Natural Community Surveys of Beaver Island Archipelago

Prepared by:
Joshua G. Cohen
Michigan Natural Features Inventory
P.O. Box 13036
Lansing, MI 48901-3036

For:
Little Traverse Bay Bands of Odawa Indians
Natural Resources Department

December 31, 2017
Report Number 2017-11

MICHIGAN STATE UNIVERSITY | Extension

LITTLE TRAVERSE BAY BANDS OF ODAWA INDIANS
ODAWA NATURAL RESOURCE DEPARTMENT

Michigan Natural Features Inventory

Fox Lake Bog, Beaver Island. Photo by Joshua G. Cohen.

Suggested Citation: Cohen, J.G. 2017. Natural Community Surveys of Beaver Island Arhipelago. Michigan Natural Features Inventory. Report Number 2017-11, Lansing, MI. 162 pp.

Cover Photo: McCauley Point open dunes, Beaver Island. Photo by Bill Parsons.

ACKNOWLEDGMENTS

Funding for this project was generously provided by the Little Traverse Bay Bands of Odawa Indians. We express our sincere gratitude to the numerous Natural Resources Department (NRD) staff that helped administer and guide this project including Bill Parsons and Archie Kiogima, Sr. (pictured below). In addition, the following NRD staff assisted with field surveys: Noah Jansen (pictured below), Bill Parsons, Archie Kiogima, Sr., Kevin Haynes, and Maxwell Field. Bill Parsons also shared hundreds of excellent photos from the surveys, many of which are featured in this report, and Noah Jansen provided editorial review of the report. For their support and assistance throughout this project, we thank our MNFI colleagues, especially Helen Enander, Phyllis Higman, Aaron Kortenhoven, Bradford Slaughter, Jesse Lincoln, Clay Wilton, Michael Monfils, Rebecca Rogers, Kraig Korroch, Nancy Toben, and Brian Klatt.

Joshua Cohen (MNFI, above), Noah Jansen (Odawa NRD, above), and Archie Kiogima, Sr. (Odawa NRD, below) surveying Little Sand Bay interdunal wetland on Beaver Island. Photos by Bill Parsons.

TABLE OF CONTENTS

TABLE OF CONTENTS

Hog Island limestone cobble shore. Photo by Bill Parsons.

LIST OF FIGURES

LIST OF TABLES

APPENDIX

Hog Island rich conifer swamp. Photo by Joshua G. Cohen.

INTRODUCTION

The Michigan Natural Features Inventory (MNFI) database of high-quality occurrences of natural communities is a critical source of information on Michigan's terrestrial ecosystems (MNFI 2017). Natural communities are defined as assemblages of interacting plants, animals, and other organisms that repeatedly occur under similar environmental conditions across the landscape and are predominantly structured by natural processes rather than modern anthropogenic disturbances (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 survived and evolved over the millennia (Kost et al. 2007, Cohen et al. 2015). This report summarizes MNFI's natural community survey efforts over a three-year period in the Beaver Island Archipelago. Surveys for high-quality natural communities occurred from 2015 through 2017 on Beaver, Garden, High, and Hog Islands.

Prior to the implementation of this survey effort, 14 high-quality occurrences of natural communities had been documented on Beaver Island with nine of those occurrences occurring on state lands (Table 1). These natural community occurrences on Beaver Island represent seven of the 77 natural community types described for Michigan by Cohen et al. (2015). Prior to the implementation of these surveys, 12 high-quality occurrences of natural communities had been documented on Garden and High Islands (Table 2). These natural community occurrences represent eight of the 77 natural community types described for Michigan by Cohen et al. (2015). Among these 12 natural community occurrences from Garden and High Islands, four are represented by natural communities that are considered critically imperiled or imperiled at the global scale, including three high-quality occurrences of coastal fen and one Great Lakes marsh (NatureServe 2010). Prior to the implementation of these surveys, six high-quality occurrences of natural communities had been documented on Hog Island (Table 3). These natural community occurrences represent six of the 77 natural community types described for Michigan by Cohen et al. (2015). Among these six natural community occurrences from Hog Island, two are represented by natural communities that are considered critically imperiled or imperiled at the global scale, including a high-quality occurrence of coastal fen and Great Lakes marsh (NatureServe 2010).

Prior to this project, the majority of the natural community occurrences on these islands had not been surveyed in over a decade, including three sites that had not been visited since 1981 and three sites that had note been visited since 1986 (Tables 1-3). Many of the natural community element occurrences that were previously documented on the islands were in need of more thorough on-the-ground surveys informed by better aerial imagery to refine, and in many cases expand, their mapped boundaries. In addition, air photo interpretation of high-resolution imagery and historical imagery from the 1930s identified the potential for new occurrences of natural communities in several locations on these islands. A critical goal of this project was to collect updated and new data for natural communities to provide natural resource managers with accurate, detailed information on the current status of ecosystems on these islands that can help guide biodiversity management and restoration and ongoing planning efforts. Our project objectives were to assist resource agencies with land-use planning and resource management by (1) updating known high-quality occurrences of natural communities occurring on state land in the Beaver Island Archipelago, (2) conducting surveys for new occurrences of natural communities on state land in the Beaver Island Archipelago, (3) synthesizing survey results and information in MNFI's conservation database, and (4) proposing biodiversity stewardship and monitoring priorities in the Beaver Island Archipelago.

Surveys were conducted during the 2015, 2016, and 2017 field seasons. On Beaver Island, MNFI conducted surveys in 2015, 2016, and 2017 of ten previously known element occurrences on state land and documented seven new natural community element occurrences on state land. Nine different natural community types are represented in the 17 element occurrences surveyed on Beaver Island (Table 1 and Figure 1). On Garden and High

Table 1. Natural community element occurrences (EOs) on Beaver Island. The ^ indicates the EOs that occur on state land.

Community Type	EO ID	Survey Site	EO RANK	Prior EO RANK	Year First Observed	Year Last Observed
Bog^	12097	Fox Lake Bog	AB	AB	1977	2016
Bog^	20442	Greene's Lake	AB	AB	2015	2015
Boreal Forest^	6311	French Bay	B	C	1981	2016
Boreal Forest	2437	Little Sand Bay	C	BC	1981	2016
Dry-Mesic Northern Forest^	9259	Pointe La Par	B	AB	1999	2016
Interdunal Wetland^	6089	Little Sand Bay	BC	C	1981	2016
Mesic Northern Forest	9328	Font Lake Old Growth	CD	CD	1999	1999
Mesic Northern Forest	4742	Lake Genesereth Old Growth	CD	CD	1998	1998
Mesic Northern Forest^	626	Martin's Bluff	BC	B	1999	2016
Mesic Northern Forest^	10493	Southwest Old Growth	BC	B	1998	2016
Open Dunes^	530	Cable Bay	C	C	1998	2016
Open Dunes	9292	Iron Ore Bay	C	C	1998	1998
Open Dunes	6701	Lookout Point	CD	CD	2015	2015
Open Dunes^	20737	McCauley Point	C	NA	2016	2016
Open Dunes^	10808	McFadden Point	C	C	1981	2016
Open Dunes	5002	Sand Bay	C	C	1998	1998
Poor Conifer Swamp^	20688	Greene's Lake Swamp	AB	NA	2016	2016
Poor Fen^	2988	Egg Lake	B	B	2006	2016
Rich Conifer Swamp^	20690	Doty's Swamp	C	NA	2016	2017
Rich Conifer Swamp^	20689	Greene's Lake Swamp	BC	NA	2016	2017
Rich Conifer Swamp^	20692	Little Sand Bay	C	NA	2016	2016

Table 2. Natural community element occurrences (EOs) on High and Garden Islands.

Community Type	EO ID	Survey Site	EO RANK	Prior EO RANK	Year First Observed	Year Last Observed	Island
Boreal Forest	7487	Garden Island Boreal Forest	A	A	1998	2015	Garden Island
Boreal Forest	4856	High Island	AB	BC	1986	2015	High Island
Coastal Fen	21328	Indian Harbor	B	NA	2017	2017	Garden Island
Coastal Fen	7888	Jensen Harbor	A	A	1999	2015	Garden Island
Coastal Fen	9513	Sweat Lodge Swale	B	B	1998	2015	Garden Island
Coastal Fen	10574	Northcutt and Monatou Bays	AB	BC	1999	2015	Garden Island
Dry-Mesic Northern Forest	20453	High Island	B	NA	2015	2015	High Island
Great Lakes Barrens	20454	Nezewabegon Barrens	AB	NA	2015	2015	High Island
Great Lakes Marsh	13020	Indian Harbor	AB	AB	1999	2017	Garden Island
Great Lakes Marsh	20450	Taganing Marsh	A	NA	2015	2015	Garden Island
Limestone Cobble Shore	6527	High Island	AB	C	1986	2015	High Island
Limestone Cobble Shore	20448	Monatou Bay	A	NA	2015	2015	Garden Island
Limestone Cobble Shore	20449	Taganing Shore	B	NA	2015	2015	Garden Island
Mesic Northern Forest	10496	Red Oak Garden	C	C	1996	2015	Garden Island
Mesic Northern Forest	20452	Nezewabegon Forest	AB	NA	2015	2015	High Island
Northern Fen	11804	Garden Island Harbor	AB	A	1999	2017	Garden Island
Open Dunes	10698	High Island	A	B	1981	2015	High Island
Sand and Gravel Beach	10977	High Island Bay	A	A	1986	2015	High Island
Sand and Gravel Beach	13026	High Island	A	A	1986	2015	High Island
Wooded Dune and Swale Complex	20451	Taganing Dune and Swale	C	NA	2015	2015	Garden Island

Table 3. Natural community element occurrences (EOs) on Hog Island.

Community Type	EO ID	Survey Site	EO RANK	Prior EO RANK	Year First Observed	Year Last Observed
Coastal Fen	3734	Hog Island	A	A	1999	2017
Great Lakes Marsh	2179	Hog Island	AB	AB	1999	2017
Hardwood-Conifer Swamp	10623	Hog Island North	A	A	1999	1999
Limestone Cobble Shore	20447	Hog Island	AB	AB	2015	2017
Mesic Northern Forest	7843	Hog Island	B	B	1986	2015
Northern Fen	20446	Hog Island	AB	NA	2015	2015
Rich Conifer Swamp	9639	Hog Island	AB	B	1986	2015
Wooded Dune and Swale Complex	3913	Hog Island - East Shoreline	AB	AB	1999	1999

Open Dunes, High Island. Photo by Joshua G. Cohen.

Islands, MNFI conducted surveys in 2015 and 2017 of 12 previously known element occurrences and documented eight new natural community element occurrences. Eleven different natural community types are represented in the 20 element occurrences surveyed (Table 2 and Figure 2). On Hog Island, MNFI conducted surveys in 2015 and 2017 of four previously known element occurrences and documented two new natural community element occurrences. Six different natural community types are represented in the six element occurrences surveyed (Table 3 and Figure 2).

Surveys assessed the element occurrence ranking, classification, and delineation of these occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities associated with each site. The primary goal of this survey effort is to provide resource managers and planners with standardized, baseline information on each natural community element occurrence. 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 ecological surveys and also presents a prioritization of stewardship and monitoring of the natural community element occurrences found in the Beaver Island Archipelago.

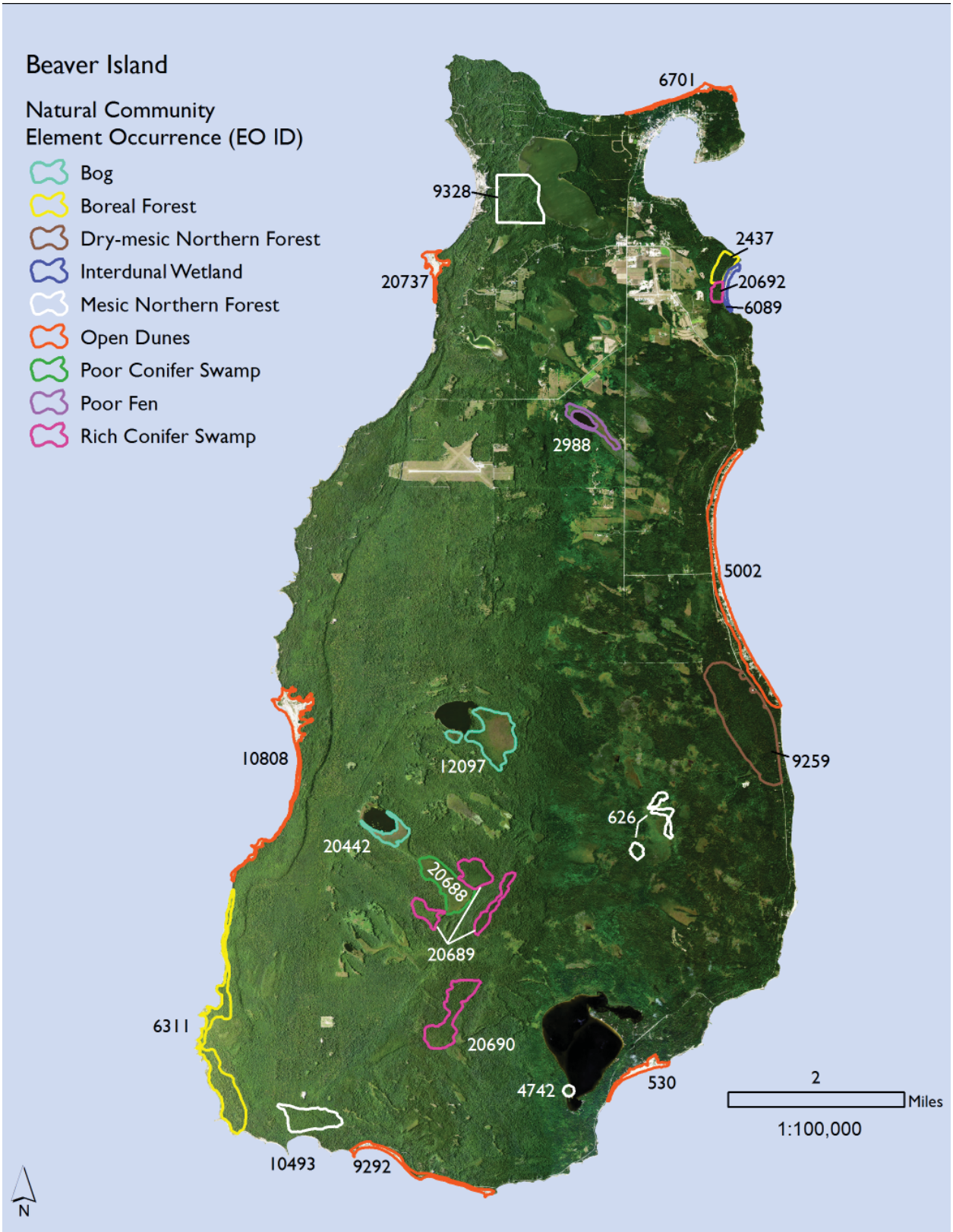


Figure 1. Natural community element occurrences (EOs) on Beaver Island.

