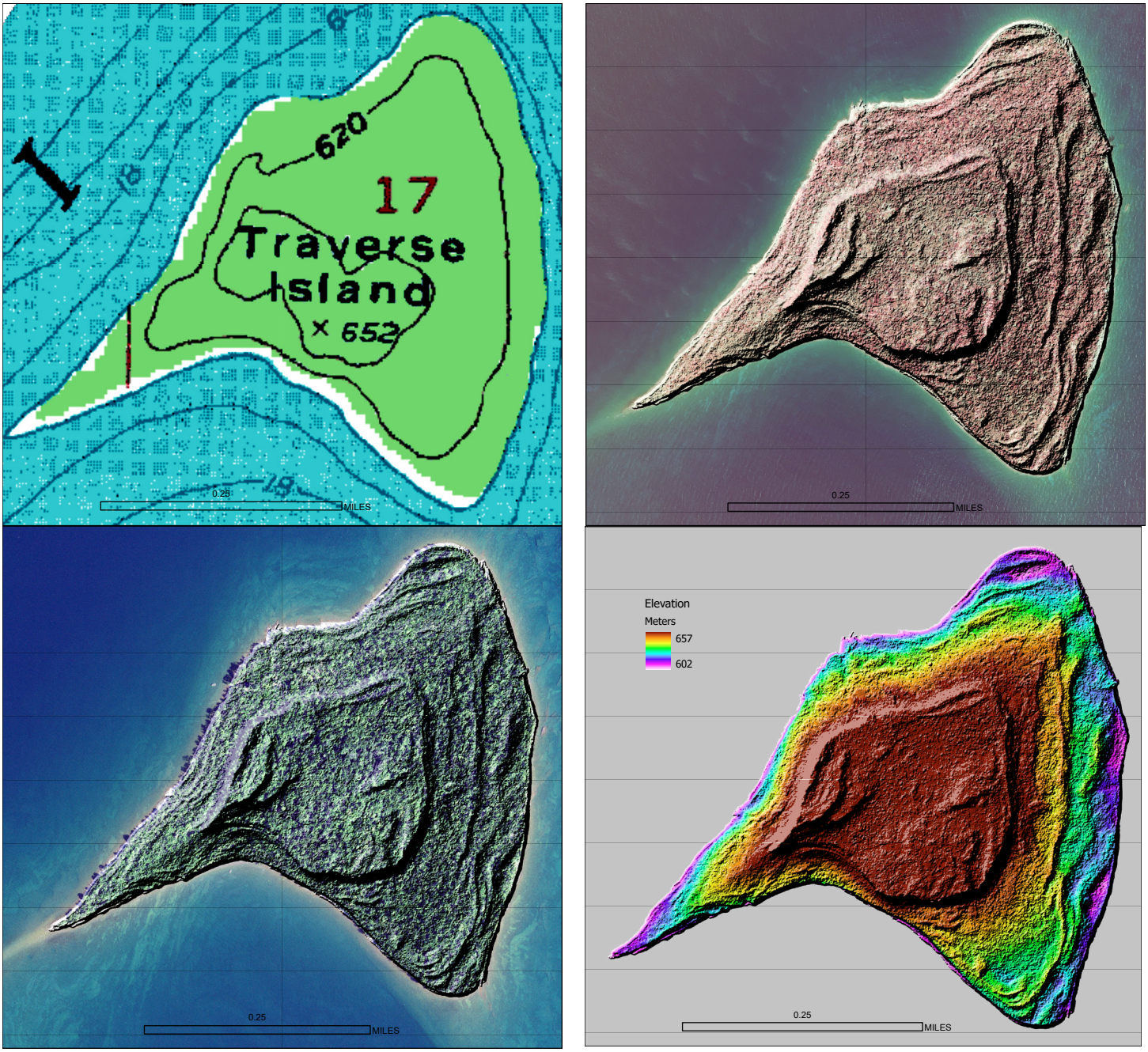


Figure 2. Spatial data layers and imagery used to prioritize survey effort. Clockwise from top left: topographic map (USGS 2024), color infrared imagery (2022) (State of Michigan 2022), true color leaf-on imagery (2020) (USDA 2020), and elevation with shaded relief (State of Michigan 2022).

Field Survey

A qualitative, plotless sampling design was employed to survey natural communities on Rabbit 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.

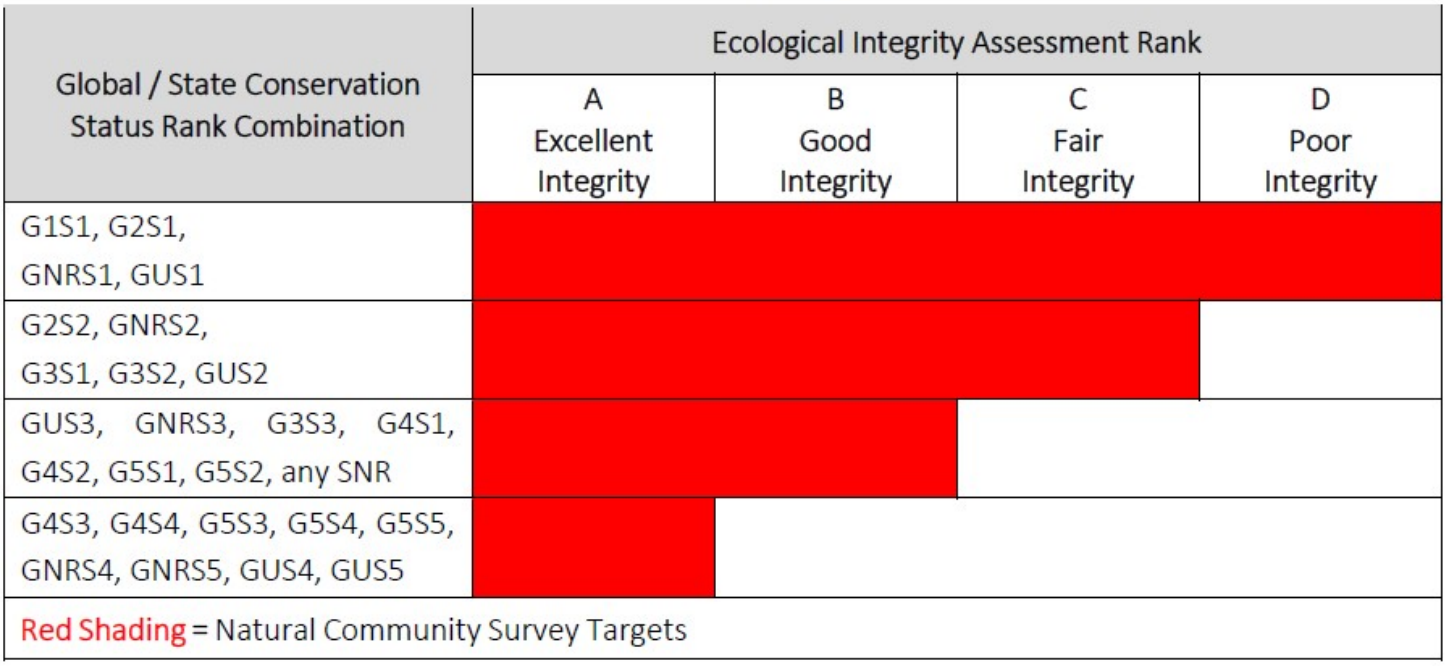


Figure 3. Decision matrix to determine natural community survey targets (NatureServe 2002, Rocchio et al. 2018). G = Global Rank, S = State Rank, U = currently unrankable, NR = not ranked; lower numbers are more imperiled than higher numbers. For more information, see Appendix 1.

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 element occurrence ranks
n) noting management needs and restoration opportunities

Following completion of the field surveys, the collected data were analyzed and transcribed to 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. 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

Representative canopy trees were measured and aged in the boreal forest (pictured above and below) and in the mesic northern forest. Photos by Joshua G. Cohen (above) and Jesse M. Lincoln (below).

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 species observed on Rabbit 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 3). 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.

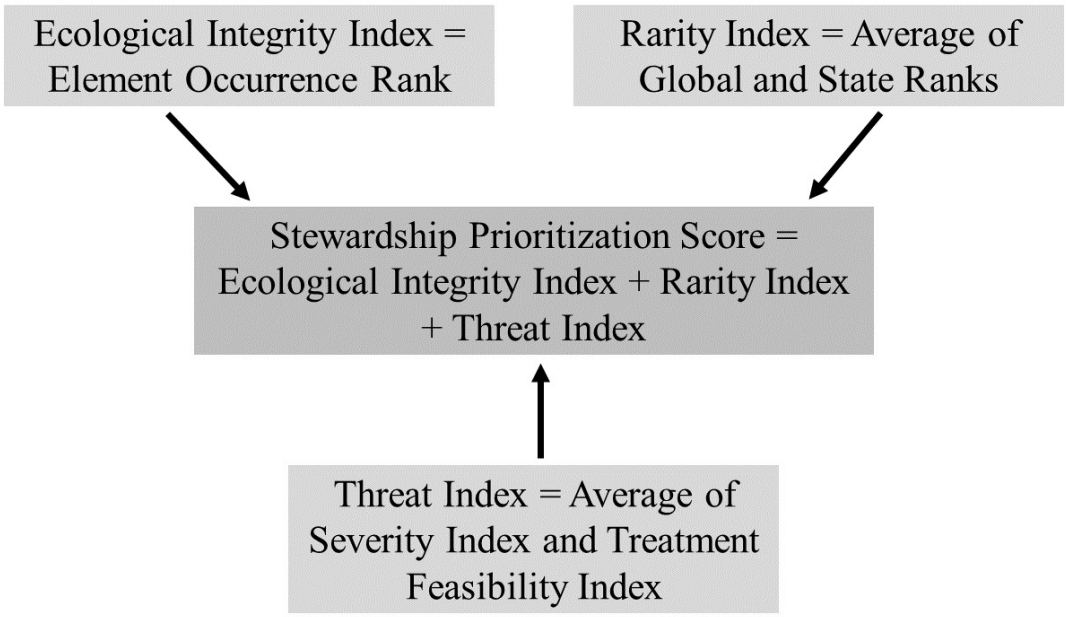


Figure 4. The Stewardship Prioritization score is the sum of the Ecological Integrity Index, Rarity Index, and Threat Index. This prioritization scoring was derived to help focus finite resources for biodiversity stewardship.

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 Rabbit Island. Nomenclature of plant species follows Michigan Flora (Voss and Reznicek 2012). Five previously undocumented high-quality natural communities were described in 2023 and represen five different natural community types including: boreal forest, mesic northern forest, sandstone bedrock lakeshore, sandstone cobble shore, and sandstone 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 five 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 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 photograph(s)
h) site description
i) threat assessment
j) management recommendations

Rabbit Island sandstone bedrock lakeshore. Photo by Jesse M. Lincoln.