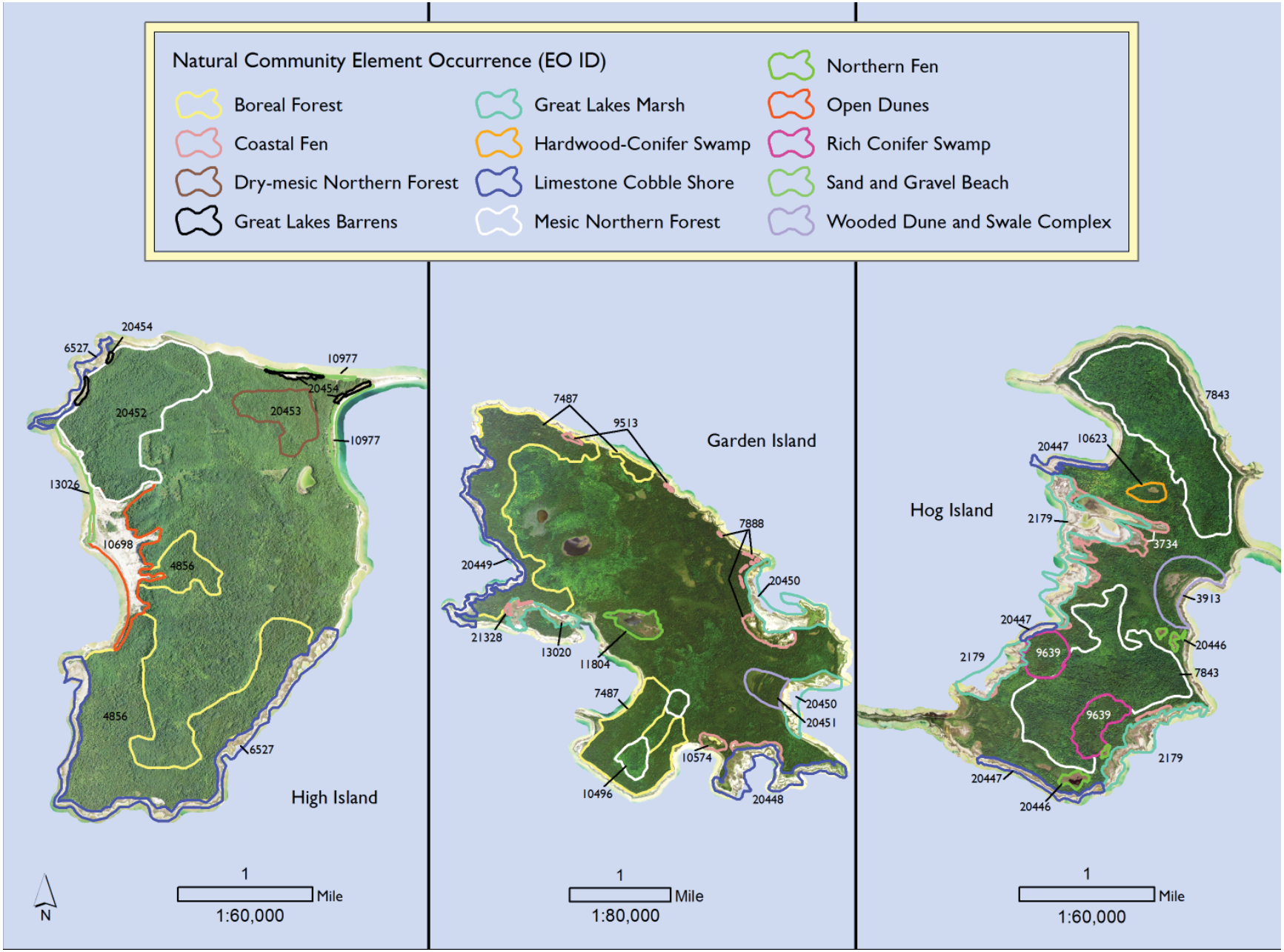


Figure 2. Natural community element occurrences (EOs) on Garden, High, and Hog Islands.

Old-growth yellow birch found within the Greene's Lake Swamp rich conifer swamp, Beaver Island. Photo by Bill Parsons.

METHODS

Field Survey Prioritization

Natural community surveys were targeted on state lands. Sites for survey were further prioritized by evaluating their date since last survey (with higher priority for older records). Targets for de novo survey were identified using aerial photographic interpretation focusing on rare ecosystems and based on past MNFI survey effort, and through site leads and recommendations from scientists with the Little Traverse Bay Bands of Odawa Indians Natural Resources Department.

Field Survey

A total of 43 high-quality natural communities were surveyed from 2015 through 2017 in the Beaver Island Archipelago with 17 surveyed on Beaver Island, 12 on Garden Island, 8 on High Island, and 6 on Hog Island (Tables 1-3). Each natural community was evaluated employing Natural Heritage and MNFI 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). If a site meets defined requirements for these three criteria (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 rank based on the consideration of its size, landscape context, and condition. Determination of element occurrence rankings is a qualitative process guided by MNFI's ranking criteria document (MNFI 1988) but also informed by comparing the natural community occurrence in question with other examples of that type across the state already described in MNFI's database (MNFI 2017).

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. Typically, a minimum of a half day was dedicated to each site, depending on the size and complexity of the site.

The ecological field surveys involved:

a) compiling comprehensive plant species lists and noting dominant and representative species
b) describing site-specific structural attributes and ecological processes
c) measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants (where appropriate)
d) analyzing soils and hydrology
e) noting current and historical anthropogenic disturbances
f) evaluating potential threats
g) ground-truthing aerial photographic interpretation using GPS (A Garmin unit was utilized)
h) taking digital photos and GPS points at significant locations
i) surveying adjacent lands when possible to assess landscape context
j) evaluating the natural community classification and mapped ecological boundaries
k) assigning or updating element occurrence ranks
l) noting management needs and restoration opportunities

Boreal forest, Little Sand Bay, Beaver Island. An increment borer was used to age canopy dominants. Photo by Joshua G. Cohen.

Soil reaction kits were used to estimate the soil pH for each natural community. Photo by Bill Parsons.

Where feasible, oblique photos were captured from tree tops. Photo by Bill Parsons.

Hog Island coastal fen above and white camas from McFadden Point open dunes below. For each natural community element occurrence, floristic composition and vegetative structure were documented. Photos by Bill Parsons.

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 2017). Natural community boundaries were mapped or re-mapped. Information from these surveys and prior surveys, if available, was used to produce site descriptions, threat assessments, and management recommendations for each natural community occurrence, which appear within the following **Survey Results** section.

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 severity index. We used the element occurrence rank to develop the ecological integrity rank, with higher scores for higher-ranked EOs. The rarity index was developed by assigning a score for each natural community type's state rank and global rank and averaging the two scores. For both state and global ranks, higher scores were assigned to rarer types. The threat severity index was developed using knowledge of general threats to natural community types and information gained during surveys on specific regional threats to natural community types. Higher scores for the threat severity index were assigned to sites with greater perceived threats. For each natural community element occurrence within the Beaver Island Archipelago, the sum of the scores for the ecological integrity index, rarity index, and threat severity index was calculated to sort the natural community element occurrences by their stewardship prioritization score. The stewardship prioritization for the natural community element occurrences found within the Beaver Island Archipelago is presented in the **Stewardship Prioritization Results** section.

Coastal Fen, Monatou Bay, Garden Island. Photo by Joshua G. Cohen.

SURVEY RESULTS

Forty-three occurrences of high-quality natural communities were surveyed during the 2015 through 2017 field seasons. A total of 16 different natural community types were visited including: bog (2 element occurrences or EOs), boreal forest (4 EOs), coastal fen (5 EOs), dry-mesic northern forest (2 EOs), Great Lakes barrens (1 EO), Great Lakes marsh (3 EOs), interdunal wetland (1 EO), limestone cobble shore (4 EOs), mesic northern forest (5 EOs), northern fen (2 EOs), open dunes (5 EOs), poor conifer swamp (1 EO), poor fen (1 EO), rich conifer swamp (4 EOs), sand and gravel beach (2 EOs), and wooded dune and swale complex (1 EO). Tables 1-3 list the visited sites, their element occurrence ranks, and their previous element occurrence ranks if applicable.

The following site summaries are organized alphabetically by community type and then by element occurrence for each of the 43 natural community EOs visited in 2015 through 2017 and summarize threats and management recommendations. Each grouping of communities begins with an overview of the natural community type, which was adapted from MNFI's natural community classification (Kost et al. 2007, Cohen et al. 2015). In addition, an ecoregional distribution map is provided for each natural community type (Albert et al. 2008). For each site summary, we indicate if the site is an update of a previously identified EO or a new EO and provide the following information:

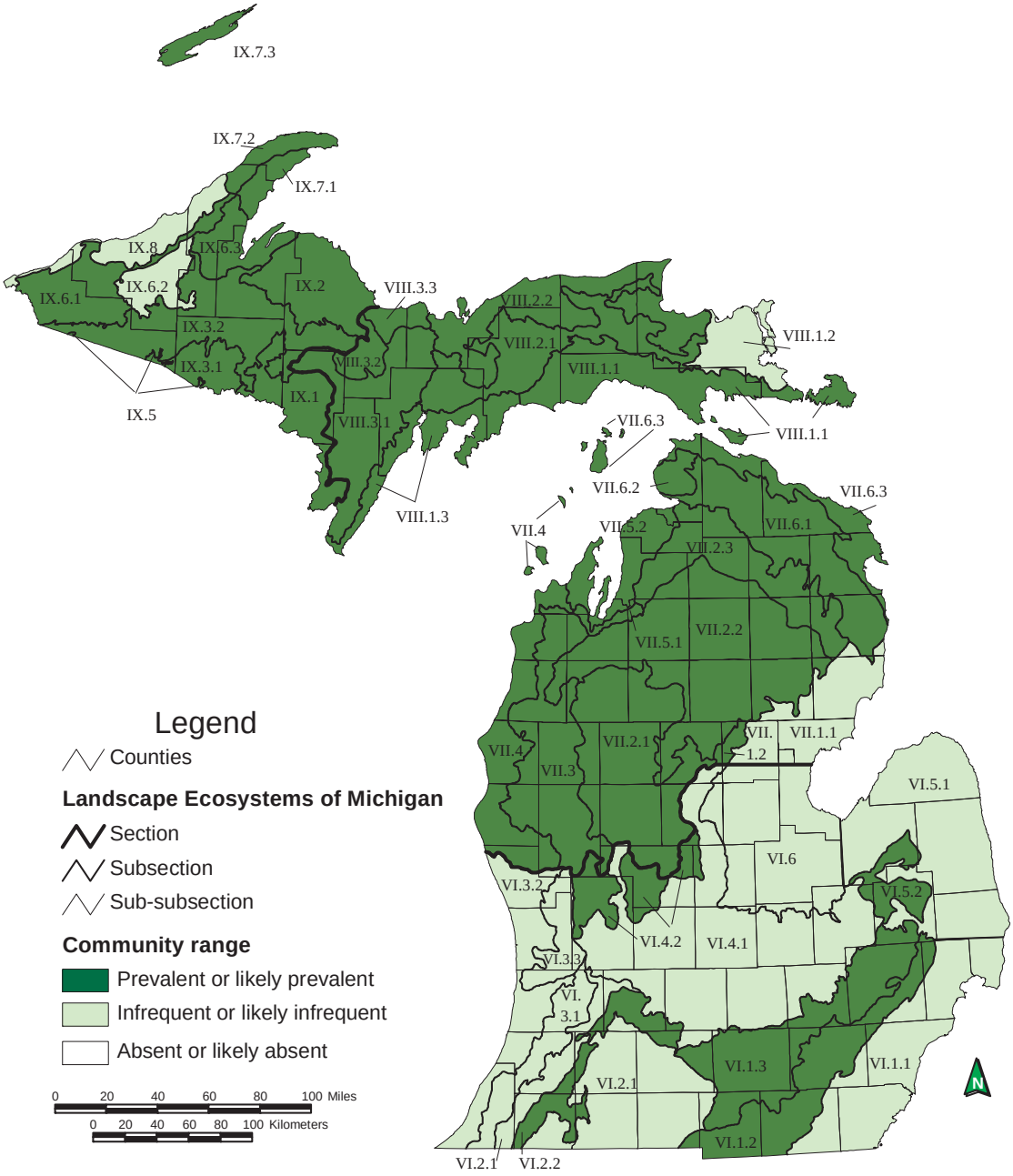
a) site name
b) natural community type
c) global and state rank (see Appendix 1 for ranking criteria)
d) current element occurrence rank
e) size
f) digital photograph(s)
g) locational information
h) site description
i) threat assessment
j) management recommendations

Great Lakes Marsh, Hog Island. Photo by Joshua G. Cohen.

SITE SUMMARIES

BOG

Overview: Bog is a nutrient-poor peatland characterized by acidic, saturated peat and the prevalence of sphagnum mosses and ericaceous shrubs. Located in depressions in glacial outwash and sandy glacial lakeplains and in kettles on pitted outwash and moraines, bogs frequently occur as a floating mat on the margins of lakes and ponds. Fire occurs naturally during drought periods and can alter the hydrology, mat surface, and flora. Beaver-induced flooding also influences bogs (Kost et al. 2007, Cohen et al. 2015).



Map 1. Distribution of bog in Michigan (Albert et al. 2008).

1. Fox Lake Bog
Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and secure within the state
Element Occurrence Rank: AB
Size: 155 acres
Location: Beaver Island
Element Occurrence Identification Number: 12097 (EO Update)

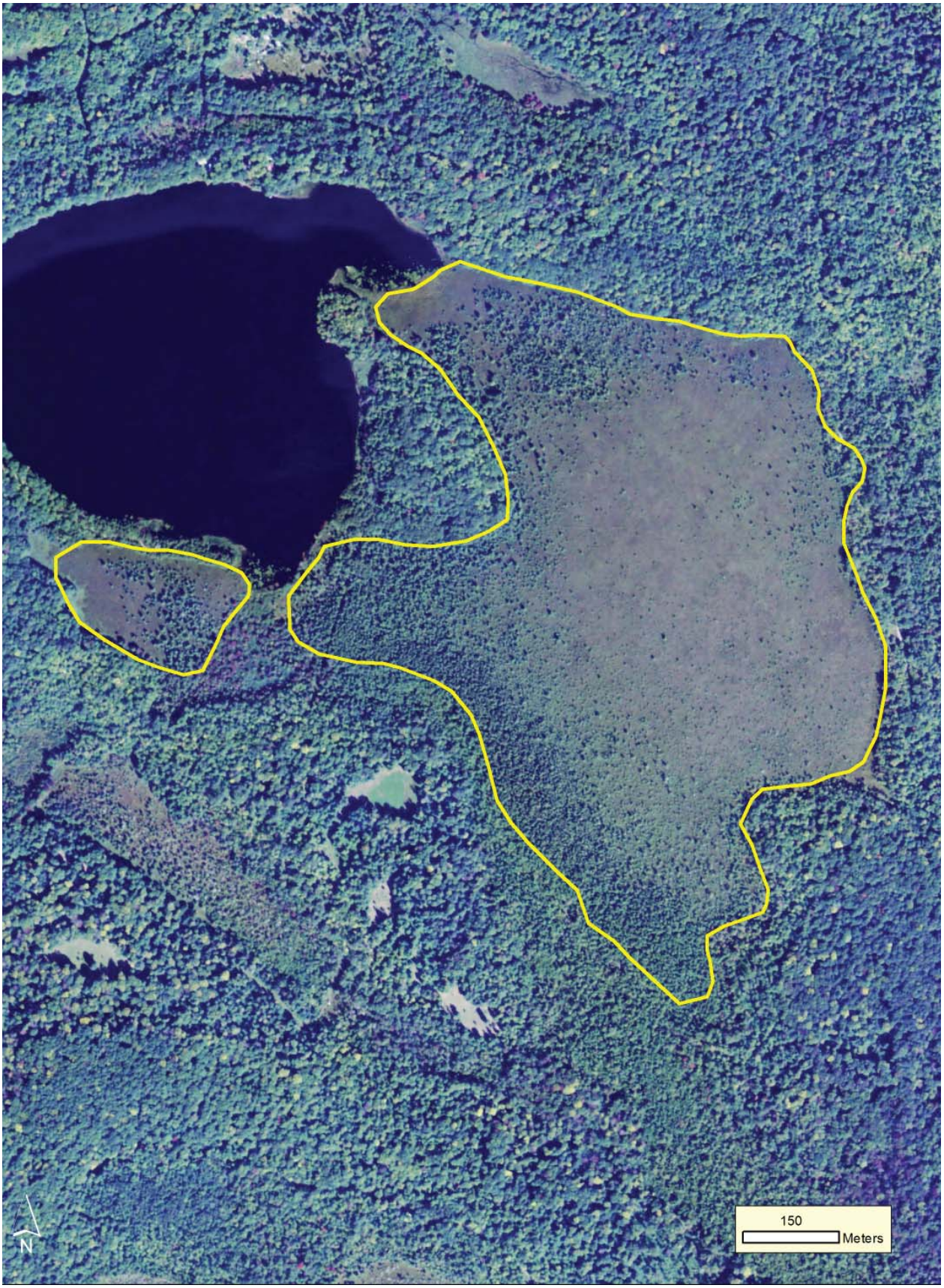
Site Description: This large ombrotrophic bog occurs on poorly drained lakeplain with deep sphagnum peats overlying sands. The sphagnum peats are strongly acidic and saturated with inundated peats occurring along the margins of Fox Lake. The lakeplain is level but diverse microtopography occurs due to sphagnum hummock and hollow development. Slightly less acidic conditions occur along the bog margin and along the floating bog mat adjacent to Fox Lake.

The bog is characterized by a scattered canopy of stunted conifers with tamarack (*Larix laricina*), black spruce (*Picea mariana*), white pine (*Pinus strobus*), and red pine (*P. resinosa*), which occurs locally. The canopy becomes denser, taller, and more closed along the bog margin where the bog mat is grounded or where paludification has occurred. The noted tree species also occur in the tall shrub and sapling layer. Along the bog margin where there is some groundwater influence, mountain holly (*Ilex mucronata*) and winterberry (*I. verticillata*) are locally dominant. Leatherleaf (*Chamaedaphne calyculata*) dominates the continuous and closed low shrub layer. Other prevalent ericaceous shrubs include bog laurel (*Kalmia polifolia*), Labrador tea (*Rhododendron groenlandicum*), and bog rosemary (*Andromeda glaucophylla*). Low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*) are locally dominant where the bog mat is grounded. The herbaceous layer is dominated by few-seed sedge (*Carex oligosperma*) along with sheathed cotton-grass (*Eriophorum spissum*). Wintergreen (*Gaultheria procumbens*) and small cranberry (*Vaccinium oxycoccos*) are common throughout. The floating bog mat adjacent to Fox Lake in the northwestern corner of the peatland supports higher biodiversity, characterized by the aforementioned species along with white beak-rush (*Rhynchospora alba*), twig-rush (*Dulichium arundinaceum*), pitcher-plant (*Sarracenia purpurea*), and round-leaved sundew (*Drosera rotundifolia*).

Threats: Uplands adjacent to and within the bog could be harvested, which would moderately influence the peat chemistry along the bog margin. The pine and aspen sand dune island within the bog could be harvested. Logging traffic could compact the peat and cause rutting. Reed canary grass (*Phalaris arundinacea*) could spread where the anthropogenic disturbances impact the hydrology and soil chemistry.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime. Portions of the bog and surrounding landscape that occur on private lands could be protected through acquisition or the establishment of conservation easements.

Fox Lake Bog. Photos by Joshua G. Cohen.



Aerial photograph of Fox Lake Bog.

2. Greene's Lake
Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and secure within the state
Element Occurrence Rank: AB
Size: 40 acres
Location: Beaver Island
Element Occurrence Identification Number: 20442 (New EO)

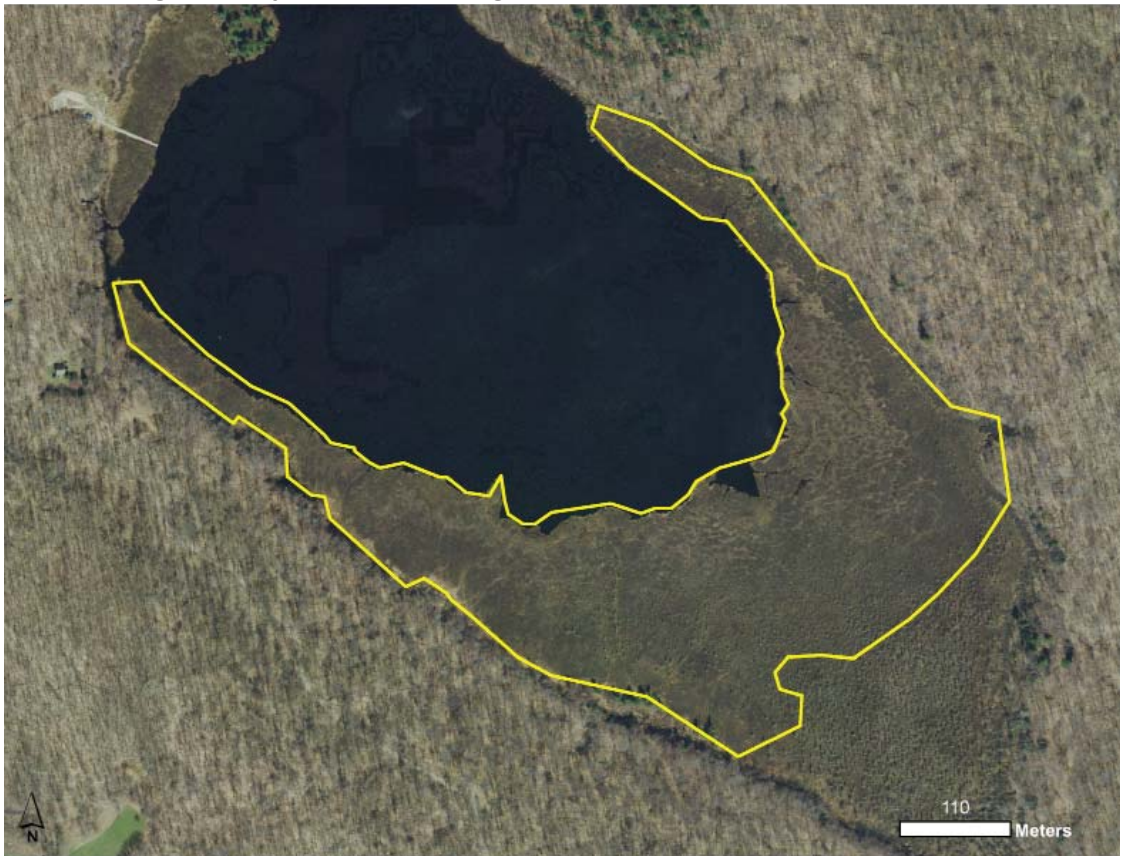
Site Description: Greene's lake bog is a weakly minerotrophic bog that occur along the southeastern portion of the Greene Lake basin in a poorly drained lakeplain with deep sphagnum peats overlying sands. The sphagnum peats are extremely acidic to very strongly acidic with well-developed sphagnum hummock and hollow microtopography. The presence and local abundance of minerotrophic indicators along the margins of the bog is evidence of localized groundwater/surface water enrichment of the sphagnum peat substrate.

The largest zone of the open bog is an inundated sphagnum mat on the eastern shore of Greene's Lake with pronounced hummock-hollow microtopography. This zone is strongly dominated by leatherleaf (*Chamaedaphne calyculata*) that occurs in a species-poor association with bog rosemary (*Andromeda glaucophylla*), bog willow (*Salix pedicellaris*), sedge (*Carex utriculata*), and large cranberry (*Vaccinium macrocarpon*). East of this area, tamarack (*Larix laricina*) increases in importance, and species richness of the bog increases. Leatherleaf is still dominant with associates including bog laurel (*Kalmia polifolia*), few-seed sedge (*Carex oligosperma*), royal fern (*Osmunda regalis*), pitcher-plant (*Sarracenia purpurea*), and small cranberry (*Vaccinium oxycoccos*). Closer to the margins of the bog, the tall shrub zone becomes more prevalent with open canopy tamarack overtopping thickets of mountain holly (*Ilex mucronata*) and winterberry (*I. verticillata*). Low shrub and ground cover species in this zone include black chokeberry (*Aronia prunifolia*), leatherleaf, Labrador tea (*Rhododendron groenlandicum*), lake sedge (*Carex lacustris*), and royal fern.

Threats: No significant disturbances or invasive plants were noted within the bog: the species composition and structure of the bog are driven by natural processes. The primary threat is hydrologic alteration that could occur if adjacent uplands are logged.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration. Wildfires should be allowed to burn the bog as well as the surrounding uplands.

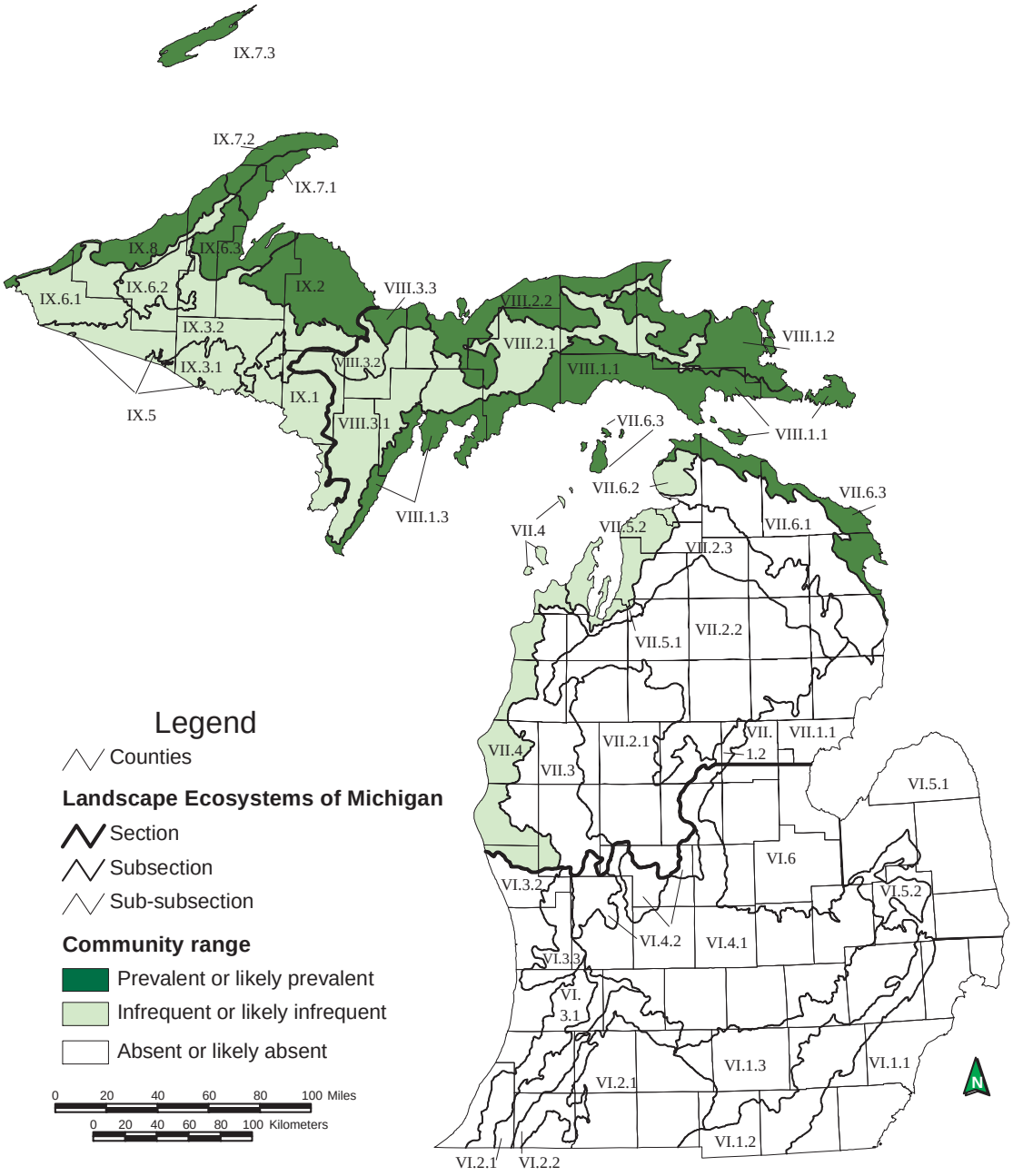
Greene's Lake Bog. Photo by Bradford S. Slaughter.



Aerial photograph of Greene's Lake Bog.

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 2. Distribution of boreal forest in Michigan (Albert et al. 2008).

3. French Bay
Natural Community Type: Boreal Forest
Rank: GU S3, globally unrankable and vulnerable within the state
Element Occurrence Rank: B
Size: 197 acres
Location: Beaver Island
Element Occurrence Identification Number: 6311 (EO update)

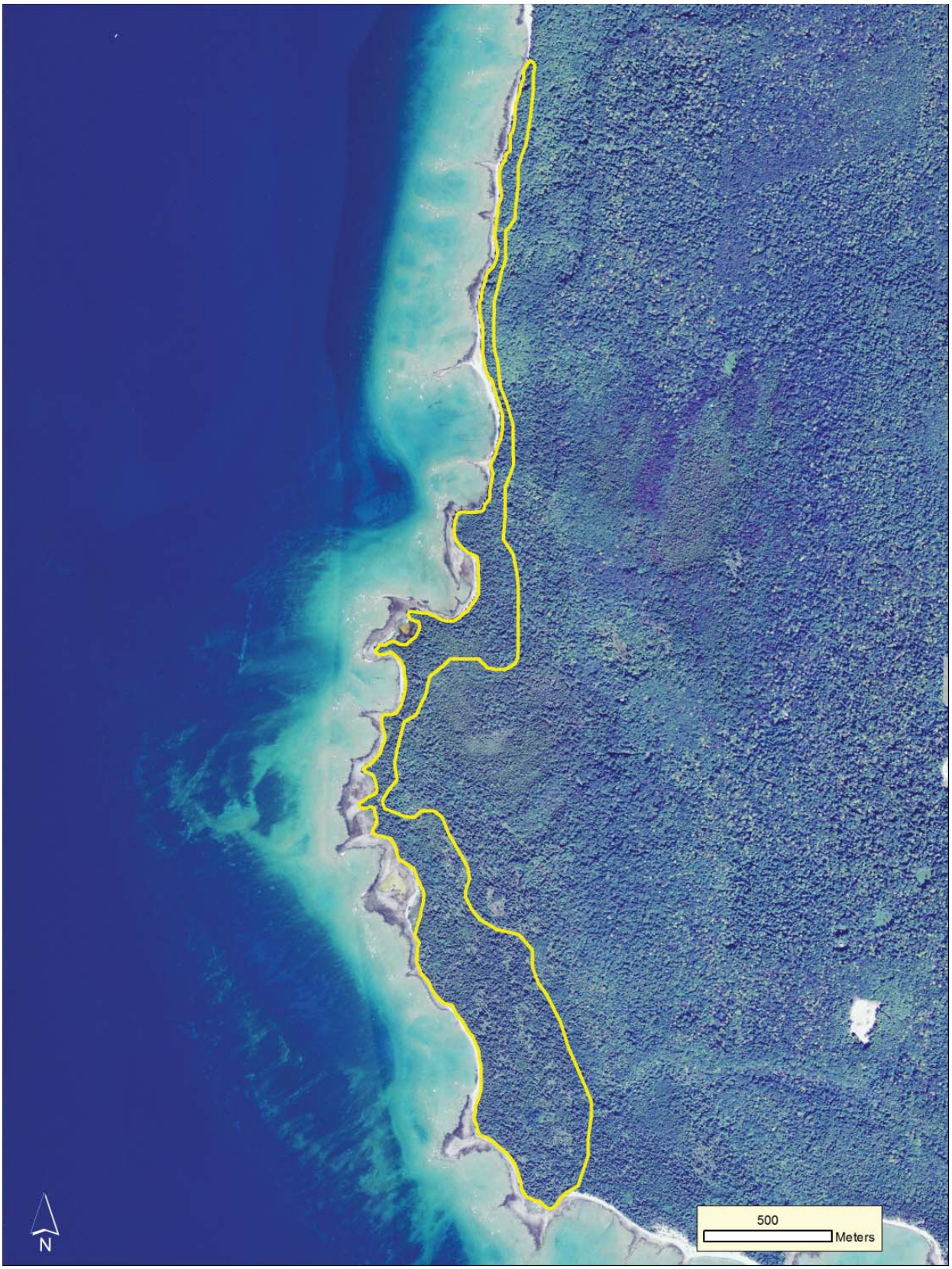
Site Description: Boreal forest occurs along the southwestern shoreline of Beaver Island. Adjacent shoreline communities include limestone cobble shore, sand and gravel beach, open dunes, and to a lesser extent Great Lakes marsh. Boreal forest is bordered along the inland margin by hardwood-conifer swamp, rich conifer swamp, dry-mesic northern forest, mature mesic northern forest, and early-successional forest. Much of the surrounding northern hardwoods have been logged. The mapped area of boreal forest contains inclusions of rich conifer swamp, mesic northern forest, and dry-mesic northern forest. Fine-scale gradients in hydrology and soils makes mapping this boreal forest precisely very difficult. The topography is rolling in areas where the boreal forest occurs on former cobble shore and sand shore. Windthrow is prevalent throughout and as a result, the boreal forest is characterized by high levels of coarse woody debris and uneven-aged stand patterning at multiple scales. Large areas of blowdown occur throughout as do small-scale windthrow gaps. A 50.2 cm red pine (*Pinus resinosa*) was cored and estimated to be over 140 years old (with excellent growth for the first 63 years). A 31.5 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be over 100 years old and a 51.5 cm northern white-cedar was cored and estimated to be over 120 years old. Deer trails occur throughout the boreal forest, which is likely used as a deer yard in the winter. The soils of the boreal forest are characterized by a shallow (5-10 cm), acidic (pH 4.5-5.0) A horizon over acidic (pH 5.0-6.0), medium-textured sands. The sands occur locally over cobble (50 cm of sand over cobble observed in one sample).