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

Community Type	EO ID	Acreage	EO Rank
Boreal Forest	27100	45	B
Mesic Northern Forest	27101	36	BC
Sandstone Bedrock Lakeshore	27103	2.0	B
Sandstone Cobble Shore	27104	6.2	B
Sandstone Lakeshore Cliff	27102	1.2	BC

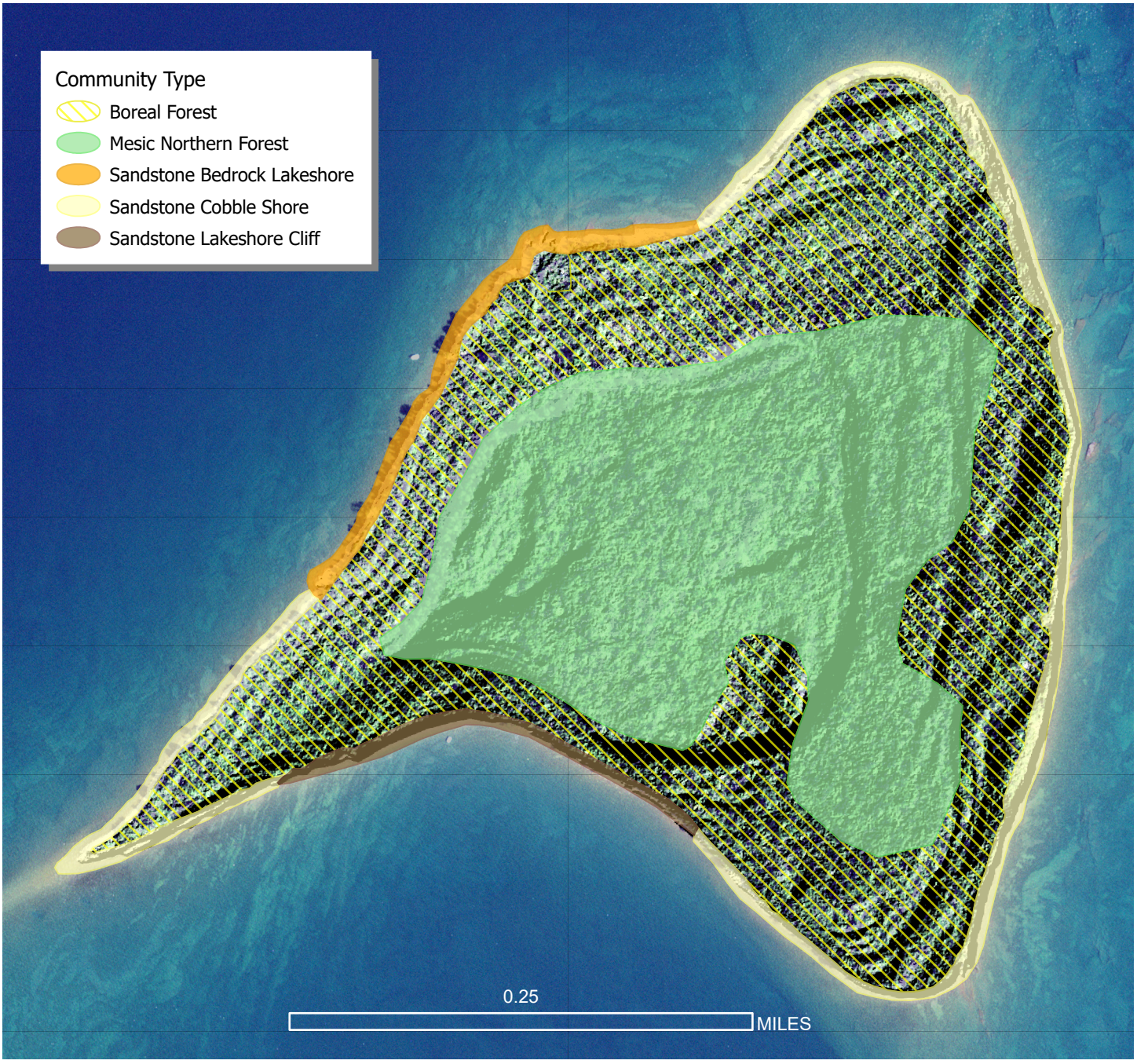
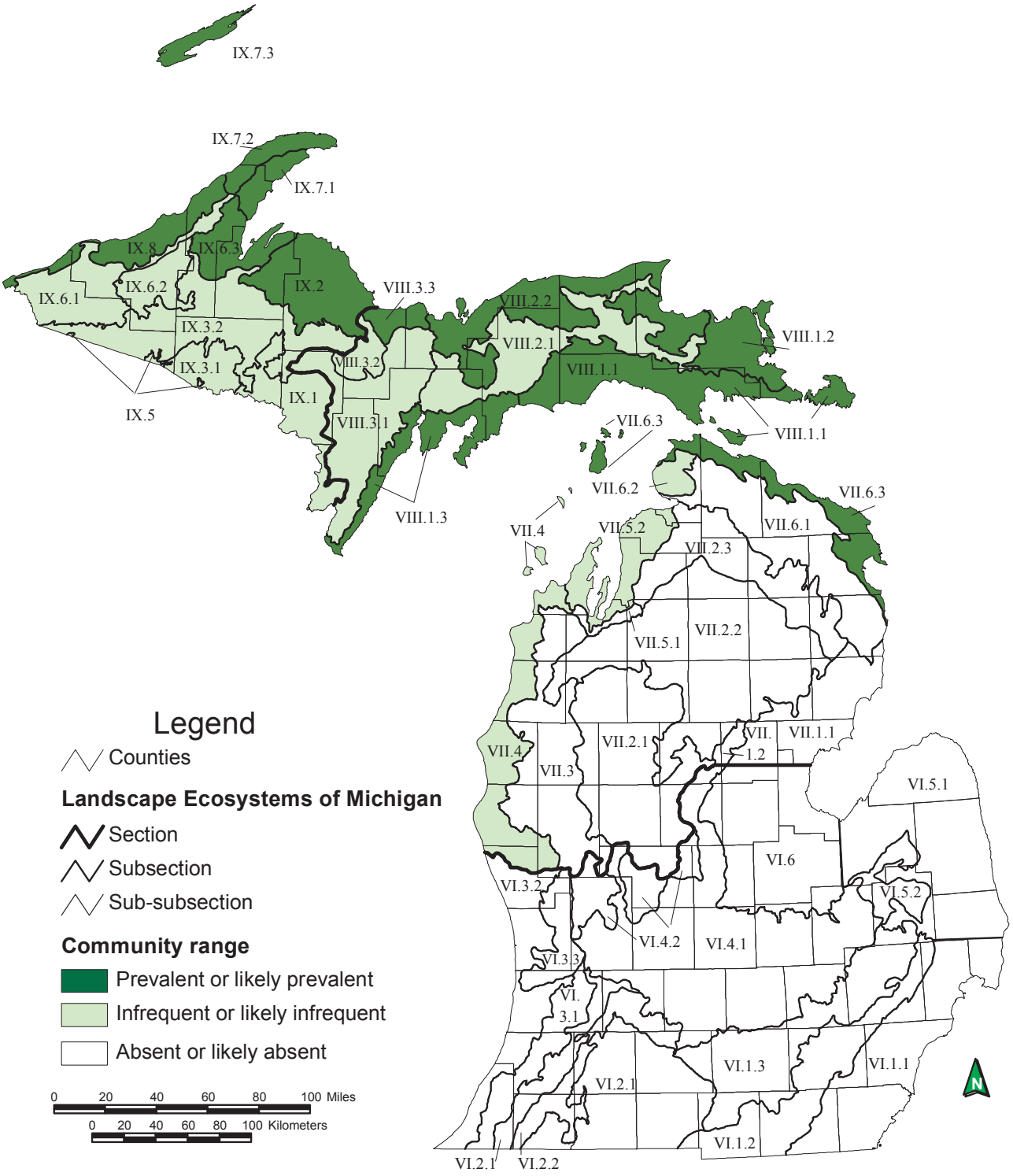


Figure 5. Natural community element occurrences on Rabbit Island.

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. Rabbit Island
Natural Community Type: Boreal Forest
Rank: GU S3, uncertain globally and vulnerable within the state
Element Occurrence Rank: B
Size: 45 acres
Element Occurrence Identification Number: 27100

Site Description: The interior of Rabbit Island contains both boreal forest and mesic northern forest with boreal forest occurring on the lower terraces on shallow soils over sandstone bedrock and mesic northern forest primarily found on the upper terrace on deeper soils. The boreal forest is subject to frequent windthrow and is also impacted by summer fog. The fog contributes to lichen growth especially on the ground (*Peltigera apthosa*) and on the branches of trees (*Usnea cavernosa*). The position of Rabbit Island in unprotected waters of Lake Superior results 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. The boreal forest occurs on shallow soils over sandstone cobble or bedrock, which contributes to the high turnover rate because of the poor rooting substrate. The soils of the boreal forest are shallow (2-4 cm), very acidic (pH 4.5-5.0) organics and loams.

Localized pockets of glade-like openings occur within the boreal forest. Prior to these surveys, sandstone bedrock glade has not been documented in Michigan, and this unique type merits consideration as a new natural community type for Michigan. The soils of the sandstone bedrock glade are shallow (2-4 cm), very acidic (pH 4.5) organics and sands overlying sandstone bedrock.

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

Rabbit Island boreal forest delineated in yellow on 2022 imagery. The boreal forest corresponds to the outer polygon.

Localized pockets of sandstone bedrock glade occur within the boreal forest. Photos by Joshua G. Cohen (above) and Jesse M. Lincoln (below).

High turnover rates within the boreal forest results in open canopy; young canopy ages; complex vertical structure; high volumes of coarse woody debris composed of early-succession species; 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 50 to 250 years and cored canopy trees included balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), and white pine (*Pinus strobus*). A 17.5 cm balsam fir was cored and estimated to be over 50 years old (43 growth rings counted); a 26.3 cm red maple was cored and estimated to be over 125 years old (115 growth rings counted); and a 60 cm white pine was cored and estimated to be over 250 years old (111 growth rings counted on 9.7 cm of a partial core due to rot).

The prevalence of robust yew (*Taxus canadensis*) on Rabbit 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. Many areas are dominated by moss and support no herbaceous vegetation. This appears to be due to substantial herbivory by snowshoe hare (*Lepus americanus*). There were many pellets throughout the boreal forest and browse was noted on several species of plants, particularly bluebead-lily (*Clintonia borealis*), young paper birch (*Betula papyrifera*) stems, and hemlock (*Tsuga canadensis*) within the adjacent mesic northern forest.

Canopy composition of the boreal forest is variable with early-successional species being prevalent due to the frequency of wind disturbance on the island. 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 mountain-ash (*Sorbus americana* and *S. decora*), white pine, northern white-cedar (*Thuja occidentalis*), red maple, and infrequent hemlock. Canopy coverage typically ranges from 40 to 65% with localized inclusions of sandstone bedrock glade occurring on shallow soils having more open canopy (20-40%). Canopy trees in the boreal forest typically range in diameter from 10 to 30 cm with scattered white pine and hemlock reaching 50 to 60 cm. Closer to the shoreline, the boreal forest is characterized by denser and smaller diameter canopy trees.

The understory layer is dense (40-65%) with yew locally dominant and additional species including pin cherry (*Prunus pensylvanica*), mountain maple (*Acer spicatum*), mountain-ash, and red maple. The low shrub layer is patchy to dense (20-40%) with common species including yew, Canada blueberry (*Vaccinium myrtilloides*), skunk currant (*Ribes glandulosum*), and mountain maple. The ground cover is sparse to patchy (15-30%) with characteristic species including bracken fern (*Pteridium aquilinum*), twinflower (*Linnaea borealis*), star-flower (*Trientalis borealis*), northern wood-sorrel (*Oxalis acetosella*), shining clubmoss (*Huperzia lucidula*), moccasin flower (*Cypripedium acaule*), goldthread (*Coptis trifolia*), creeping snowberry (*Gaultheria hispidula*), Indian-pipe (*Monotropa uniflora*), and smooth white violet (*Viola macloskeyi*). Feathermoss occurs throughout the boreal forest and patches of lichen (*Peltigera apthosa*) occur locally on the forest floor.

Areas of sandstone bedrock glade are dominated by an open canopy and understory of balsam fir, paper birch, mountain-ash, and white pine with feathermoss, star-flower, and Canada mayflower (*Maianthemum canadense*) prevalent in the ground cover. These localized pockets of sandstone bedrock glade occur on Jacobsville Sandstone bedrock, which is a relatively resistant sandstone.

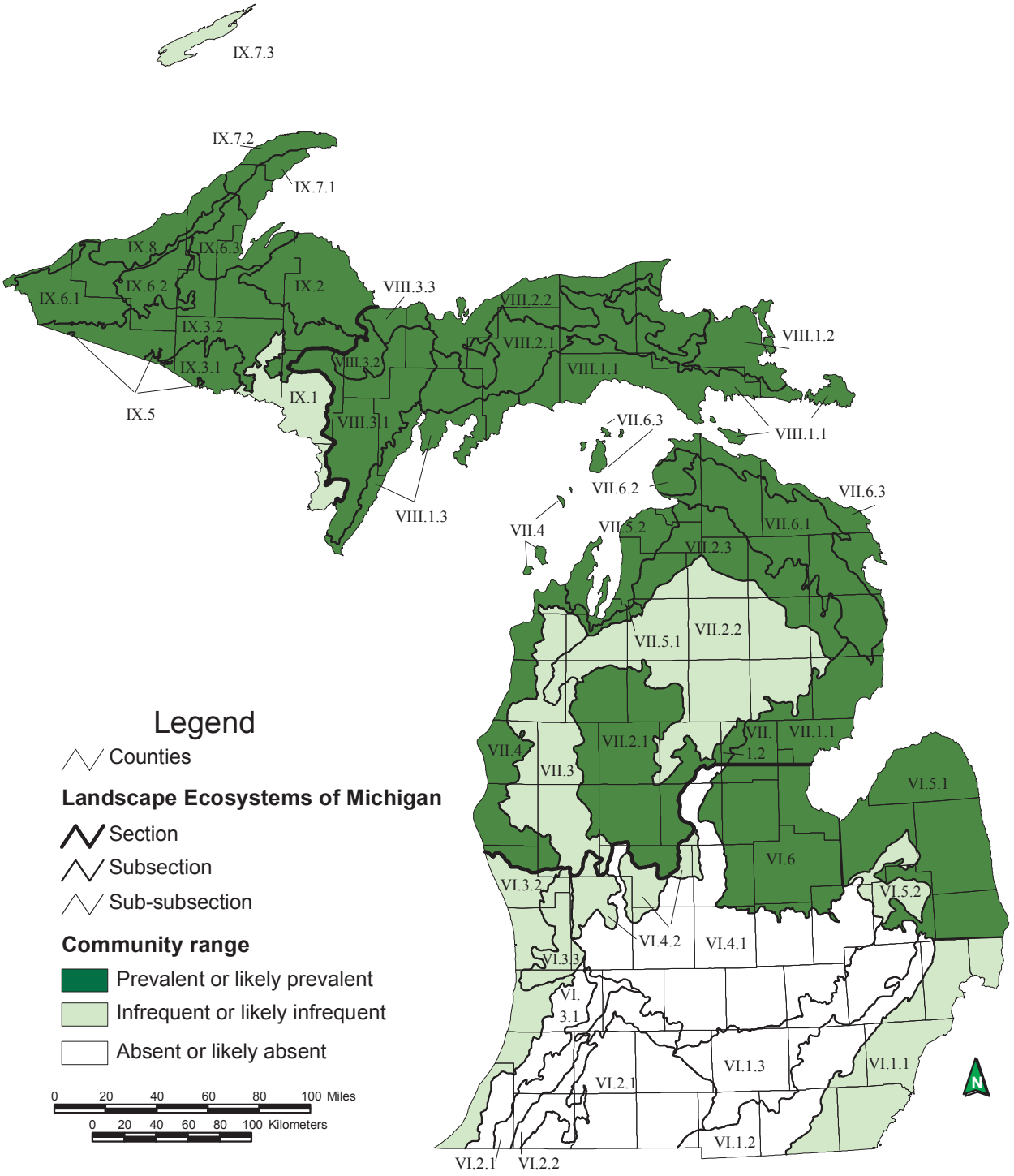
The Rabbit Island boreal forest was surveyed August 24th, 2023. Twenty-seven native plant species were documented with no non-native species observed (Appendix 2.1). The total FQI was 22.9.

Threats: Species composition and structure are patterned by natural processes. No invasive species were noted within the boreal forest. Snowshoe hare browsing is likely altering the composition of the ground layer and limiting the recruitment of tree species.

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. Species composition and vegetative structure should be monitored over time to gauge the impact of snowshoe hare browse.

MESIC NORTHERN FOREST

Overview: Mesic northern forest is a forest type of moist to dry-mesic sites lying mostly north of the climatic tension zone, characterized by the dominance of northern hardwoods, particularly sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*). Conifers such as hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) are frequently important canopy associates. This community type breaks into two broad classes: northern hardwood forest and hemlock-hardwood forest. It is primarily found on coarse-textured ground and end moraines, and soils are typically loamy sand to sandy loam. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of the shade-tolerant canopy species. Catastrophic windthrow occurs infrequently with several generations of trees passing between large-scale, severe disturbance events. Historically, mesic northern forest occurred as a matrix system, dominating vast areas of mesic uplands in the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries (Kost et al. 2007, Cohen et al. 2015).



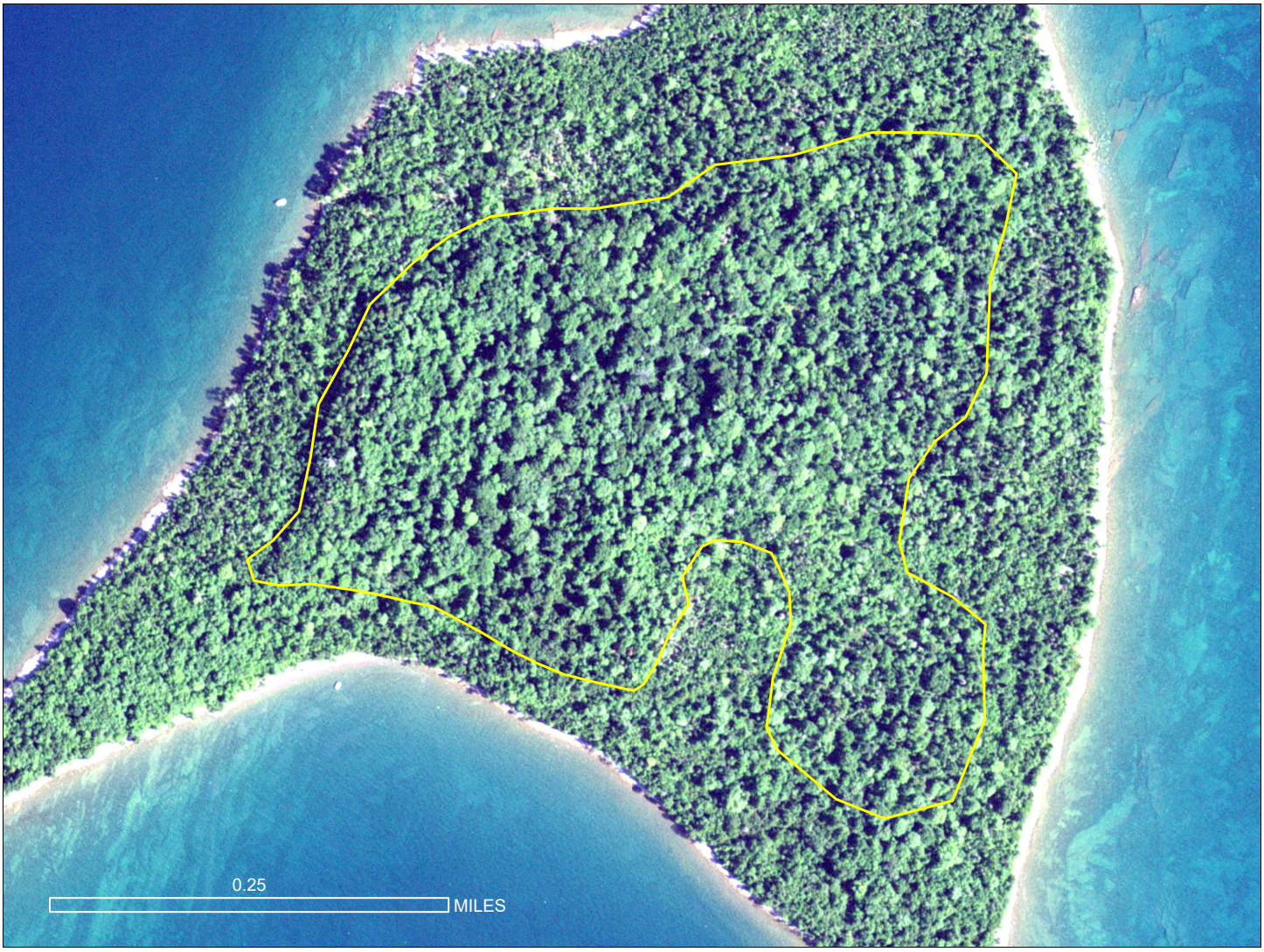
Map 2. Distribution of mesic northern forest in Michigan (Albert et al. 2008).