The boreal forest is dominated by northern white-cedar with canopy associates including white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), red maple (*Acer rubrum*), white pine (*Pinus strobus*), red pine, and red oak (*Quercus rubra*). Canopy trees typically range in DBH from 20 to 50 cm with some scattered larger DBH white pine and red oak (50-70 cm). Canopy closure ranges widely from 50 to 90% with areas of more open canopy (50-70%) occurring following large windthrow events. Where the boreal forest occurs on former sand shoreline features, pines are most prevalent in the canopy. Where the boreal forest occurs on former limestone cobble shore, northern white-cedar is dominant. The understory is typically sparse (5-15%) with some areas with more open canopy having higher densities (20-40%). Characteristic understory species include balsam fir (*Abies balsamea*), white spruce, trembling aspen, and beaked hazelnut (*Corylus cornuta*). Yew (*Taxus canadensis*) is noticeably absent from the understory and low shrub layer (yew is an overwhelming dominant on nearby High Island). The absence of yew is a likely indication that deer browse pressure has impacted the species composition and structure of this boreal forest. Prevalent species in the low shrub layer include wild red raspberry (*Rubus strigosus*), balsam fir, and Canada blueberry (*Vaccinium myrtilloides*) with soapberry (*Shepherdia canadensis*), Canadian fly honeysuckle (*Lonicera canadensis*), and snowberry (*Symphoricarpos albus*) occurring locally. Characteristic ground cover species include starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wild sarsaparilla (*Aralia nudicaulis*), sedges (*Carex pedunculata* and *C. eburnea*), oak fern (*Gymnocarpium dryopteris*), big-leaved aster (*Aster maculata*), gay-wings (*Polygala paucifolia*), bunchberry (*Cornus canadensis*), naked miterwort (*Mitela nuda*), goldthread (*Coptis trifolia*), bracken fern (*Pteridium aquilinum*), dwarf raspberry (*Rubus pubescens*), stiff clubmoss (*Spinulum annotinum*), and dwarf lake iris (*Iris lacustris*, state and federally threatened), which is a local dominant.

Threats: Species composition and vegetative structure are patterned by natural processes but have been influenced by past logging and deer herbivory. Deer trails and deer browse were noted throughout. Scattered cut stumps occur near the shoreline and near two-tracks.

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 boreal forest. Reducing deer densities on the island could be accomplished through culling and/or increasing late-successional habitat by allowing early-successional stands to senesce and succeed to more mature, shade-tolerant systems. In addition, establishment of deer exclosures within the site will foster conifer seedling and sapling regeneration. Placement of exclosures should be located around concentrations of coarse woody debris or nurse logs since these microsites provide important establishment sites for plants. The impacts of deer herbivory should be monitored, especially if exclosures are erected.

French Bay boreal forest. Photo by Joshua G. Cohen.



Aerial photograph of French Bay boreal forest.

4. Garden Island Boreal Forest
Natural Community Type: Boreal Forest
Rank: GU S3, globally unrankable and vulnerable within the state
Element Occurrence Rank: A
Size: 906 acres
Location: Garden Island
Element Occurrence Identification Number: 7487 (EO update)

Site Description: The Garden Island Boreal Forest is composed of three polygons of uneven-aged boreal forest occurring along the shoreline margin of Garden Island in the southern, northwestern, and northern portions of the island. Garden Island Boreal Forest is one of three A-ranked boreal forests in the state. Surveys in 2015 expanded the existing element occurrence. The boreal forest, which contains inclusions of rich conifer swamp and northern hardwoods, occurs on rolling topography of former cobble shore. Windthrow is prevalent throughout the forest, and as a result, the boreal forest is characterized by high levels of coarse woody debris. The coarse woody debris load is primarily composed of early-successional species, primarily balsam fir (*Abies balsamea*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*). Estimated tree ages ranged from 135 to 165 years old: a 32.7 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be over 145 years old; a 37.1 cm northern white-cedar was cored and estimated to be over 165 years old; and a 52.7 cm white pine (*Pinus strobus*) was cored and estimated to be over 135 years old. The soils within the boreal forest are characterized by shallow (1-4 cm), alkaline (pH 7.5-8.0) loams and loamy organics overlying limestone cobble.

Northern white-cedar dominates the canopy with overstory associates including balsam fir, paper birch, white spruce (*Picea glauca*), trembling aspen, and white pine. Canopy trees typically range in diameter at breast height (DBH) from 30 to 50 cm. Canopy closure ranges widely from 50% to 90% with areas of more open canopy (50-65%) occurring following large windthrow events. The understory is characterized by balsam fir, round-leaved dogwood (*Cornus rugosa*), mountain maple (*Acer spicatum*), red elderberry (*Sambucus racemosa*), beaked hazelnut (*Corylus cornuta*), trembling aspen, and sugar maple (*Acer saccharum*). Prevalent species in the low shrub layer include Canadian fly honeysuckle (*Lonicera canadensis*), bush honeysuckle (*Diervella lonicera*), yew (*Taxus canadensis*), wild red raspberry (*Rubus strigosus*), balsam fir, white ash (*Fraxinus americana*), and sugar maple. Characteristic ground cover species include starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wild sarsaparilla (*Aralia nudicaulis*), woodferns (*Dryopteris* spp.), sedge (*Carex pedunculata*), oak fern (*Gymnocarpium dryopteris*), large-leaved aster (*Eurybia macrophylla*), poison ivy (*Toxicodendron radicans*), gay-wings (*Polygala paucifolia*), false spikenard (*Maianthemum racemosum*), and herb Robert (*Geranium robertianum*).

Threats: Species composition and vegetative structure are patterned by natural processes. No threats were observed during the course of the survey. Scattered non-natives observed in the ground cover include bittersweet nightshade (*Solanum dulcamara*) (locally common) and helleborine (*Epipactis helleborine*).

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 boreal forest. The forest should be periodically monitored for invasive species and deer herbivory.

Garden Island Boreal Forest. Photos by Joshua G. Cohen.

Aerial photograph of Garden Island Boreal Forest.

5. High Island
Natural Community Type: Boreal Forest
Rank: GU S3, globally unrankable and vulnerable within the state
Element Occurrence Rank: AB
Size: 784 acres
Location: High Island
Element Occurrence Identification Number: 4856 (EO update)

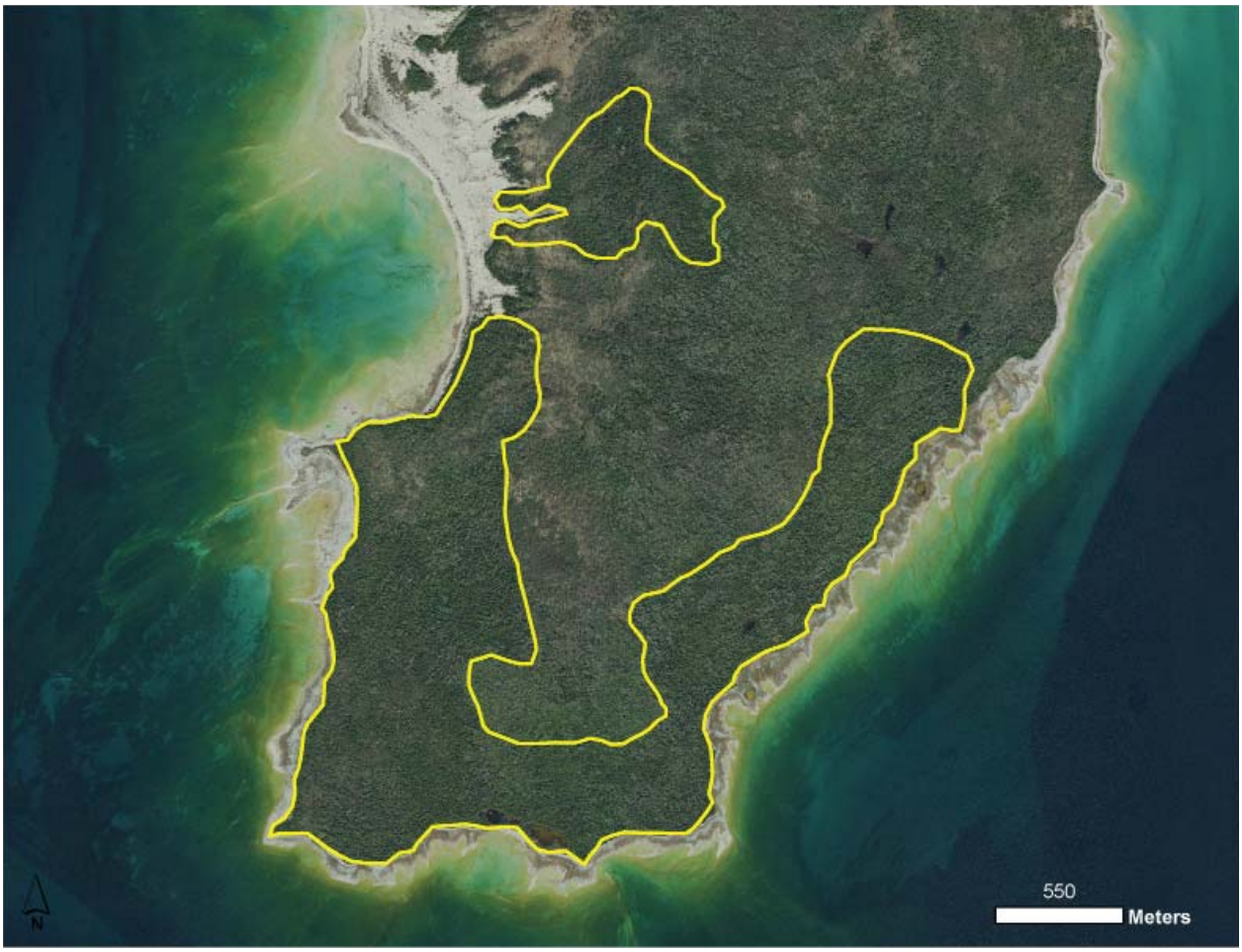
Site Description: The High Island boreal forest is composed of two polygons occurring along the southern portion and central-western portion of High Island. Surveys in 2015 expanded the existing element occurrence. The southern polygon of boreal forest occurs inland from limestone cobble shore on former cobble shore and the central-western polygon occurs inland from open dunes on former sand dunes. The mapped area of boreal forest contains inclusions of rich conifer swamp, mesic northern forest, and dry-mesic northern forest. Fine-scale gradients in hydrology and soils make precisely mapping this boreal forest very difficult. In addition, the prevalence of yew (*Taxus canadensis*) in the understory throughout the island makes mapping challenging because the yew generate a similar signature as conifer-dominated boreal forest. Where yew is an overwhelming dominant in the understory, this species is likely impacting species diversity and regeneration through competition for light resources. Topography ranges from rolling in areas where boreal forest occurs on former cobble shore to rugged where boreal forest occurs on former sand dune. Windthrow is prevalent throughout the forest and as a result, the boreal forest is characterized by high levels of coarse woody debris. A 50.5 cm white spruce (*Picea glauca*) was cored and estimated to be over 100 years old. The alkaline (pH 7.5-7.8) soils of the boreal forest are variable with sands, gravelly sands, and clayey sands and a shallow (10-20cm), acidic (pH 4.5-4.8) organic layer.

Northern white-cedar (*Thuja occidentalis*) dominates the canopy with overstory associates including white spruce, paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), red pine (*Pinus resinosa*), red oak (*Quercus rubra*), American mountain-ash (*Sorbus americana*), and white pine (*Pinus strobus*). Canopy trees typically range in DBH from 30 to 50 cm with wind-protected areas behind the dunes supporting larger trees (60-100cm). Canopy closure ranges widely from 50% to 90% with areas of more open canopy (50-70%) occurring following large windthrow events. The understory is overwhelmingly dominated by robust and dense yew. Understory associates include balsam fir (*Abies balsamea*), mountain maple (*Acer spicatum*), choke cherry (*Prunus virginiana*), red maple, and northern white-cedar. Yew is also dominat in the low shrub layer with associates including Canadian fly honeysuckle (*Lonicera canadensis*), mountain maple, balsam fir, and beaked hazelnut (*Corylus cornuta*). Characteristic ground cover species include starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wild sarsaparilla (*Aralia nudicaulis*), bunchberry (*Cornus canadensis*), gay-wings (*Polygala paucifolia*), Jack-in-the-pulpit (*Arisaema triphyllum*), and rattlesnake plantains (*Goodyera* spp.)

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

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 boreal forest. The forest should be periodically monitored for invasive species and deer herbivory.

High Island boreal forest. Photos by Joshua G. Cohen.



Aerial photograph of High Island boreal forest.

6. Little Sand Bay
Natural Community Type: Boreal Forest
Rank: GU S3, globally unrankable and vulnerable within the state
Element Occurrence Rank: C
Size: 37 acres
Location: Beaver Island
Element Occurrence Identification Number: 2437 (EO update)

Site Description: Boreal forest occurs along the northeastern shoreline of Beaver Island. The boreal forest occurs adjacent to a sandy bay that supports interdunal wetland and a low foredune with open dunes vegetation. To the south of the boreal forest is a small pocket of rich conifer swamp. Immediately adjacent to the boreal forest to the east is a narrow forested swale that has been flooded by beaver and as a result, the canopy of northern white-cedars (*Thuja occidentalis*) is flood-killed. Inland from the boreal forest is managed northern hardwoods. The mapped area of boreal forest contains inclusions of rich conifer swamp and mesic northern forest. Fine-scale gradients in hydrology and soils makes mapping this boreal forest precisely very difficult. The topography of the boreal forest is rolling, occurring on former sandy shoreline. Windthrow is prevalent throughout and as a result, the boreal forest is characterized by high levels of coarse woody debris and uneven-aged stand patterning at multiple scales. Large areas of blowdown occur throughout as do small-scale windthrow gaps. A 31 cm northern white-cedar was cored and estimated to be 145 years old. A 61 cm red oak (*Quercus rubra*) was cored and estimated to be 180 years old. Beaver sign and deer browse occur throughout the boreal forest. The soils of the boreal forest are characterized by a shallow (5 cm), acidic (pH 4.5) A horizon over slightly acidic to circumneutral (pH 6.5-7.0) medium-textured sands.