2. Rabbit Island
Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 36 acres
Element Occurrence Identification Number: 27101

Site Description: The interior of the island contains both mesic northern forest and boreal forest with mesic northern forest primarily found on the upper terrace on deeper soils and boreal forest occurring on the lower terraces on shallow soils over sandstone bedrock. Areas of mesic northern forest are characterized by 20 to 30 cm of acidic (pH 5.0), loamy sand over glacial till. Localized blocks of sandstone and pockets of sandstone cliff and talus occur within the mesic northern forest. The sandstone cliff reaches six feet in height and is not large enough to qualify as an independent element occurrence. Yellow birch (*Betula alleghaniensis*) grows locally on sandstone blocks. A 71.8 cm hemlock (*Tsuga canadensis*) was cored and estimated to be over 220 years old (counted 194 growth rings). Heavy browse from snowshoe hare (*Lepus americanus*) was noted throughout the interior of the island. There were many pellets throughout the mesic forest and adjacent boreal forest and browse was noted on several species of plants, particularly bluebead-lily (*Clintonia borealis*), young birch stems, and hemlock (*Tsuga canadensis*) saplings.

The canopy of the Rabbit Island mesic northern forest is dominated by yellow birch and red maple (*Acer rubrum*) with hemlock and paper birch (*Betula papyrifera*) as canopy associates. Canopy coverage typically ranges from 60 to 85% and canopy trees typically range in diameter from 50 to 70 cm with scattered large diameter red maple, hemlock, and yellow birch all reaching over 70 cm. The understory layer is sparse to patchy (10-20%) with balsam fir (*Abies balsamea*), red maple, and mountain maple (*Acer spicatum*). The low shrub layer is patchy (15-30%) with common species including yew

Rabbit Island mesic northern forest. Photo by Joshua G. Cohen.



Rabbit Island mesic northern forest delineated in yellow on 2022 imagery.

(*Taxus canadensis*), Canadian fly honeysuckle (*Lonicera canadensis*), and mountain maple. The ground cover (40-60%) is overwhelmingly dominated by robust bluebead-lily. Other less frequent species include spinulose woodfern (*Dryopteris carthusiana*), clubmoss (*Spinulum canadense*), and tree clubmoss (*Dendrolycopodium dendroideum*).

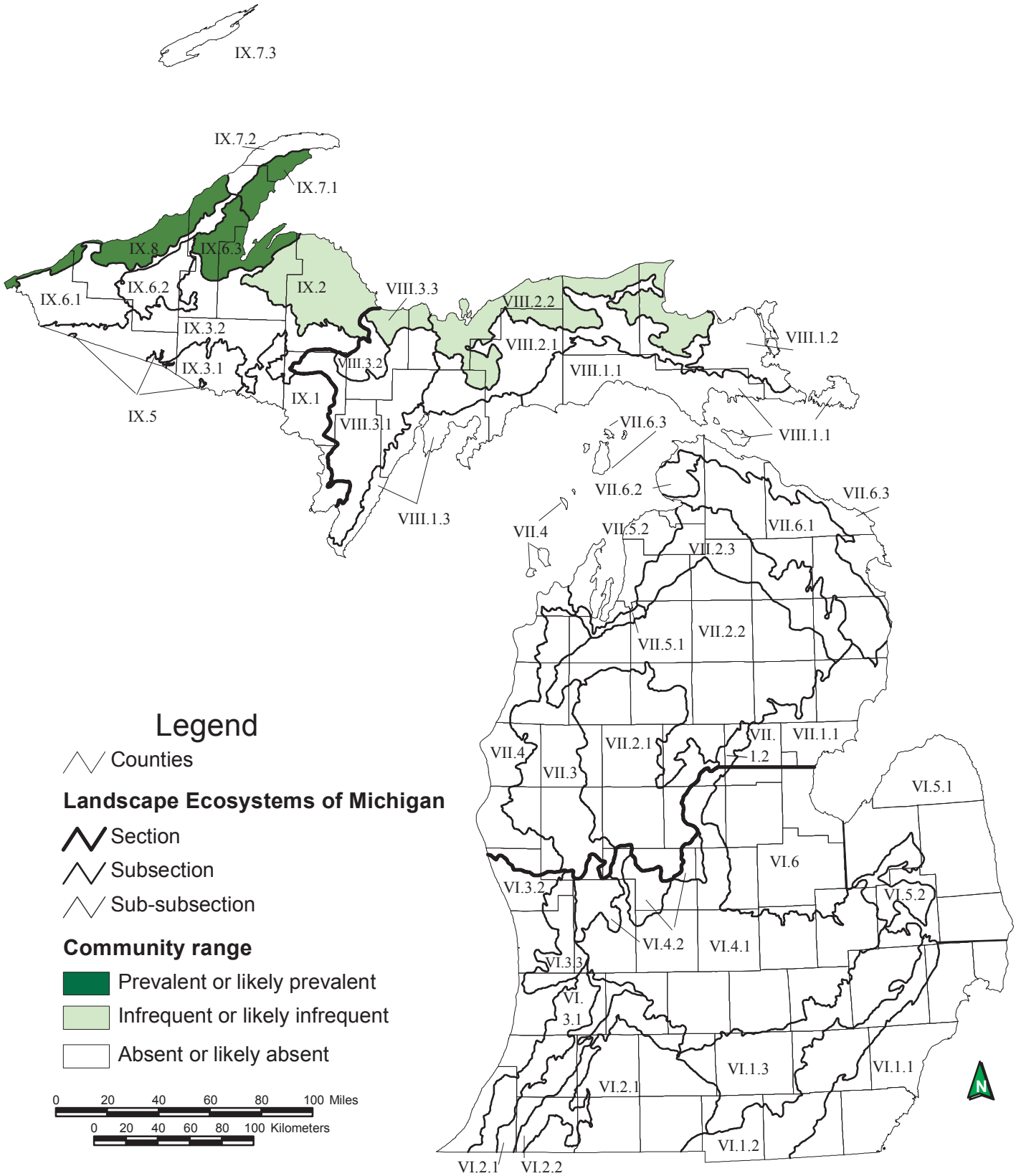
The Rabbit Island mesic northern forest was surveyed August 24th, 2023. Twelve native plant species were documented with no non-native species observed (Appendix 2.2). The total FQI was 15.6.

Threats: Species composition and structure are patterned by natural processes. The mesic northern forest supports very low herbaceous diversity, which may reflect its isolation on the island as well as intense browse pressure from snowshoe hare.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a natural buffer surrounding the mesic northern forest. Species composition and vegetative structure should be monitored over time to gauge the impact of snowshoe hare browse.

SANDSTONE BEDROCK LAKESHORE

Overview: Sandstone bedrock lakeshore is a sparsely vegetated community that occurs along the Lake Superior shoreline in the central and western Upper Peninsula. Exposed sandstone bedrock is prominent, with lichens and mosses locally dominant, and scattered sedges, grasses, forbs, shrubs, and occasionally trees restricted to cracks, joints, and depressions in the bedrock (Kost et al. 2007, Cohen et al. 2015).



Map 3. Distribution of sandstone bedrock lakeshore in Michigan (Albert et al. 2008).

3. Rabbit Island
Natural Community Type: Sandstone Bedrock Lakeshore
Rank: G4G5 S2, apparently secure to secure globally and imperiled within the state
Element Occurrence Rank: B
Size: 2.0 acres
Element Occurrence Identification Number: 27103

Site Description: The Rabbit Island sandstone bedrock lakeshore spans for approximately a third of a mile along the northwestern shore of the island. The bedrock lakeshore ranges in width from 3 to 7 meters and is more prevalent during low water years. The majority of the shoreline of Rabbit Island is characterized by sandstone cobble shore with a localized stretch of sandstone lakeshore cliff occurring along the southern shoreline. The sandstone shoreline systems are backed by a band of boreal forest along the island's lower terrace with mesic northern forest occurring primarily along the island's upper terrace.

Due to the frequent wave activity, ice scour, the resistance of the bedrock, and the lack of suitable sites for soil retention, vegetation is sparse along the sandstone bedrock lakeshore. Wave action, freeze thaw dynamics, and weathering cause erosion of the sandstone bedrock. Sandstone 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 frequently disturb sandstone bedrock lakeshore, removing fine mineral sediments and organic soils. Winter storms scour vegetation from sandstone bedrock lakeshore. Long-term cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of sandstone 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 sandstone bedrock lakeshore. High water levels and increased wave activity have likely reduced the overall cover of herbaceous species in the sandstone bedrock lakeshore. Horizontal bedrock coastal systems are more impacted by Great Lakes water level fluctuations compared to vertical bedrock systems such as sandstone lakeshore cliff.

Rabbit Island sandstone bedrock lakeshore. Photo by Joshua G. Cohen.

Rabbit Island sandstone bedrock lakeshore delineated in yellow on 2022 imagery.

The soils of the sandstone bedrock lakeshore are characterized by shallow (1-2 cm) organics and sands accumulating in crevices under moss. One sample of sandy organics collected from a crevice within the sandstone bedrock lakeshore was alkaline (pH 7.5-7.8). Soil chemistry of the soils within the bedrock lakeshore and adjacent sandstone cobble shore is likely linked to the decomposition of the local organic material.

The sandstone bedrock lakeshore is sparsely vegetated with herbaceous plants (<1%) and scattered tree and shrub cover (<1%) restricted to the inland edge and cracks and crevices within the bedrock. Characteristic herbaceous species include harebell (*Campanula rotundifolia*), fireweed (*Chamaenerion angustifolium*), ticklegrass (*Agrostis scabra*), Dudley's rush (*Juncus dudleyi*), fragile fern (*Cystopteris fragilis*), horseweed (*Conyza canadensis*), rough cinquefoil (*Potentilla norvegica*), marsh fern (*Thelypteris palustris*), and wild sarsaparilla (*Aralia nudicaulis*). Non-native species documented along the shore include ox-eye daisy (*Leucanthemum vulgare*), common St. John's-wort (*Hypericum perforatum*), Canada bluegrass (*Poa compressa*), and pearlwort (*Sagina procumbens*). Scattered trees and shrubs (<1%) concentrated along the upper margin of the shoreline include paper birch (*Betula papyrifera*), northern white-cedar (*Thuja occidentalis*), quaking aspen (*Populus tremuloides*), pin cherry (*Prunus pensylvanica*), and bush honeysuckle (*Diervilla lonicera*).

The Rabbit Island sandstone bedrock lakeshore was surveyed August 24th, 2023. Eighteen plant species were documented with 14 native species and 4 non-native species (Appendix 2.3). The total FQI was 9.3.

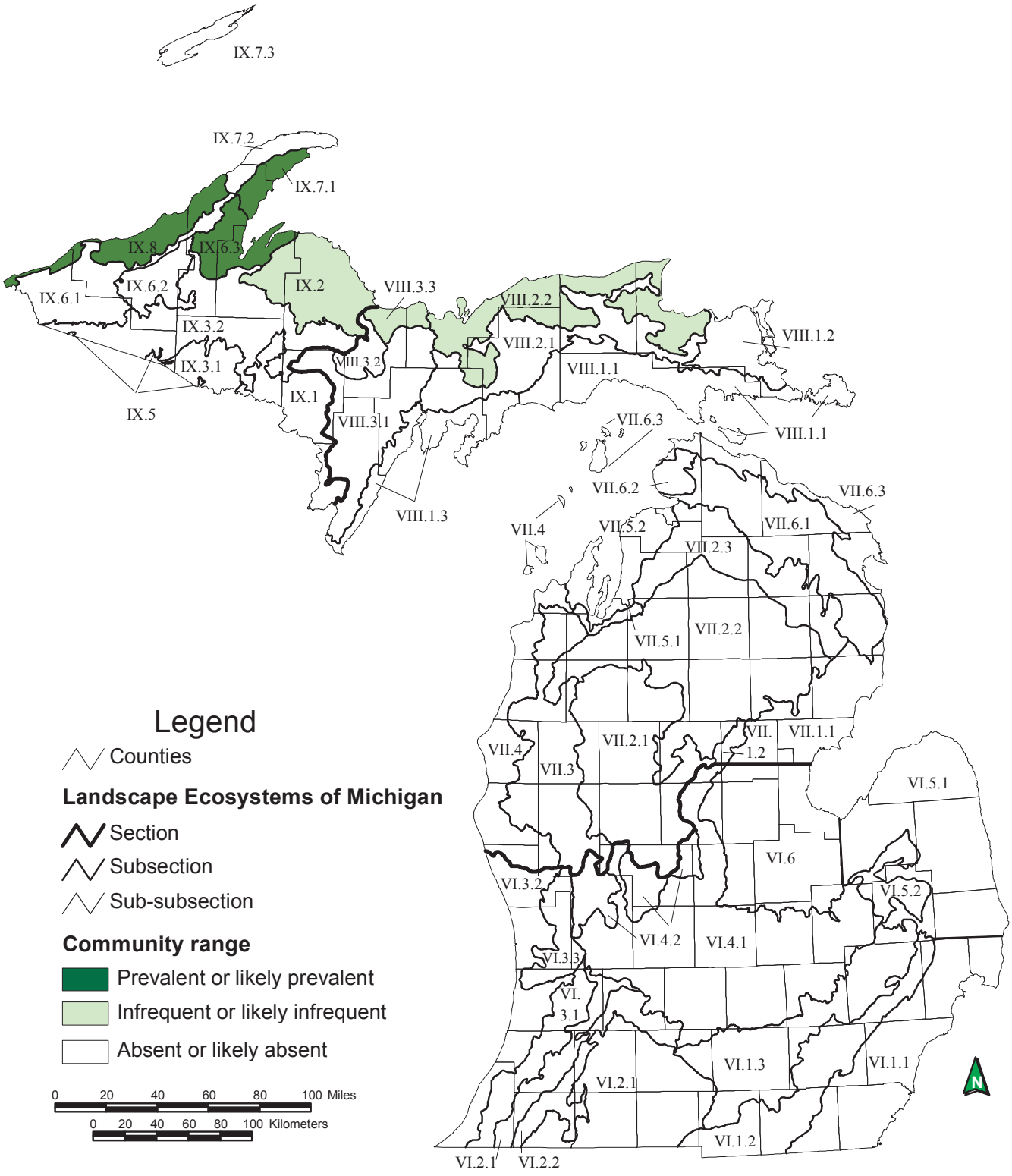
Threats: Non-native species documented along the shore include ox-eye daisy, common St. John's-wort, Canada bluegrass, and pearlwort. Dispersed foot traffic occurs along the shore and is concentrated near the artist's residence.

Management Recommendations: A natural buffer surrounding the sandstone bedrock lakeshore should be maintained. Efforts to control invasive species should be evaluated and if implemented, control efforts should be monitored.

Rabbit Island sandstone bedrock lakeshore (foreground) transitioning to sandstone cobble shore (background). Photo by Andrew Ranville (Rabbit Island Foundation).

SANDSTONE COBBLE SHORE

Overview: Sandstone cobble shore is a sparsely vegetated community that occupies the edges of Lake Superior, predominantly occurring in coves and gently curving bays in association with bedrock cliff, bedrock outcrop, sandstone bedrock lakeshore, and sand and gravel beach. These cobble shores may be nearly level and support a diversity of herbaceous plants where they border sand and gravel beach or relatively steep and terraced in coves between bedrock outcrops, with vegetation mostly limited to the highest cobble beach ridge, where scattered trees and shrubs are dominant. Sandstone cobble shore is dominated by flat, round-sided sandstones that move readily when subject to intense wave action, limiting soil development and vegetation establishment (Kost et al. 2007, Cohen et al. 2015).



Map 4. Distribution of sandstone cobble shore in Michigan (Albert et al. 2008).

4. Rabbit Island
Natural Community Type: Sandstone Cobble Shore
Rank: G2G3 S2, imperiled to vulnerable globally and imperiled within the state
Element Occurrence Rank: B
Size: 6.2 acres
Element Occurrence Identification Number: 27104

Site Description: The Rabbit Island sandstone cobble shore occurs along a 1.2-mile stretch of Lake Superior shoreline. The areas of cobble shore are typically narrow, ranging from 2 to 4 meters wide. The cobble shores are composed of cobbles that originated from weathering, glacial erosion, and wave action breaking down the island's Jacobsville Sandstones. 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. 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 sandstone 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 sandstone cobble shore intergrades with sandstone bedrock lakeshore along the northwestern portion of the island and locally with sandstone lakeshore cliff along the southern end of the island. The position of Rabbit Island in unprotected waters of Lake Superior results in the island experiencing frequent high winds across the island and high waves along the shorelines.

The sandstone 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 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.

Rabbit Island sandstone cobble shore. Photo by Joshua G. Cohen.

Scattered tree saplings and tall shrubs (<1%) along the upper margin of the sandstone cobble shore include paper birch (*Betula papyrifera*), white pine (*Pinus strobus*), northern white-cedar (*Thuja occidentalis*), quaking aspen (*Populus tremuloides*), mountain-ash (*Sorbus decora*), white spruce (*Picea glauca*), red maple (*Acer rubrum*), pin cherry (*Prunus pensylvanica*), mountain maple (*Acer spicatum*), and red-osier (*Cornus sericea*). Occasional low shrubs (<1%) include ninebark (*Physocarpus opulifolius*), bush honeysuckle (*Diervilla lonicera*), choke cherry (*Prunus virginiana*), and seedling paper birch. Recorded ground cover (<1%) include fireweed (*Chamaenerion angustifolium*), hair grass (*Deschampsia cespitosa*), Canada goldenrod (*Solidago canadensis*), and harebell (*Campanula rotundifolia*).

The Rabbit Island sandstone cobble shore was surveyed August 24th, 2023. Fourteen native plant species were documented with no non-native species observed (Appendix 2.4). The total FQI was 17.0.

Threats: No threats were observed during the course of the survey. Species composition and structure are patterned by natural processes. The remote nature of Rabbit Island limits anthropogenic disturbance to the island. Foot traffic is limited, seasonal, and concentrated along the shoreline near the artist's residence. Non-native species recorded within the adjacent sandstone bedrock lakeshore include ox-eye daisy (*Leucanthemum vulgare*), common St. John's-wort (*Hypericum perforatum*), Canada bluegrass (*Poa compressa*), and pearlwort (*Sagina procumbens*) and non-natives recorded within the adjacent sandstone lakeshore cliff include bluegrass (*Poa nemoralis*), pearlwort, king devil (*Hieracium caespitosum*), and mullein (*Verbascum thapsus*).

Management Recommendations: The main management recommendations are to maintain a forested buffer surrounding the sandstone cobble shore, evaluate control invasive species in the adjacent sandstone bedrock lakeshore and sandstone lakeshore cliff, and monitor any control efforts and monitor for invasives within the sandstone cobble shore.