The boreal forest is dominated by northern white-cedar with canopy associates including paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), trembling aspen (*P. tremuloides*), red maple (*Acer rubrum*), hemlock (*Tsuga canadensis*), and red oak. Canopy trees typically range in DBH from 20 to 40 cm with some scattered larger DBH trembling aspen, red oak, and hemlock (60-80 cm). Canopy closure ranges widely from 65 to 90% with areas of more open canopy (50-70%) occurring following large windthrow events. The understory ranges from 15 to 35% and characteristic understory species include balsam fir (*Abies balsamea*), mountain maple (*Acer spicatum*), striped maple (*A. pensylvanicum*), trembling aspen, and northern white-cedar, which occurs locally in areas of heavy blowdown. Yew (*Taxus canadensis*) is noticeably absent from the understory and low shrub layer (yew is an overwhelming dominant on nearby High Island). The absence of yew is a likely indication that deer browse pressure has impacted the species composition and structure of this boreal forest. Prevalent species in the low shrub layer include balsam fir, Canadian fly honeysuckle (*Lonicera canadensis*), white ash (*Fraxinus americana*), and striped maple. Characteristic ground cover species include starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wild sarsaparilla (*Aralia nudicaulis*), sedge (*Carex pedunculata*), goldthread (*Coptis trifolia*), bracken fern (*Pteridium aquilinum*), and stiff clubmoss (*Spinulum annotinum*).

Threats: Species composition and vegetative structure are patterned by natural processes but have been influenced by past logging, deer herbivory, and beaver flooding. Deer browse was noted throughout.

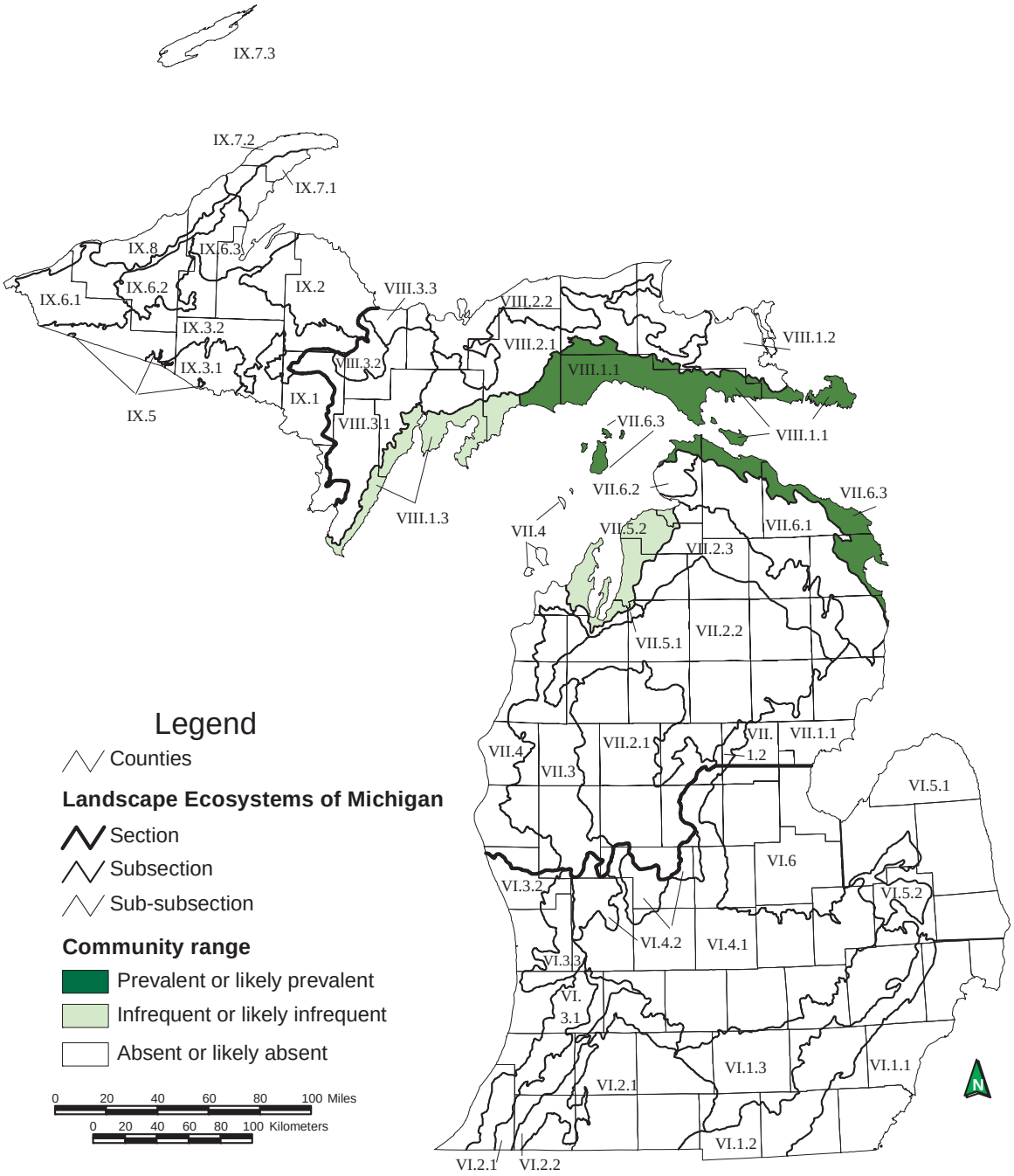
Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to retain an intact buffer of natural communities surrounding the boreal forest. The forest should be periodically monitored for invasive species and deer herbivory.

Little Sand Bay boreal forest. Photos by Joshua G. Cohen.

Aerial photograph of Little Sand Bay boreal forest.

COASTAL FEN

Overview: Coastal fen is a sedge- and rush-dominated wetland that occurs on calcareous substrates along Lake Huron and Lake Michigan north of the climatic tension zone. The community occurs where marl and organic soils accumulate in protected coves and abandoned coastal embayments and grade to moderately alkaline glacial tills and lacustrine sediments lakeward. Sediments along the lakeshore are typically fine-textured and rich in calcium and magnesium carbonates. Vegetation is comprised primarily of calcicolous species capable of growing on wet alkaline substrates (Kost et al. 2007, Cohen et al. 2015).



Map 3. Distribution of coastal fen in Michigan (Albert et al. 2008).

7. Hog Island
Natural Community Type: Coastal Fen
Rank: G1G2 S2, globally critically imperiled to imperiled and imperiled within the state
Element Occurrence Rank: A
Size: 60 acres
Location: Hog Island
Element Occurrence Identification Number: 3734 (EO update)

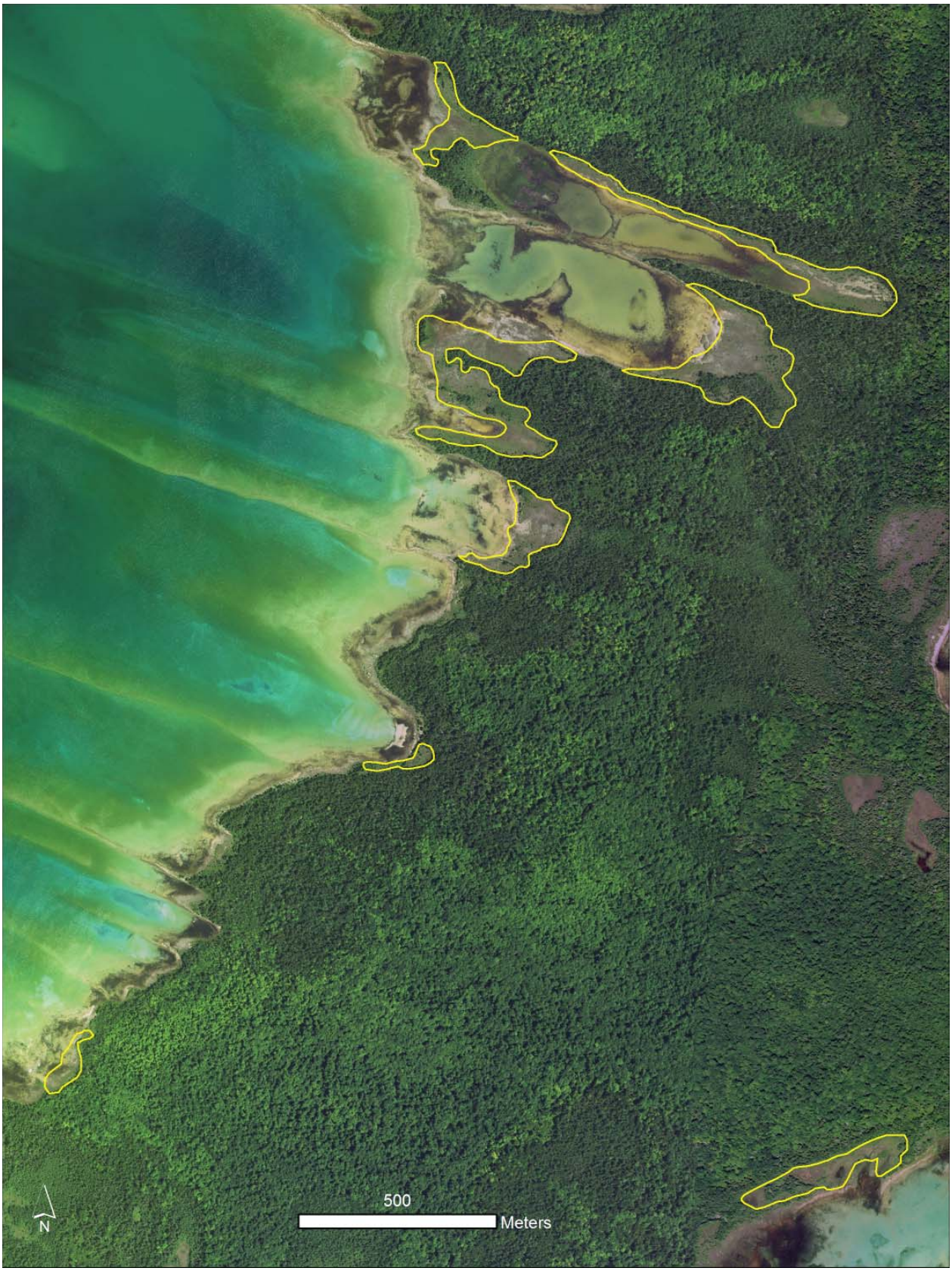
Site Description: Extensive coastal fen occurs along the shoreline of Hog Island. This coastal fen is one of five A-ranked coastal fens in the state. The coastal fen grades to Great Lakes marsh and limestone cobble shore lakeward and the margin between these communities shifts from year to year with fluctuations of the Great Lakes. The fen was surveyed in 2015 and 2017, both high water years. Portions of coastal fen were inundated in August, 2017 by 5 to 20 cm of water and appear to be transitioning to Great Lakes marsh. The coastal complex is backed by rich conifer swamp and boreal forest. Soils of the coastal fen are characterized as shallow (5-20 cm deep), alkaline peats (pH 7.8-8.0) and marl (pH 8.0) occurring over wet alkaline (pH 8.0) gravelly, sands and cobble. Scattered sphagnum hummocks are concentrated along the inland margin of the fen. Where sphagnum hummocks are beginning to develop, there are fine-scale gradients in soil moisture and soil chemistry with the tops of the sphagnum hummocks being acidic (pH 4.5). In an inland portion of the fen where sphagnum hummock and hollow topography is well developed, a 13.5 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be over 175 years old. Numerous marl pools and crayfish burrows occur throughout the fen. Portions of this fen, especially adjacent to Baldimore Bay, appear to support habitat for Hine's emerald dragonfly (*Somatochlora hineana*, state and federally threatened).

Dominant ground cover vegetation include wiregrass sedge (*Carex lasiocarpa*), threesquare (*Schoenoplectus pungens*), white beak-rush (*Rhynchospora alba*), beak-rush (*R. capillacea*), twig-rush (*Cladium mariscoides*), and Baltic rush (*Juncus balticus*). Additional characteristic species include Kalm's lobelia (*Lobelia kalmii*), bird's-eye primrose (*Primula mistassinica*), limestone calamint (*Clinopodium arkansanum*), false asphodel (*Triantha glutinosa*), sundews (*Drosera* spp.), bladderworts (*Utricularia* spp.), grass-of-Parnassus (*Parnassia glauca*), small cranberry (*Vaccinium oxycoccos*), large cranberry (*V. macrocarpon*), goldenrods (*Solidago* spp.), little bluestem (*Schizachyrium scoparium*), northern ragwort (*Packera paupercula*), and joe-pye-weed (*Eutrochium maculatum*). Scattered low shrubs (15-30% cover) include shrubby cinquefoil (*Dasiphora fruticosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), alder-leaved buckthorn (*Rhamnus alnifolia*), and soapberry (*Shepherdia canadensis*), and scattered understory (10-20% cover) and overstory (1-2%) conifers include northern white-cedar and tamarack (*Larix laricina*).

Threats: Species composition and zonation are patterned by natural processes. No threats were observed during the survey.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain a natural community buffer surrounding the shoreline to minimize surface water flow into the fen and to maintain groundwater seepage, and monitor for invasive plant populations.

Hog Island coastal fen. Photos by Joshua G. Cohen.



Aerial photograph of Hog Island coastal fen.

8. Indian Harbor
Natural Community Type: Coastal Fen
Rank: G1G2 S2, globally critically imperiled to imperiled and imperiled within the state
Element Occurrence Rank: B
Size: 4 acres
Location: Garden Island
Element Occurrence Identification Number: 21328 (New EO)

Site Description: This coastal fen occurs adjacent to Great Lakes marsh in Indian Harbor on Garden Island. The coastal fen grades to Great Lakes marsh and limestone cobble shore lakeward and the margin between these communities shifts from year to year with fluctuations of the Great Lakes. The site was surveyed in 2017, a high water year. Portions of the coastal fen were inundated in August. The coastal complex is backed by rich conifer swamp and boreal forest. Soils of the coastal fen are characterized as shallow (1-2 cm deep) alkaline (pH 8.0) organics over wet, alkaline, gravelly sands and cobble. Ant mounds occur scattered within the fen.

Characteristic ground cover vegetation include wiregrass sedge (*Carex lasiocarpa*), sedge (*Carex flava*), twig-rush (*Cladium mariscoides*), beak-rush (*Rhynchospora capillacea*), false asphodel (*Triantha glutinosa*), grass-of-Parnassus (*Parnassia glauca*), Kalm's lobelia (*Lobelia kalmii*), Ohio goldenrod (*Solidago ohioensis*), blue-joint (*Calamagrostis canadensis*), limestone calamint (*Clinopodium arkansanum*), bastard-toadflax (*Comandra umbellata*), common bog arrow-grass (*Triglochin maritima*), and Baltic rush (*Juncus balticus*). Scattered low shrubs (60-70%) include shrubby cinquefoil (*Dasiphora fruticosa*) and Kalm's St. John's-wort (*Hypericum kalmianum*) and scattered northern white-cedar (*Thuja occidentalis*) occurs in the understory (1-2% cover). Accumulation of organics within the coastal fen is correlated with the occurrence of scattered shrubs and northern white-cedar.

Threats: Species composition and zonation are patterned by natural processes. No threats were observed during the survey.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain a natural community buffer surrounding the shoreline to minimize surface water flow into the fen and to maintain groundwater seepage, and monitor for invasive plant populations.

Indian Harbor coastal fen. Photos by Joshua G. Cohen.

Aerial photograph of Indian Harbor coastal fen.

9. Jensen Harbor
Natural Community Type: Coastal Fen
Rank: G1G2 S2, globally critically imperiled to imperiled and imperiled within the state
Element Occurrence Rank: A
Size: 59 acres
Location: Garden Island
Element Occurrence Identification Number: 7888 (EO update)

Site Description: The Jensen Harbor coastal fen occurs on Garden Island in Jensen Harbor and also along the shoreline to the northwest of Jensen Harbor. This coastal fen is one of five A-ranked coastal fens in the state. The coastal fen grades to Great Lakes marsh lakeward and the margin between these communities shifts from year to year with fluctuations of the Great Lakes. Following surveys in 2015, the boundaries of this coastal fen were adjusted with a new Great Lakes marsh element occurrence (Taganing Marsh, EO ID 20450) also being mapped in Jensen Harbor. Within the coastal fen, the soils are characterized as alkaline (pH 8.0) peat and marl over wet alkaline (pH 8.0) sands. Scattered sphagnum hummocks are concentrated along the inland margin of the fen. Numerous marl pools and crayfish burrows occur throughout the fen.