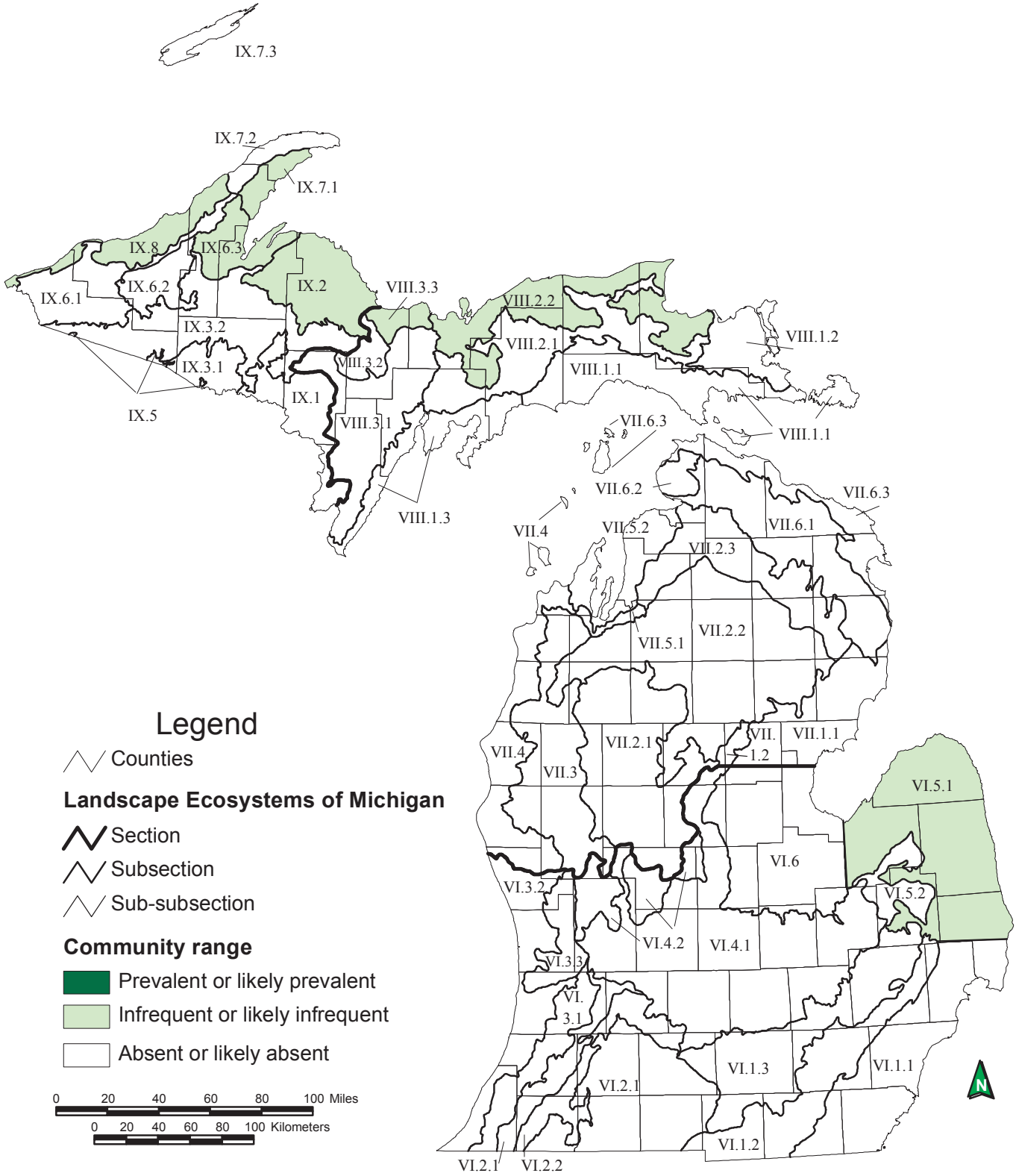
Rabbit Island sandstone cobble shore delineated in yellow on 2022 imagery.

Sandstone cobble shore is prevalent along the eastern shore of Rabbit Island, which experiences frequent high wave action. Photo by Rabbit Island Foundation.

Rabbit Island sandstone cobble shore. Photo by Joshua G. Cohen.

SANDSTONE LAKESHORE CLIFF

Overview: Sandstone lakeshore cliff consists of vertical or near-vertical exposures of bedrock with sparse coverage of vascular plants, lichens, mosses, and liverworts. The community occurs primarily in the central and western Upper Peninsula along Lake Superior but also is found along a short stretch of shore along Lake Huron in the thumb region. Sandstone lakeshore cliffs range from 2 to 65 m (6 to 200 ft) high and are characterized by high site moisture due to the proximity to the Great Lakes and a stressed and unstable environment because of severe waves, wind, and winter ice (Kost et al. 2007, Cohen et al. 2015).



Map 5. Distribution of sandstone lakeshore cliff in Michigan (Albert et al. 2008).

5. Manitou Island
Natural Community Type: Sandstone Lakeshore Cliff
Rank: G3 S2, vulnerable globally and imperiled within the state
Element Occurrence Rank: BC
Size: 1.2 acres
Element Occurrence Identification Number: 27102

Site Description: The Rabbit Island sandstone lakeshore cliff extends for approximately a quarter mile along the southern shoreline of the island. In addition to sandstone lakeshore cliff, the Rabbit Island shoreline also supports sandstone cobble shore and sandstone bedrock lakeshore. The sandstone shoreline systems are backed by a band of boreal forest along the island's lower terrace with mesic northern forest occurring primarily along the island's upper terrace. The sandstone lakeshore cliff ranges in height from 2 to 4 meters tall with approximately 2 meters of till along the top of the escarpment. The vertical structure of the cliff and erosive nature of sandstone causes constant erosion and restricts soil development to the cliff edge, ledges, crevices, and the base of the cliff where organic matter and sandy particles can accumulate. Soils sampled from crevices and ledges along the base of the sandstone lakeshore cliff are characterized by shallow (1-2 cm), acidic (pH 4.5-5.0) organics and sands. Soil chemistry of the soils within the sandstone lakeshore cliff and adjacent sandstone cobble shore is likely linked to the decomposition of the local organic material. The thin soils and direct exposure to wind, ice, and sun produce desiccating conditions that limit plant growth and results in sparse vegetation. Summer fog occurs regularly on the coast, fostering the growth of moss and lichen along the vertical cliff face. Trees and shrubs growing along the cliff are stunted by ice and wind and are limited in extent because of the lack of substrate for root establishment and growth. Cliff faces and accompanying plant debris are scoured by ice and waves, further increasing rates of erosion. Sandstone breaks off usually in the winter during freeze thaw periods. Wave action, freeze thaw dynamics, and weathering cause erosion of the cliff face and generation of talus and cobble at the cliff base. Much of the talus is sloughing off directly into the lake and sandstone cobble accumulates along the base of the cliff.

Rabbit Island sandstone lakeshore cliff. Photo by Joshua G. Cohen.

Rabbit Island sandstone lakeshore cliff delineated in yellow on 2022 imagery.

Vegetation is sparse, being generally restricted to the flat, exposed bedrock at the upper edge of the cliff (i.e., lip), cracks and joints in the cliff face, ledges along the cliff face, and talus blocks along the bottom of the cliff. The majority of the vertical cliff face is bare of all vascular vegetation, but lichens, mosses, and liverworts are prevalent. Sparse herbaceous cover (2-4%) includes fireweed (*Chamaenerion angustifolium*), hair grass (*Deschampsia cespitosa*), grass-leaved goldenrod (*Euthamia graminifolia*), dwarf raspberry (*Rubus pubescens*), and ticklegrass (*Agrostis scabra*). Non-natives documented locally along the cliff include bluegrass (*Poa nemoralis*), pearlwort (*Sagina procumbens*), king devil (*Hieracium caespitosum*), and mullein (*Verbascum thapsus*). Tree seedlings occur in the sparse shrub layer (1-2%) and include paper birch (*Betula papyrifera*) and quaking aspen (*Populus tremuloides*). The understory layer (2-4%) contains sapling balsam fir (*Abies balsamea*), paper birch, red-osier (*Cornus sericea*), pin cherry (*Prunus pensylvanica*), mountain-ash (*Sorbus decora*), wild red raspberry (*Rubus strigosus*), Bebb's willow (*Salix bebbiana*), mountain maple (*Acer spicatum*), and quaking aspen. Scattered and often stunted trees (1-2%) occur on the lip, ledges, and crevices and include paper birch and quaking aspen. Lichens are prevalent along the cliff with different species occupying various repeating niche spaces along the cliff. Frosted rock tripe (*Umbilicaria americana*) is especially prevalent on southeast exposures.

The Rabbit Island sandstone lakeshore cliff was surveyed August 24th, 2023. Eighteen plant species were documented with 14 native species and 4 non-native species (Appendix 2.5). The total FQI was 11.0.

Threats: Non-natives documented locally along the cliff include bluegrass (*Poa nemoralis*), pearlwort, king devil, and mullein (*Verbascum thapsus*).

Management Recommendations: A natural buffer surrounding the sandstone lakeshore cliff should be maintained. Efforts to control invasive species should be evaluated and if implemented, control efforts should be monitored.

Stewardship Prioritization Results

The stewardship prioritization scores for each natural community element occurrence from Rabbit 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 (≥ 9; red), medium (7 and < 9; yellow), or low (< 7; blue) stewardship priority. The highest ranking natural community element occurrences for stewardship intervention on Rabbit Island are the sandstone bedrock lakeshore and the sandstone lakeshore cliff. These are both Great Lakes endemic natural community types that are being impacted by non-native species incursions. Controlling non-native species within these systems should be evaluated. In addition, we recommend monitoring Rabbit Island's shoreline ecosystems for invasive species infestations and monitoring the impacts of snowshoe hare browse on the floristic composition and structure of the forests in the island's interior.

Table 2. Stewardship prioritization for natural community element occurrences (EOs) on Rabbit 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 Feasability	Threat Index	Stewardship Priority Score
27103	Sandstone Bedrock Lakeshore	B	4	G4G5	1.5	S2	4	2.75	2	3	2.5	9.25
27102	Sandstone Lakeshore Cliff	BC	3.5	G3	3	S2	4	3.5	2	2	2	9
27104	Sandstone Cobble Shore	B	4	G2G3	3.5	S2	4	3.75	-	-	0	7.75
27100	Boreal Forest	B	4	GU	-	S3	3	3	-	-	0	7
27101	Mesic Northern Forest	BC	3.5	G4	2	S3	3	2.5	-	-	0	6

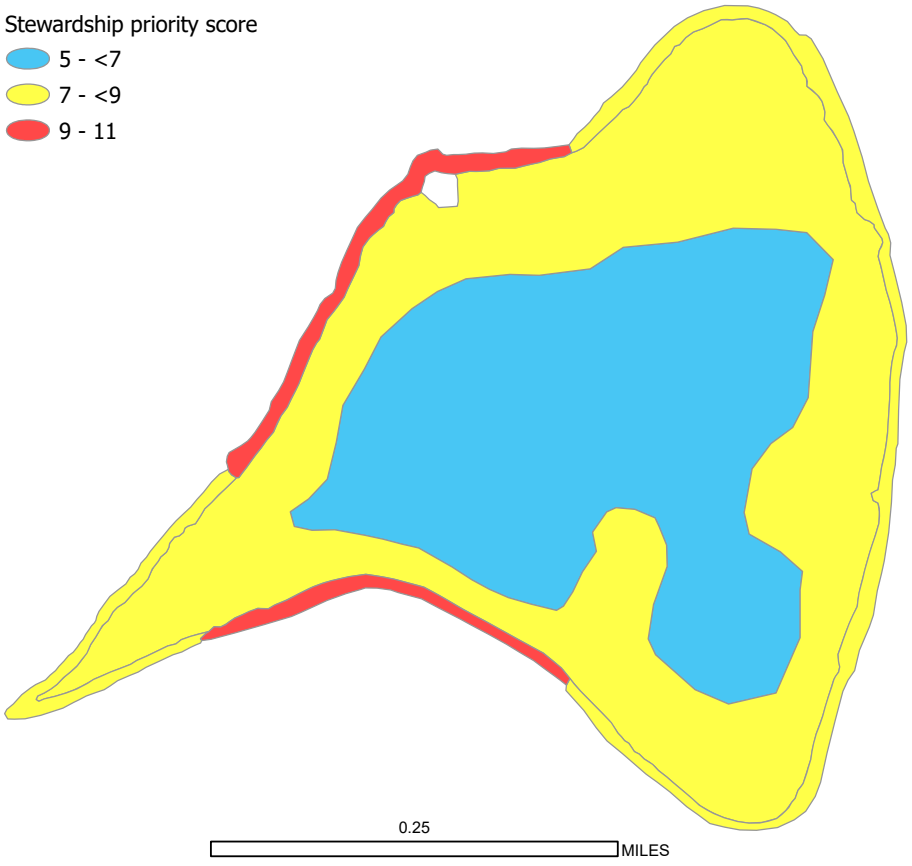


Figure 6. Stewardship prioritization for natural community element occurrences on Rabbit Island. Element occurrences are displayed by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority. The sandstone bedrock lakeshore and sandstone lakeshore cliff had the highest stewardship prioritization scores. We recommend evaluatuing invasive species control in these natural communities.

The sandstone bedrock lakeshore (above) and sandstone lakeshore cliff (below) on Rabbit Island ranked as the highest stewardship priorities. These sites represent Great Lakes endemic natural community types and their integrity is threatened by non-native species. Photos by Jesse M. Lincoln (above) and Joshua G. Cohen (below).

Discussion

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 and landowners. 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.

Rabbit 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 Rabbit 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 predominantly uninhabited ones like Rabbit 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.

Rabbit Island mesic northern forest. Photo by Joshua G. Cohen.

Conclusion

Through this project we evaluated the ecological integrity of high-quality natural communities on Rabbit Island. We documented five new element occurrences including boreal forest, mesic northern forest, sandstone bedrock lakeshore, sandstone cobble shore, and sandstone lakeshore cliff. This report provides site-based assessments of these five natural community element occurrences. Threats and management needs 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 evaluating non-native plant species control efforts on the sandstone bedrock lakeshore and sandstone lakeshore cliff. The bedrock lakeshore communities on Rabbit Island support populations of non-native invasive species that are common but occur at low densities. Shoreline communities are disturbance-prone and face a continual threat from non-native species, regardless of treatment efforts. Therefore, we urge managers to carefully evaluate the likely success of treatment. If implemented, treatment should be carefully conducted by experienced stewards to minimize collateral damage to populations of native species and herbicide should be avoided. These efforts should be monitored to determine the long-term effectiveness of reducing invasive species and the benefit to native flora. In addition, we recommend monitoring the impacts of snowshoe hare browse on the floristic composition and structure of the forests in the interior of the island. Finally, we emphasize the importance of long-term monitoring to help inform adaptive management and future stewardship priorities.

Rabbit Island supports several Great Lakes endemic natural communities including sandstone lakeshore cliff (above). We recommend carefully evaluating non-native species control along the sandstone bedrock lakeshore and sandstone lakeshore cliff. Photo by Jesse M. Lincoln

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Rabbit Island sandstone cobble shore. Photo by Joshua G. Cohen.

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 species observed on Rabbit Island that are listed in "Plants used by the Great Lakes Ojibwa" (Meeker et al. 1993).

Appendix 2.1. Rabbit Island Boreal Forest FQA

Conservatism-Based Metrics:

Total Mean C:	4.4
Native Mean C:	4.4
Total FQI:	22.9
Native FQI:	22.9
Adjusted FQI:	44
% C value 0:	3.7
% C value 1-3:	18.5
% C value 4-6:	66.7
% C value 7-10:	11.1
Native Tree Mean C:	3.4
Native Shrub Mean C:	5.8
Native Herbaceous Mean C:	4.8

Species Richness:

Total Species:	27	
Native Species:	27	100.00%
Non-native Species:	0	0.00%

Species Wetness:

Mean Wetness:	0.3
Native Mean Wetness:	0.3

Physiognomy Metrics:

Tree:	10	37.00%
Shrub:	5	18.50%
Vine:	0	0.00%
Forb:	9	33.30%
Grass:	0	0.00%
Sedge:	0	0.00%
Rush:	0	0%
Fern:	3	11.10%
Bryophyte:	0	0%

Duration Metrics:

Annual:	0	0.00%
Perennial:	27	100.00%
Biennial:	0	0.00%
Native Annual:	0	0.00%
Native Perennial:	27	100.00%
Native Biennial:	0	0.00%

Appendix 2.1. Rabbit Island Boreal Forest FQA (continued)

Scientific Name	Common Name	Acronym	Native?	C	W
Abies balsamea	balsam fir	ABIBAL	native	3	0
Acer rubrum	red maple	ACERUB	native	1	0
Acer spicatum	mountain maple	ACESPI	native	5	3
Betula papyrifera	paper birch	BETPAP	native	2	3
Clintonia borealis	bluebead-lily; corn-lily	CLIBOR	native	5	0
Coptis trifolia	goldthread	COPTRI	native	5	-3
Cypripedium acaule	pink lady-slipper; moccasin flower	CYPACA	native	5	-3
Cystopteris fragilis	fragile fern	CYSFRA	native	4	3
Gaultheria hispidula	creeping-snowberry	GAUHIS	native	8	-3
Huperzia lucidula	shining clubmoss	HUPLUC	native	5	0
Ilex mucronata; nemopanthus m.	mountain holly	ILEMUC	native	7	-5
Linnaea borealis	twinflower	LINBOR	native	6	0
Maianthemum canadense	canada mayflower	MAICAN	native	4	3
Monotropa uniflora	indian-pipe	MONOUN	native	5	3
Oxalis acetosella	northern wood-sorrel	OXAACE	native	7	3
Pinus strobus	white pine	PINSTR	native	3	3
Prunus pensylvanica	pin cherry	PRUPEN	native	3	3
Pteridium aquilinum	bracken fern	PTEAQU	native	0	3
Ribes glandulosum	skunk currant	RIBGLA	native	5	-3
Sorbus americana	american mountain-ash	SORAME	native	4	0
Sorbus decora	mountain-ash	SORDEC	native	4	3
Taxus canadensis	yew	TAXCAN	native	5	3
Thuja occidentalis	arbor vitae	THUOCC	native	4	-3
Trientalis borealis	star-flower	TRIBOR	native	5	0
Tsuga canadensis	hemlock	TSUCAN	native	5	3
Vaccinium myrtilloides	canada blueberry	VACMYR	native	4	-3
Viola macloskeyi	smooth white violet	VIOMAC	native	6	-5

Appendix 2.2. Rabbit Island Mesic Northern Forest FQA

Conservatism-Based Metrics:

Total Mean C:	4.5
Native Mean C:	4.5
Total FQI:	15.6
Native FQI:	15.6
Adjusted FQI:	45
% C value 0:	0
% C value 1-3:	25
% C value 4-6:	66.7
% C value 7-10:	8.3
Native Tree Mean C:	3.8
Native Shrub Mean C:	5
Native Herbaceous Mean C:	5.3

Physiognomy Metrics:

Tree:	6	50.00%
Shrub:	2	16.70%
Vine:	0	0.00%
Forb:	1	8.30%
Grass:	0	0.00%
Sedge:	0	0.00%
Rush:	0	0%
Fern:	3	25.00%
Bryophyte:	0	0%

Species Richness:

Total Species:	12	
Native Species:	12	100.00%
Non-native Species:	0	0.00%

Duration Metrics:

Annual:	0	0.00%
Perennial:	12	100.00%
Biennial:	0	0.00%
Native Annual:	0	0.00%
Native Perennial:	12	100.00%
Native Biennial:	0	0.00%

Species Wetness:

Mean Wetness:	1.3
Native Mean Wetness:	1.3

Scientific Name	Common Name	Acronym	Native?	C	W
Abies balsamea	balsam fir	ABIBAL	native	3	0
Acer rubrum	red maple	ACERUB	native	1	0
Acer spicatum	mountain maple	ACESPI	native	5	3
Betula alleghaniensis	yellow birch	BETALL	native	7	0
Betula papyrifera	paper birch	BETPAP	native	2	3
Clintonia borealis	bluebead-lily; corn-lily	CLIBOR	native	5	0
Dendrolycopodium dendroideum; ly	tree clubmoss	DENDEN	native	5	3
Dryopteris carthusiana	spinulose woodfern	DRYCAR	native	5	-3
Lonicera canadensis	canadian fly honeysuckle	LONCAN	native	5	3
Spinulum canadense	clubmoss	SPICAN	native	6	0
Taxus canadensis	yew	TAXCAN	native	5	3
Tsuga canadensis	hemlock	TSUCAN	native	5	3

Appendix 2.3. Rabbit Island Sandstone Bedrock Lakeshore FQA

Conservatism-Based Metrics:

Total Mean C:	2.2
Native Mean C:	2.8
Total FQI:	9.3
Native FQI:	10.5
Adjusted FQI:	24.7
% C value 0:	33.3
% C value 1-3:	33.3
% C value 4-6:	33.3
% C value 7-10:	0
Native Tree Mean C:	2.5
Native Shrub Mean C:	4
Native Herbaceous Mean C:	2.8

Physiognomy Metrics:

Tree:	4	22.20%
Shrub:	1	5.60%
Vine:	0	0.00%
Forb:	8	44.40%
Grass:	2	11.10%
Sedge:	0	0.00%
Rush:	1	6%
Fern:	2	11.10%
Bryophyte:	0	0%

Species Richness:

Total Species:	18	
Native Species:	14	77.80%
Non-native Species:	4	22.20%

Duration Metrics:

Annual:	2	11.10%
Perennial:	16	88.90%
Biennial:	0	0.00%
Native Annual:	2	11.10%
Native Perennial:	12	66.70%
Native Biennial:	0	0.00%

Species Wetness:

Mean Wetness:	1.5
Native Mean Wetness:	1

Scientific Name	**Common Name**	**Acronym**	**Native?**	**C**	**W**
Agrostis scabra; a. hyemalis	ticklegrass	AGRSCA	native	4	0
Aralia nudicaulis	wild sarsaparilla	ARANUD	native	5	3
Betula papyrifera	paper birch	BETPAP	native	2	3
Campanula rotundifolia	harebell	CAMROT	native	6	3
Chamerion angustifolium; epilobium a.	fireweed	CHAANG	native	3	0
Conyza canadensis	horseweed	CONCAN	native	0	3
Cystopteris fragilis	fragile fern	CYSFRA	native	4	3
Diervilla lonicera	bush-honeysuckle	DIELON	native	4	5
Hypericum perforatum	**common st. johns-wort**	**HYPPER**	**non-native**	**0**	**5**
Juncus dudleyi	dudleys rush	JUNDUD	native	1	-3
Leucanthemum vulgare; chrysanthemum leucanthemum	**ox-eye daisy**	**LEUVUL**	**non-native**	**0**	**5**
Poa compressa	**canada bluegrass**	**POACOM**	**non-native**	**0**	**3**
Populus tremuloides	quaking aspen	POPTRE	native	1	0
Potentilla norvegica	rough cinquefoil	POTNOR	native	0	0
Prunus pensylvanica	pin cherry	PRUPEN	native	3	3
Sagina procumbens	**pearlwort**	**SAGPRO**	**non-native**	**0**	**0**
Thelypteris palustris	marsh fern	THEPAL	native	2	-3
Thuja occidentalis	arbor vitae	THUOCC	native	4	-3