Dominant ground cover vegetation include spike-rush (*Eleocharis rostellata*), twig-rush (*Cladium mariscoides*), beak-rush (*Rhynchospora capillacea*), tufted bulrush (*Trichophorum cespitosum*), and sedges (*Carex* spp.). Additional characteristic species include butterwort (*Pinguicula vulgaris*, state special concern), pitcher-plant (*Sarracenia purpurea*), false asphodel (*Triantha glutinosa*), grass-of-Parnassus (*Parnassia glauca*), bird's-eye primrose (*Primula mistassinica*), hardstem bulrush (*Schoenoplectus acutus*), Kalm's lobelia (*Lobelia kalmii*), blue-joint (*Calamagrostis canadensis*), white beak-rush (*Rhynchospora alba*), round-leaved sundew (*Drosera rotundifolia*), and small cranberry (*Vaccinium oxycoccos*). Scattered low shrubs include shrubby cinquefoil (*Dasiphora fruticosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), sweet gale (*Myrica gale*), alder-leaved buckthorn (*Rhamnus alnifolia*), bog rosemary (*Andromeda glaucophylla*), and Labrador-tea (*Rhododendron groenlandicum*), and scattered understory species include northern white-cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), and trembling aspen (*Populus tremuloides*). This fen supports a population of Hine's emerald dragonfly (*Somatochlora hineana*, state and federally threatened).

Threats: Species composition and zonation are patterned by natural processes. No threats were observed during the survey.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain a natural community buffer surrounding the shoreline to minimize surface water flow into the fen and to maintain groundwater seepage, and monitor for invasive plant populations.

Jensen Harbor coastal fen. Photos by Joshua G. Cohen.

Aerial photograph of Jensen Harbor coastal fen.


Jensen Harbor coastal fen. Photo by Joshua G. Cohen.

10. Northcutt and Monatou Bays
Natural Community Type: Coastal Fen
Rank: G1G2 S2, globally critically imperiled to imperiled and imperiled within the state
Element Occurrence Rank: AB
Size: 37 acres
Location: Garden Island
Element Occurrence Identification Number: 10574 (EO update)

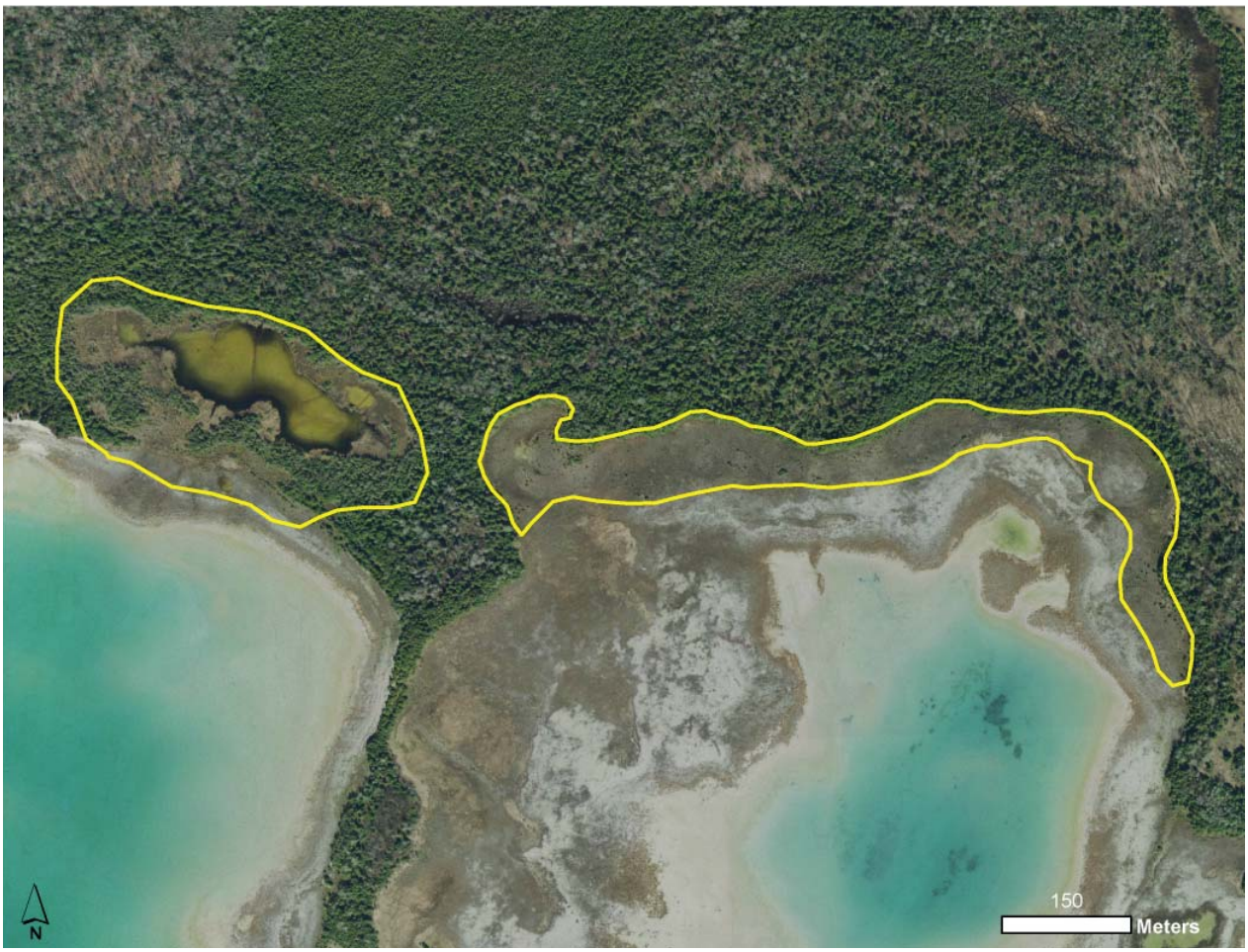
Site Description: This coastal fen occurs in Northcutt and Monatou Bays on Garden Island. In 2015, surveys focused on the shoreline in Monatou Bay just east of Northcutt Bay. Surveys resulted in the expansion of this coastal fen to include areas of fen along the Monatou Bay shoreline. This area of coastal fen grades to Great Lakes marsh and limestone cobble shore lakeward and the margin between these communities shifts from year to year with fluctuations of the Great Lakes. Soils of the coastal fen in Monatou Bay are characterized as alkaline (pH 8.0) gravelly marl. Soils of the coastal fen in Northcutt Bay are characterized as shallow (8-10cm) organics over alkaline (pH 8.0) sands. Scattered sphagnum hummocks are concentrated along the inland margin of the fen. Numerous marl pools occur throughout the Monatou Bay fen.

Within the Monatou Bay coastal fen characteristic ground cover vegetation include tufted bulrush (*Trichophorum cespitosum*), sedge (*Carex livida*), twig-rush (*Cladium mariscoides*), pitcher-plant (*Sarracenia purpurea*), false asphodel (*Triantha glutinosa*), grass-of-Parnassus (*Parnassia glauca*), bird's-eye primrose (*Primula mistassinica*), hardstem bulrush (*Schoenoplectus acutus*), bog goldenrod (*Solidago uliginosa*), and Indian paintbrush (*Castilleja coccinea*). Areas around the marl pools include spatulate-leaved sundew (*Drosera intermedia*), pitcher-plant, and tufted bulrush. Shrubby cinquefoil (*Dasiphora fruticosa*) is prevalent in the low shrub layer and scattered understory species include northern white-cedar (*Thuja occidentalis*) and tamarack (*Larix laricina*). The portion of fen associated with Northcutt Bay wraps around a large marl pond and is dominated by a mat of wiregrass sedge (*Carex lasiocarpa*) with associates including tufted bulrush, bulrush (*Trichophorum alpinum*), pitcher-plant, false asphodel, bog goldenrod, Indian paintbrush, and bastard-toadflax (*Comandra umbellata*). The coastal fen in Monatou Bay appears to have suitable habitat for Hine's emerald dragonfly (*Somatochlora hineana*, state and federally threatened).

Threats: Species composition and zonation are patterned by natural processes. No threats were observed during the survey.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain a natural community buffer surrounding the shoreline to minimize surface water flow into the fen and to maintain groundwater seepage, and monitor for invasive plant populations.

Northcutt and Monatou Bays coastal fen. Photos from Monatou Bay by Joshua G. Cohen.



Aerial photograph of Northcutt (left) and Monatou (right) Bays coastal fen.


Northcutt and Monatou Bays coastal fen. Photo from Monatou Bay by Joshua G. Cohen.

11. Sweat Lodge Swale
Natural Community Type: Coastal Fen
Rank: G1G2 S2, globally critically imperiled to imperiled and imperiled within the state
Element Occurrence Rank: B
Size: 6.7 acres
Location: Garden Island
Element Occurrence Identification Number: 9513 (EO update)

Site Description: Sweat Lodge Swale is a coastal fen composed of two distinct polygons that occur along the northern shore of Garden Island. This coastal fen is backed by boreal forest and limestone cobble shore occurs lakeward. The soils are characterized as shallow, alkaline (pH 7.5-8.0) organics over cobble. Scattered sphagnum hummocks are concentrated along the inland margin of the fen and a marl pool occurs in the eastern portion of the largest fen polygon.

Dominant ground cover vegetation include tufted bulrush (*Trichophorum cespitosum*), threesquare (*Schoenoplectus pungens*), and twig-rush (*Cladium mariscoides*) with additional characteristic species including Baltic rush (*Juncus balticus*), Kalm's lobelia (*Lobelia kalmii*), reed (*Phragmites australis* subsp. *americanus*, native), horned bladderwort (*Utricularia cornuta*), and silverweed (*Potentilla anserina*). The low shrub layer is prevalent, especially in narrow portions of fen and includes shrubby cinquefoil (*Dasiphora fruticosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), and northern white-cedar (*Thuja occidentalis*).

Threats: Species composition and zonation are patterned by natural processes. No threats were observed during the survey.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain a natural community buffer surrounding the shoreline to minimize surface water flow into the fen and to maintain groundwater seepage, and monitor for invasive plant populations.

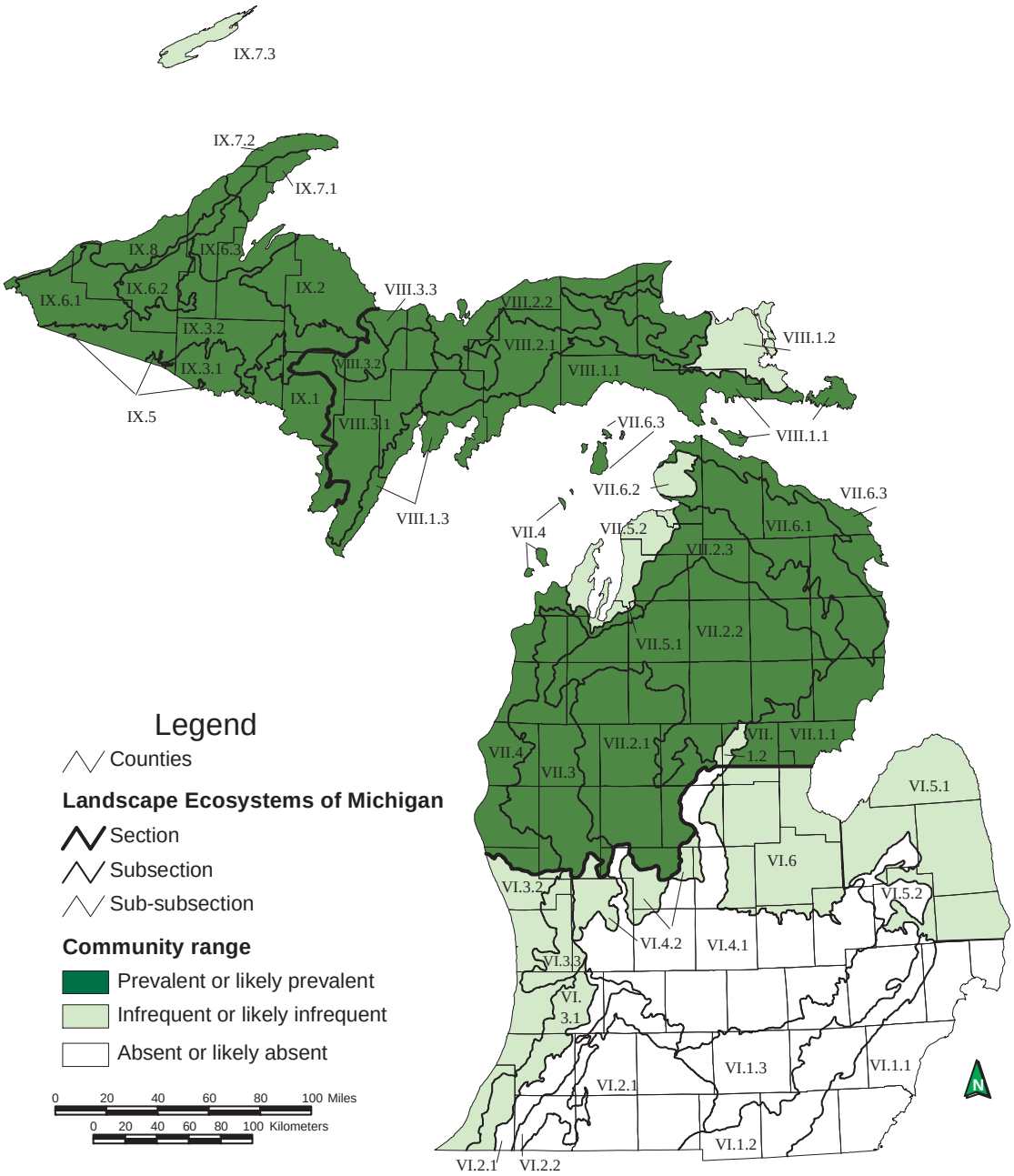
Sweat Lodge Swale coastal fen. Photo by Joshua G. Cohen.

Sweat Lodge Swale coastal fen. Photo by Joshua G. Cohen.

Aerial photograph of Sweat Lodge Swale coastal fen.

DRY-MESIC NORTHERN FOREST

Overview: Dry-mesic northern forest is a pine or pine-hardwood forest type of generally dry-mesic sites located mostly north of the transition zone. Dry-mesic northern forest is characterized by acidic, coarse- to medium-textured sand or loamy sand and occurs principally on sandy glacial outwash, sandy glacial lakeplains, and less often on inland dune ridges, coarse-textured moraines, and thin glacial drift over bedrock. The community historically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires (Kost et al. 2007, Cohen et al. 2015).



Map 4. Distribution of dry-mesic northern forest in Michigan (Albert et al. 2008).

12. High Island
Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 115 acres
Location: High Island
Element Occurrence Identification Number: 20453 (New EO)

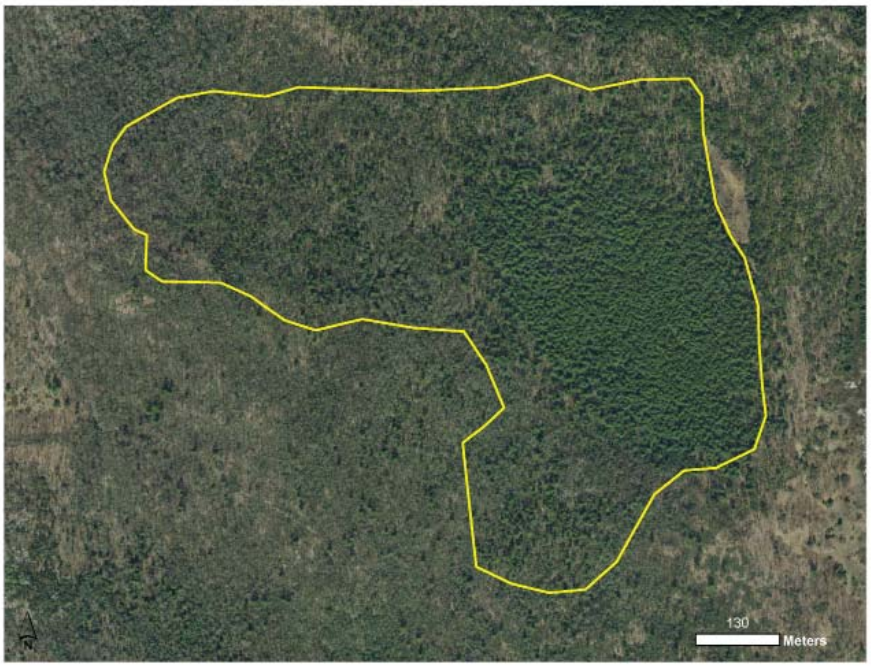
Site Description: The High Island dry-mesic northern forest occurs in the northeastern portion of High Island on undulating topography of former dune shoreline. This forest likely established over 120 years ago following a severe fire event. Charcoal was noted on old tree stumps. Estimated tree ages ranged from 100 to 120 years old: a 58 cm hemlock (*Tsuga canadensis*) was cored and estimated to be over 103 years old; a 59.2 cm hemlock was cored and estimated to be over 115 years old; and a 45.6 cm red pine (*Pinus resinosa*) was cored and estimated to be over 120 years old. Windthrow occurs throughout the forest and coarse woody debris of early-successional species is starting to accumulate. Soils are characterized by a typically shallow (5-10cm), acidic (pH 5.0) A horizon over fine- to medium-textured acidic (pH 4.5-5.0) sands. Where hemlock is prevalent in the canopy, a zone of leaching occurs in the soil profile.

The overstory of the dry-mesic northern forest ranges from 70 to 80% with canopy dominants including white pine (*Pinus strobus*), hemlock, and red oak (*Quercus rubra*). Canopy associates include red pine, paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), bigtooth aspen (*Populus grandidentata*), and white spruce (*Picea glauca*). Canopy trees typically range in DBH from 40 to 60 cm. The understory ranges from 10 to 20% and characteristic species include balsam fir (*Abies balsamea*), sugar maple (*Acer saccharum*), red maple, beaked hazelnut (*Corylus cornuta*), and yew (*Taxus canadensis*). The low shrub layer ranges from sparse (0-10%) to dense (30-60%) with yew locally abundant. Additional species in the low shrub layer include Canadian fly honeysuckle (*Lonicera canadensis*), bush honeysuckle (*Diervella lonicera*), Canada blueberry (*Vaccinium myrtilloides*), balsam fir, sugar maple, and red maple. The ground cover is characterized by wild sarsaparilla (*Aralia nudicaulis*), twinflower (*Linnaea borealis*), bluebead lily (*Clintonia borealis*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), sedge (*Carex pedunculata*), cow-wheat (*Melampyrum lineare*), ground-pine (*Dendrolycopodium obscurum*), running ground-pine (*Lycopodium clavatum*), and stiff clubmoss (*Huperzia annotinum*).

Threats: Species composition and vegetative structure are patterned by natural processes. No threats were observed during the course of the survey. Scattered cut stumps occur within the forest.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site), retain an intact buffer of natural communities surrounding the dry-mesic northern forest, and monitor for invasive species.

High Island dry-mesic northern forest. Photo by Joshua G. Cohen.



Aerial photograph of High Island dry-mesic northern forest.

13. Pointe La Par
Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 387 acres
Location: Beaver Island
Element Occurrence Identification Number: 9259 (EO Update)

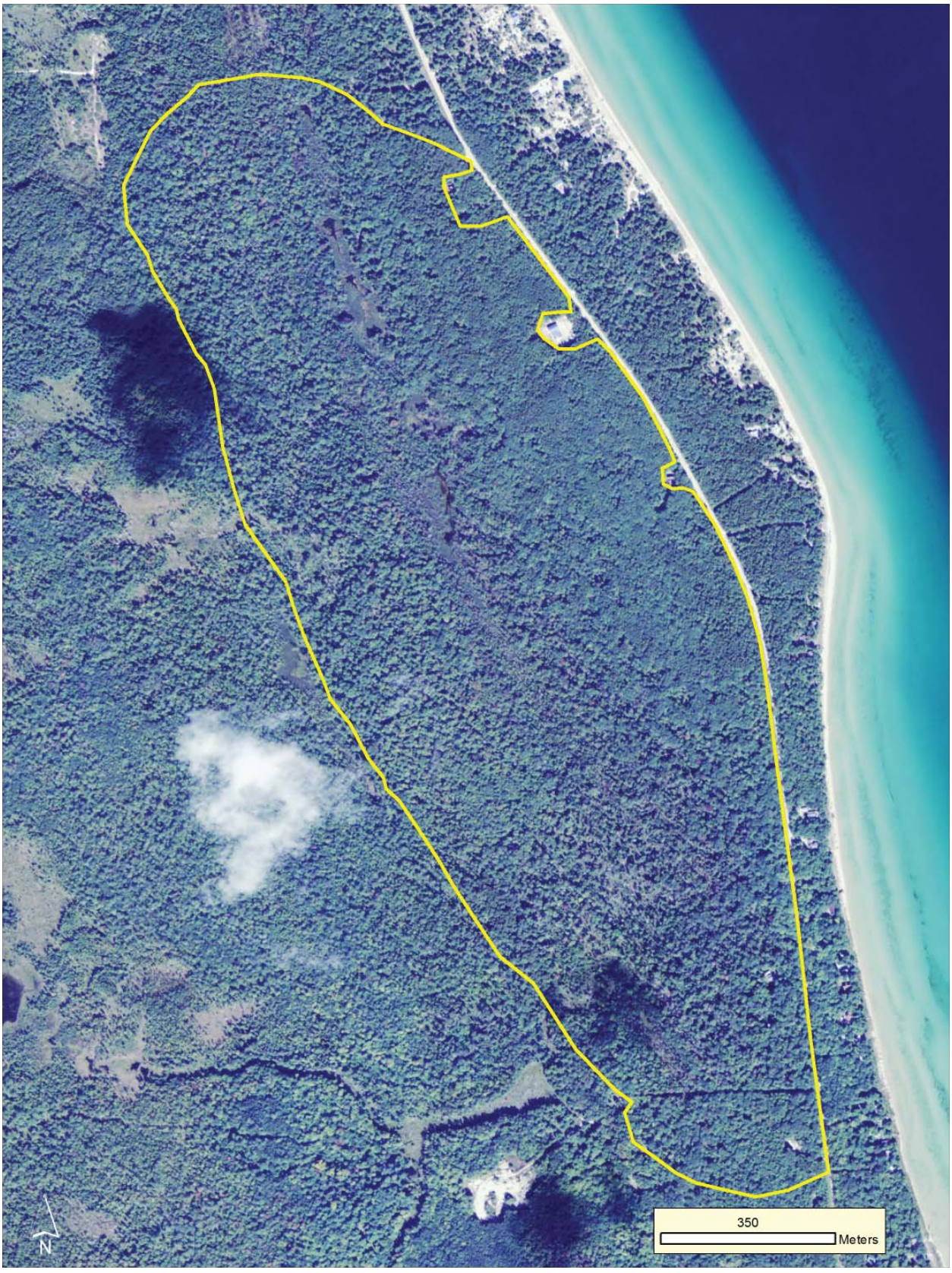
Site Description: This uneven-aged, dry-mesic northern forest occurs on mildly developed dune and swale topography oriented from northwest to southeast with numerous wooded swales. The soils are fine-textured dune sands that are acidic on the dune ridges with a thick needle duff. A soil sample from the dune ridge was characterized by a 5 cm, acidic (pH 4.5) A horizon over medium- to fine-textured, acidic (pH 5.5-6.0) dune sands. The sand in the swales is coarse-textured, wet and alkaline with a high water table (40 cm). The site was likely historically burned by Native Americans. The forest is characterized by a moderate level of coarse woody debris due to senescence and blowdown. A 52 cm red oak (*Quercus rubra*) was cored and estimated to be over 100 years old in the southwestern portion of the complex. A 43 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be between 150 and 175 years old.

The canopy is dominated by red pine (*Pinus resinosa*) and red oak with supercanopy white pine (*Pinus strobus*), aspen (*Populus* spp.) clones, and patches of hemlock (*Tsuga canadensis*), which occur primarily in the southern extent of the occurrence. Additional canopy associates include paper birch (*Betula papyrifera*) and red maple (*Acer rubrum*). In addition, northern white-cedar occurs locally along the sand ridges, especially adjacent to rich conifer swamp inclusions in the western portion of the forest. Red maple and balsam fir (*Abies balsamea*) are prevalent in the subcanopy and understory, indicating many decades of fire suppression (50-70 years). White pine dominates the understory with balsam fir locally dominant, red maple common, and red pine occasional. The scarcity of red oak in the understory layer is likely indicative of high levels of deer herbivory. The low shrub layer is dominated by blueberries (*Vaccinium* spp.) and huckleberry (*Gaylussacia baccata*) with occasional common blackberry (*Rubus allegheniensis*), striped maple (*Acer pensylvanicum*), and Canadian fly honeysuckle (*Lonicera canadensis*). The ground layer is dominated by bracken fern (*Pteridium aquilinum*) with wintergreen (*Gaultheria procumbens*), starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), and red oak and white pine seedlings. Additional common ground layer species include Canada mayflower (*Maianthemum canadense*) and bunchberry (*Cornus canadensis*). The swales, which occur intermittently between the dune ridges, are typically forested with an open canopy of small-diameter green ash (*Fraxinus pennsylvanica*) and northern white-cedar. The low shrub layer is dominated by alder-leaved buckthorn (*Rhamnus alnifolia*). Occasional tall shrubs include beaked hazelnut (*Corylus cornuta*), dogwoods (*Cornus* spp.), and buttonbush (*Cephalanthus occidentalis*). Characteristic ground cover species include tussock sedge (*Carex stricta*), fowl manna grass (*Glyceria striata*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), and northern bugleweed (*Lycopus uniflorus*).

Threats: Continued fire suppression and deer herbivory could negatively impact species composition, structure, and the site's future successional trajectory. Private portions of the site could be logged or developed. Prevalence of balsam fir and red maple in the subcanopy and understory indicate fire suppression has affected the site for the past 50 to 70 years. Logging stumps occur in portions of the forest. A trail passes through the northwestern portion of the forest.

Management Recommendations: Prescribed fire should be employed to mimic ground fires in order to set back mesophytic species, such as red maple and balsam fir, and establish conditions favorable for pine and oak regeneration. The site should be monitored for invasive species encroachment and deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities on the island is recommended. High-quality dry-mesic northern forest on private lands could be protected through acquisition or the establishment of conservation easements.

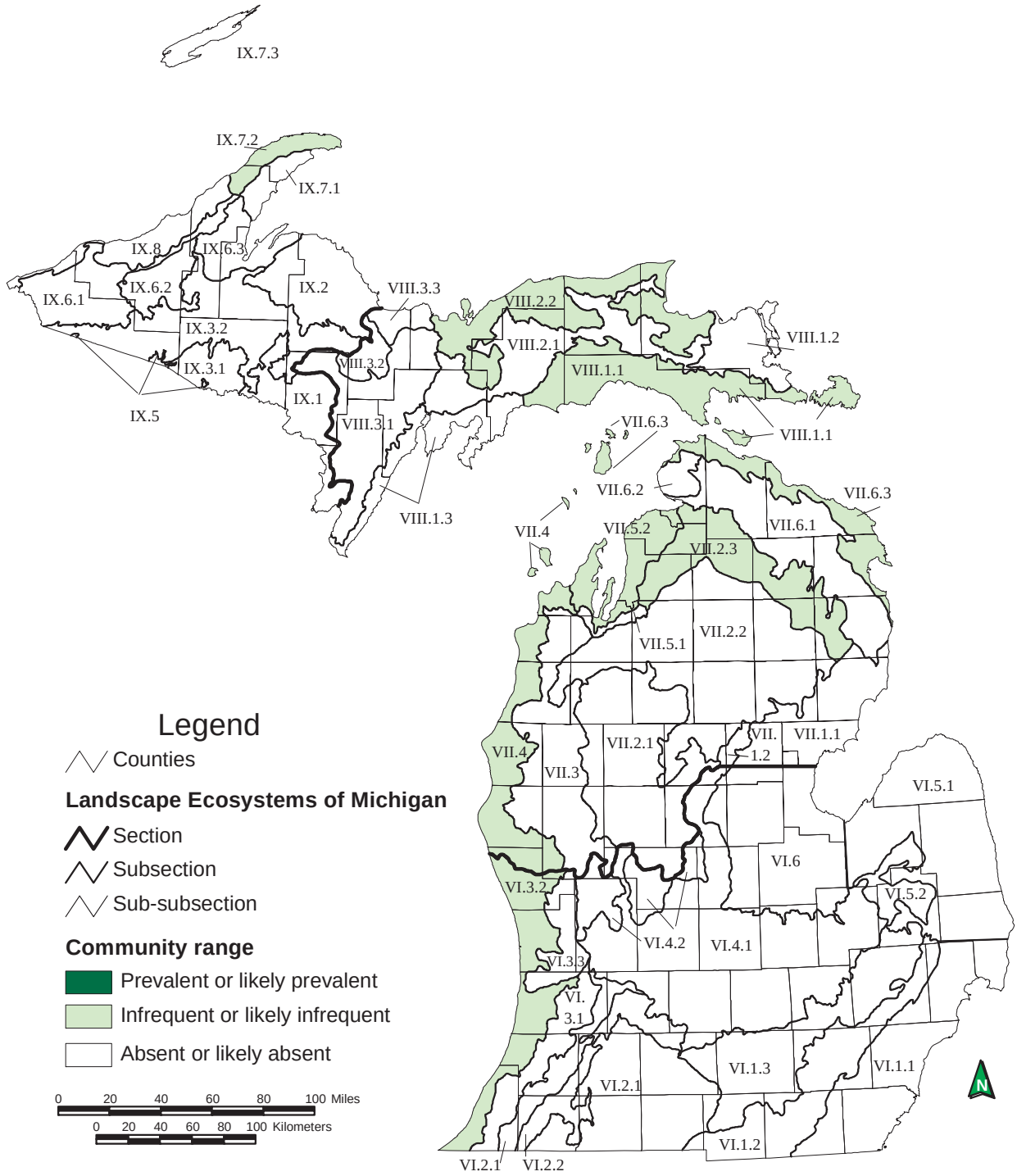
Pointe La Par dry-mesic northern forest. Photos by Joshua G. Cohen.



Aerial photograph of Pointe La Par dry-mesic northern forest.

GREAT LAKES BARRENS

Overview: Great Lakes barrens is a coniferous savanna community of scattered and clumped trees, and an often dense, low or creeping shrub layer. The community occurs along the shores of the Great Lakes where it is often associated with interdunal wetlands and open dunes (Kost et al. 2007, Cohen et al. 2015).



Map 5. Distribution of Great Lakes barrens in Michigan (Albert et al. 2008).

14. Nezewabegon Barrens
Natural Community Type: Great Lakes Barrens
Rank: G3 S2, vulnerable globally and imperiled within the state
Element Occurrence Rank: AB
Size: 19 acres
Location: High Island
Element Occurrence Identification Number: 20454 (New EO)

Site Description: The Nezewabegon Barrens consists of four polygons of Great Lakes barrens occurring along the northern portion of High Island on rolling dunes slightly elevated from the adjacent shoreline. The Great Lakes barrens polygons occur perched above low foredune and sand and gravel beach or limestone cobble shore with dry-mesic northern forest, boreal forest, and mesic northern forest inland. A combination of water erosion and wind deposition resulted in the formation of Great Lakes coastal dunes. The sand source for the coastal dunes was glacial sediment that was eroded by streams and by waves eroding bluffs along the Great Lakes shoreline. These sediments were then moved along the Great Lakes shoreline by nearshore currents, and then deposited along the shoreline by wave action. Strong winds then carried the sands inland, creating dunes. This Great Lakes barrens has developed on a small dune field where sand is stable enough to allow trees to establish and mature. A 28.8 cm red pine (*Pinus resinosa*) was cored and estimated to be 53 years old. The soils are fine- to medium-textured wind-blown and wave-worked, alkaline (pH 8.0), dune sands with shallow (1-2cm), slightly acidic (pH 6.5-6.7) organics occurring locally.