Appendix 2.4. Rabbit Island Sandstone Cobble Shore FQA

Conservatism-Based Metrics:

Total Mean C:	3.4
Native Mean C:	3.4
Total FQI:	14
Native FQI:	14
Adjusted FQI:	34
% C value 0:	0
% C value 1-3:	58.8
% C value 4-6:	35.3
% C value 7-10:	5.9
Native Tree Mean C:	2.9
Native Shrub Mean C:	3
Native Herbaceous Mean C:	4.8

Physiognomy Metrics:

Tree:	9	52.90%
Shrub:	4	23.50%
Vine:	0	0.00%
Forb:	3	17.60%
Grass:	1	5.90%
Sedge:	0	0.00%
Rush:	0	0%
Fern:	0	0.00%
Bryophyte:	0	0%

Duration Metrics:

Annual:	0	0.00%
Perennial:	17	100.00%
Biennial:	0	0.00%
Native Annual:	0	0.00%
Native Perennial:	17	100.00%
Native Biennial:	0	0.00%

Species Richness:

Total Species:	17	
Native Species:	17	100.00%
Non-native Species:	0	0.00%

Species Wetness:

Mean Wetness:	1.2
Native Mean Wetness:	1.2

Scientific Name	Common Name	Acronym	Native?	C	W
Acer rubrum	red maple	ACERUB	native	1	0
Acer spicatum	mountain maple	ACESPI	native	5	3
Betula papyrifera	paper birch	BETPAP	native	2	3
Campanula rotundifolia	harebell	CAMROT	native	6	3
Chamerion angustifolium; epilobium a.	fireweed	CHAANG	native	3	0
Cornus sericea; c. stolonifera	red-osier	CORSER	native	2	-3
Deschampsia cespitosa	hair grass	DESCES	native	9	-3
Diervilla lonicera	bush-honeysuckle	DIELON	native	4	5
Physocarpus opulifolius	ninebark	PHYOPU	native	4	-3
Picea glauca	white spruce	PICGLA	native	3	3
Pinus strobus	white pine	PINSTR	native	3	3
Populus tremuloides	quaking aspen	POPTRE	native	1	0
Prunus pensylvanica	pin cherry	PRUPEN	native	3	3
Prunus virginiana	choke cherry	PRUVIR	native	2	3
Solidago canadensis	canada goldenrod	SOLCAN	native	1	3
Sorbus decora	mountain-ash	SORDEC	native	4	3
Thuja occidentalis	arbor vitae	THUOCC	native	4	-3

Appendix 2.5. Rabbit Island Sandstone Lakeshore Cliff FQA

Conservatism-Based Metrics:

Total Mean C:	2.6
Native Mean C:	3.3
Total FQI:	11
Native FQI:	12.3
Adjusted FQI:	29.1
% C value 0:	22.2
% C value 1-3:	50
% C value 4-6:	22.2
% C value 7-10:	5.6
Native Tree Mean C:	3
Native Shrub Mean C:	2.3
Native Herbaceous Mean C:	4.8

Physiognomy Metrics:

Tree:	6	33.30%
Shrub:	4	22.20%
Vine:	0	0.00%
Forb:	5	27.80%
Grass:	3	16.70%
Sedge:	0	0.00%
Rush:	0	0%
Fern:	0	0.00%
Bryophyte:	0	0%

Species Richness:

Total Species:	18	
Native Species:	14	77.80%
Non-native Species:	4	22.20%

Duration Metrics:

Annual:	0	0.00%
Perennial:	17	94.40%
Biennial:	1	5.60%
Native Annual:	0	0.00%
Native Perennial:	14	77.80%
Native Biennial:	0	0.00%

Species Wetness:

Mean Wetness:	0.7
Native Mean Wetness:	0

Scientific Name	**Common Name**	**Acronym**	**Native?**	**C**	**W**
Abies balsamea	balsam fir	ABIBAL	native	3	0
Acer spicatum	mountain maple	ACESPI	native	5	3
Agrostis scabra; a. hyemalis	ticklegrass	AGRSCA	native	4	0
Betula papyrifera	paper birch	BETPAP	native	2	3
Chamerion angustifolium; epilobium a.	fireweed	CHAANG	native	3	0
Cornus sericea; c. stolonifera	red-osier	CORSER	native	2	-3
Deschampsia cespitosa	hair grass	DESCES	native	9	-3
Euthamia graminifolia	grass-leaved goldenrod	EUTGRA	native	3	0
Hieracium caespitosum	**king devil**	**HIECAE**	**non-native**	**0**	**5**
Poa nemoralis	**bluegrass**	**POANEM**	**non-native**	**0**	**3**
Populus tremuloides	quaking aspen	POPTRE	native	1	0
Prunus pensylvanica	pin cherry	PRUPEN	native	3	3
Rubus pubescens	dwarf raspberry	RUBPUB	native	4	-3
Rubus strigosus	wild red raspberry	RUBSTR	native	2	0
Sagina procumbens	**pearlwort**	**SAGPRO**	**non-native**	**0**	**0**
Salix bebbiana	bebbs willow	SALBEB	native	1	-3
Sorbus decora	mountain-ash	SORDEC	native	4	3
Verbascum thapsus	**common mullein**	**VERTHA**	**non-native**	**0**	**5**

Appendix 3 - Ojibwe Names for Plants Observed on Rabbit Island

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

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

Ojibwe Name	Restored	Page	Scientific Name	English Name
(g)odotaagaans	Yes	318	*Clintonia borealis*	bluebead-lily; corn-lily
(g)odotaagaans; ?ziiginise; ziiginish€	Yes	35	*Campanula rotundifolia*	harebell
(gi)chigamiiwashk, -oon	Yes	112	*Juncus dudleyi (*J. tenuis)*	path rush
?bebaamaabiig; okaaadaak; waaboozojiibik	Yes	235	*Aralia nudicaulis*	wild sarsaparilla
agongosimin, -an, -ag	Yes	326	*Maianthemum canadense*	canada mayflower
ah-o-je-mahg (adjimag)	No	333	*Sorbus americana; Sorbus decora*	mountain-ash
ajidamoowaanow; giiziso-mashkiki	Yes	349	*Solidago canadensis; S. altissima*	canada goldenrod
ana ' ganuck	No	378	*Dryopteris carthusiana (*D. cristata)*	spinulose woodfern
aninaandag, -oog; ininaandag, -oog; bigiwaandag, -oog; zhinbog, --g; zhingobaaandag, -oog; zhingob bigiwaandag	Yes	313	*Abies balsamea*	balsam fir
asa/isaweminagaawanzh (plant); asa/isawemin (berry)	Yes	256	*Prunus virginiana*	choke cherry
azaadi(i); azaadiins	Yes	253	*Populus tremuloides*	quaking aspen
bawa'iminaan; gozigwaakomin, -ag	Yes	329	*Prunus pensylvanica*	pin cherry
cigona ' gan	No	250	*Dendrolycopodium obscurum; D. dendroideum (*Lycopodium o.)*	ground-pine
gaagaagimizh; gaagaagiwa/inzh	Yes	309	*Tsuga canadensis*	hemlock
gaawaandag; gaawaandagwaatig; mina'ig; wadab; zesegaandag	Yes	327	*Picea glauca*	white spruce
gichi-ode'iminijiibik	Yes	49	*Potentilla norvegica*	rough cinquefoil
giizhik, -ag; gizhikens, -ag; giizhikenh	Yes	387	*Thuja occidentalis*	arbor vitae
kokbenognik keya; sasgob-mins	No	54	*Salix bebbiana (*Salix exigua)*	willows
makizin	Yes	376	*Cypripedium acaule (*C. calceolus)*	pink lady-slipper
maskwi ' widzhi ' wiko 'kok	No	312	*Viola macloskeyi (*V. canadensis)*	violets
mickiminu ' nimic	No	198	*Ilex mucronata (Nemopanthus mucronatus)*	mountain holly
miinagaawanzh (plant); miin, -an (berry)	Yes	227	*Vaccinium myrtilloides (*V. angustifolium)*	canada blueberry
miskominagaawanzh; miskwiminagaawanzh; miskomin, -ag; miskimin, -ag	Yes	125	*Rubus strigosus (R. idaeus)*	wild red raspberry
miskoobimizh; miskwaabiimizh	Yes	340	*Cornus sericea*	red-osier
miskwazi-wusk	No	47	*Physocarpus opulifolius*	Rosaceae
nawo 'buguk; wunukibugauh	No	336	*Trientalis borealis*	star-flower
ne 'bagandag '; pebamabid-singup	No	335	*Taxus canadensis*	yew
neezhodaeyun	No	325	*Linnaea borealis*	twinflower
ozaawaajiibik; ozaawijiibik	Yes	375	*Coptis trifolia*	goldthread
ozhaashijiibik; ozhaashijiibikens; zhooshkijiibik	Yes	106	*Chamerion angustifolium (Epilobium a.)*	fireweed

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

Ojibwe Name	Restored	Page	Scientific Name	English Name
skizgu-min	No	331	*Rubus pubescens*	dwarf raspberry
waabigwan	Yes	104	*Conyza canadensis*	horseweed
waabigwan; memisku 'nakuk	No	20	*Hieracium caespitosum (*H. kalmii)*	hawkweeds
waaboozobagoons; waaboozobanzh	Yes	42	*Gaultheria hispidula*	creeping-snowberry
waaboozojiibik	Yes	330	*Ribes glandulosum*	skunk currant
wezaawaaskoneg	Yes	41	*Euthamia graminifolia*	flat-topped goldenrod
wezauskwagmik; osawa ' skanet	No	245	*Diervilla lonicera*	bush-honeysuckle
wiigwaas, -an, -ag; wiigwaasaatig; wiigwaasi-mitig; wiigwaasimizh	Yes	239	*Betula papyrifera*	paper birch
wiinizik	Yes	277	*Betula alleghaniensis*	yellow birch
zeewunubugushk	No	298	*Oxalis acetosella*	northern wood-sorrel
zhaashaagobiimag	Yes	315	*Acer spicatum*	mountain maple
zhiishiiginewanzh, iig; zhiishiigimiiwanzh, -iig	Yes	229	*Acer rubrum*	red maple
zhingwaak	Yes	220	*Pinus strobus*	white pine