The scattered canopy of the Great Lakes barrens is diverse with canopy associates including white pine (*Pinus strobus*), red pine, northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), red oak (*Quercus rubra*), paper birch (*Betula papyrifera*), and balsam fir (*Abies balsamea*). Canopy closure is typically 10 to 25%. Tree cover increases with increasing distance from the lakeshore. Many of the canopy trees are open grown with wide, sprawling branches. Canopy trees range in DBH from 10 to 20 cm with some areas of larger trees (20-40 cm). The understory is scattered and includes white pine, northern white-cedar, white spruce, trembling aspen (*Populus tremuloides*), paper birch, serviceberry (*Amelanchier* sp.), and choke cherry (*Prunus virginiana*). The low shrub layer is dense and dominated by common juniper (*Juniperus communis*) and bearberry (*Arctostaphylos uva-ursi*) with associates including creeping juniper (*J. horizontalis*), sand cherry (*Prunus pumila*), soapberry (*Shepherdia canadensis*), red-osier dogwood (*Cornus sericea*), choke cherry, and yew (*Taxus canadensis*). The sparse to patchy groundcover is characterized by wormwood (*Artemisia campestris*), starry false Solomon-seal (*Maianthemum stellatum*), white camas (*Anticlea elegans*), little bluestem (*Schizachyrium scoparium*), plains puccoon (*Lithospermum caroliniense*), poison ivy (*Toxicodendron radicans*), wild strawberry (*Fragaria virginiana*), silverweed (*Potentilla anserina*), sand reed grass (*Calamovilfa longifolia*), marram grass (*Ammophila breviligulata*), wheat grass (*Elymus lanceolatus*), common milkweed (*Asclepias syriaca*), and bastard-toadflax (*Comandra umbellata*). Pitcher's thistle (*Cirsium pitcheri*, state threatened) and Lake Huron tansy (*Tanacetum huronense*, state threatened) occur locally within the Great Lakes barrens. Canada bluegrass (*Poa compressa*) is locally common within the Great Lakes Barrens.

Threats: Species composition and structure are driven by natural processes. The Great Lakes barrens is threatened by invasive plants. Canada bluegrass (*Poa compressa*) is locally common within the Great Lakes barrens. Invasives found along the nearby shoreline include mossy stonecrop (*Sedum acre*), narrow-leaved cat-tail (*Typha angustifolia*), reed (*Phragmites australis* subsp. *australis*, invasive), and white sweet-clover (*Melilotus albus*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, eliminate clusters of non-native plants within the Great Lakes barrens and nearby areas of shoreline, and monitor for invasive species with the Great Lakes barrens and adjacent shoreline.

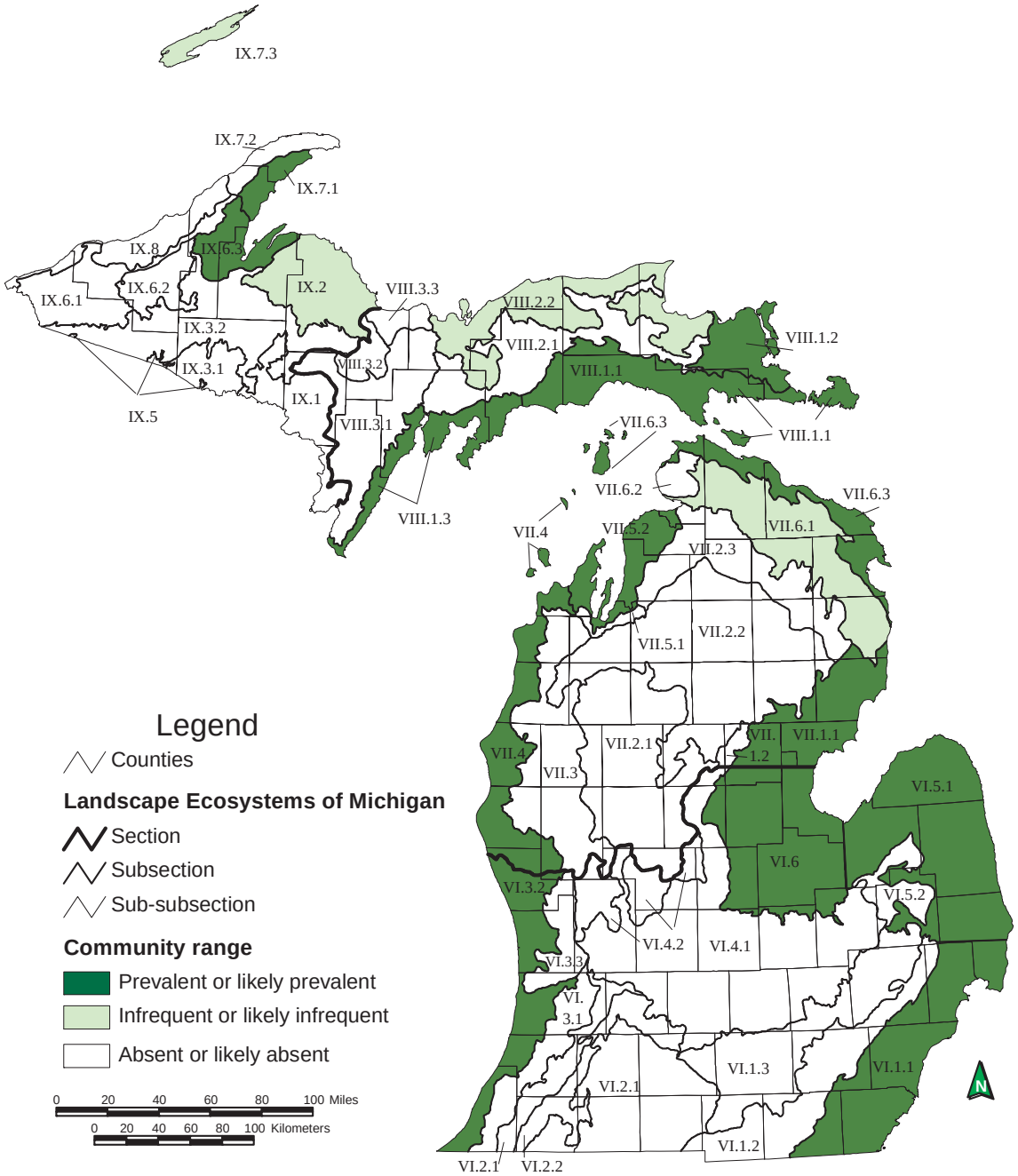
Nezewabegon Barrens Great Lakes barrens. Photo by Joshua G. Cohen.

Aerial photograph of Nezewabegon Barrens Great Lakes barrens.


Nezewabegon Barrens Great Lakes barrens. Photo by Joshua G. Cohen.

GREAT LAKES MARSH

Overview: Great Lakes marsh is an herbaceous wetland community occurring statewide along the shoreline of the Great Lakes and their major connecting rivers. Vegetational patterns are strongly influenced by water level fluctuations and type of coastal feature, but generally include the following: a deep marsh with submerged plants; an emergent marsh of mostly narrow-leaved species; and a sedge-dominated wet meadow that is inundated by storms. Great Lakes marsh provides important habitat for migrating and breeding waterfowl, shore-birds, spawning fish, and medium-sized mammals (Kost et al. 2007, Cohen et al. 2015).



Map 6. Distribution of Great Lakes marsh in Michigan (Albert et al. 2008).

15. Hog Island
Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: AB
Size: 284 acres
Location: Hog Island
Element Occurrence Identification Number: 2179 (EO Update)

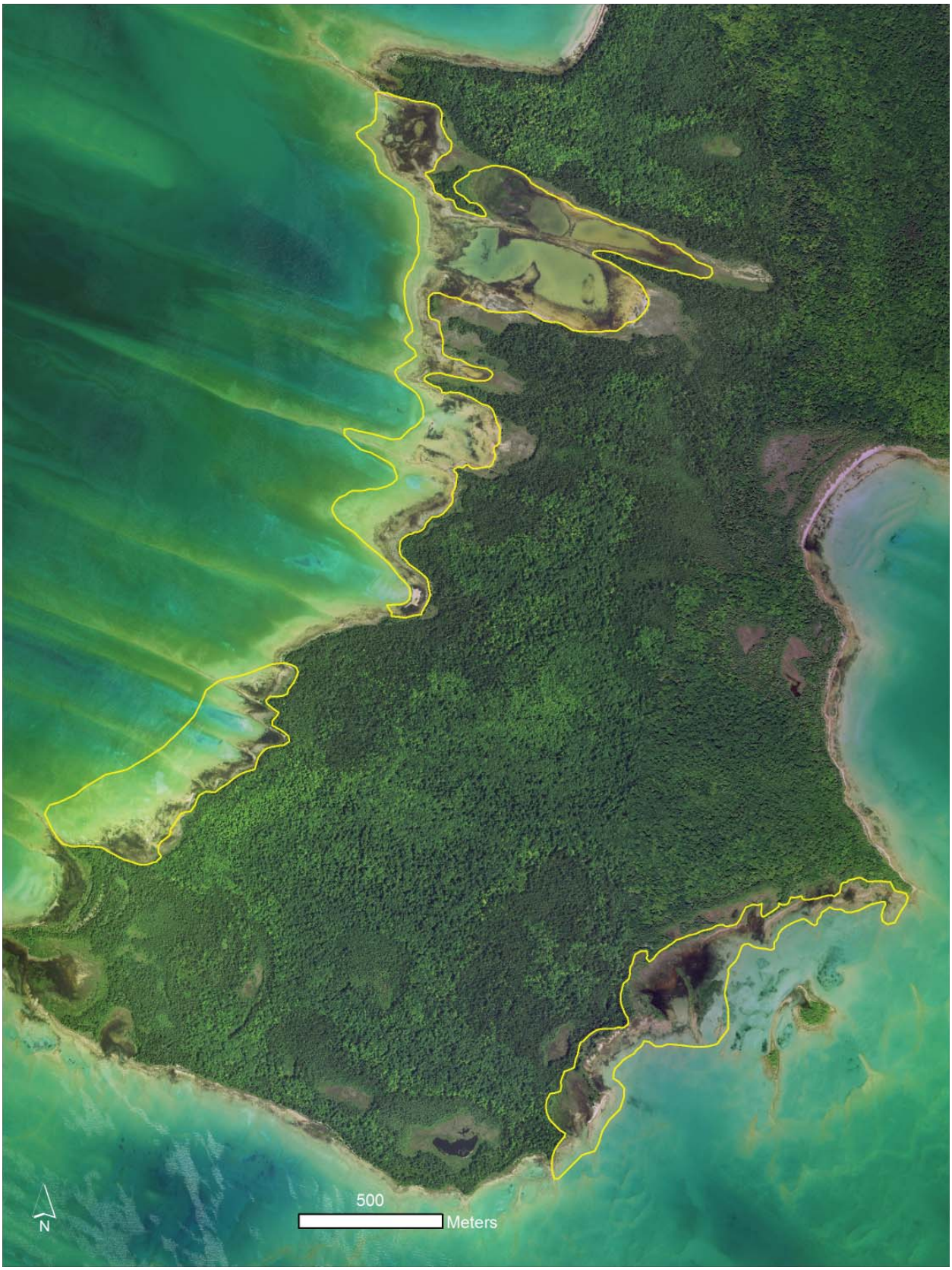
Site Description: Great Lakes marsh on Hog Island occurs along the western and southeastern shores of the island. Pockets of coastal fen occur on the inland margin of the Great Lake marsh and the marsh grades locally to limestone cobble shore. The margin between these communities shifts from year to year with fluctuations of the Great Lakes. Bays along the island's shoreline are characterized by the most extensive development of marsh. The Great Lakes marsh, coastal fen, and limestone cobble shore complex was surveyed in 2015 and 2017, both high-water years. During the 2017 surveys, the marsh was inundated with water depths typically ranging from 30 to 60 cm in the meadow zone of the marsh and between 90 to 120 cm in areas of emergent marsh. Portions of the adjacent coastal fen were inundated in August, 2017 by 5 to 20 cm of water and appear to be transitioning to Great Lakes marsh. The coastal complex is backed by rich conifer swamp and boreal forest. This extensive marsh has variable dominance patterns.

The Great Lakes marsh is dominated by emergent graminoid vegetation with variable dominance by Baltic rush (*Juncus balticus*), threesquare (*Schoenoplectus pungens*), hardstem bulrush (*Schoenoplectus acutus*), and twig-rush (*Cladium mariscoides*). Areas of emergent marsh are dominated by hardstem bulrush, threesquare, and Baltic rush. The marsh meadow zone is characterized by a shift in dominance to sedge species (*Carex* spp.) and blue-joint (*Calamagrostis canadensis*) and a greater diversity of forb and graminoid associates including Ohio goldenrod (*Solidago ohioensis*), Kalm's lobelia (*Lobelia kalmii*), limestone calamint (*Clinopodium arkansanum*), grass-of-Parnassus (*Parnassia glauca*), common bog arrow-grass (*Triglochin maritima*), broad-leaved cat-tail (*Typha latifolia*), false asphodel (*Triantha glutinosa*), nodding ladies'-tresses (*Spiranthes cernua*), beak-rush (*Rhynchospora capillacea*), Indian paintbrush (*Castilleja coccinea*), and reed (*Phragmites australis* subsp. *americanus*, native). Scattered shrubs and trees occur along the transitional margin between Great Lakes marsh and coastal fen and limestone cobble shore and on sand and cobble spits that protrude into areas of marsh. Common trees saplings and shrubs include northern white-cedar (*Thuja occidentalis*), Kalm's St. John's-wort (*Hypericum kalmianum*), and shrubby cinquefoil (*Dasiphora fruticosa*). The invasive narrow-leaved cat-tail (*Typha angustifolia*) is locally dominant in scattered clumps.

Threats: Species composition and zonation are patterned by natural processes. The only threat observed during the course of the survey was the invasive plant, narrow-leaved cat-tail, which is locally dominant and occurs in scattered clumps.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, maintain a natural community buffer surrounding the shoreline, control the invasive narrow-leaved cat-tail, and monitor for invasive species.

Hog Island Great Lakes marsh. Photos by Joshua G. Cohen.



Aerial photograph of Hog Island Great Lakes marsh.

16. Indian Harbor
Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: AB
Size: 57 acres
Location: Garden Island
Element Occurrence Identification Number: 13020 (EO Update)

Site Description: This Great Lakes marsh occurs within Indian Harbor on Garden Island. The Great Lakes marsh grades locally to coastal fen and limestone cobble shore and the margin between these communities shifts from year to year with fluctuations of the Great Lakes. Indian Harbor is backed by rich conifer swamp and boreal forest. The hydrologic regime of Great Lakes marsh is directly linked to that of the Great Lakes. As such, the water table is not stable, being 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 Great Lakes marsh, reconfiguring the substrate and removing fine mineral sediments and organic soils. Long-term cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of Great Lakes marsh, with vegetation and organic soils becoming well established during low-water periods and reduced or eliminated during high-water periods. Many of the shrubs that have invaded the marsh are now dying due to three consecutive high water years. A flood-killed northern white-cedar (*Thuja occidentalis*, 3.5 cm in DBH and 2.3 m tall) occurring on the upper margin of the marsh was cored and estimated to be 15 to 20 years old.

The soils of the Great Lakes marsh are characterized by shallow organics (0-1cm) occurring over wet, alkaline (pH 7.8-8.0) sandy gravel, sandy clay, and cobble substrate. The floristic diversity and variability of zonation in the Great Lakes marsh is driven in part by the variability of the shoreline substrate and water depth. Water depth varies from 0 to 150 cm with areas of emergent marsh having 50 to 150 cm of water and areas of meadow being saturated to inundated with 0 to 50 cm of standing water.

The Great Lakes marsh at Indian Harbor is an important location for fish spawning and is used extensively by a diverse array of shorebirds including secretive marsh birds. During the course of surveys in 2017, two American bittern (*Botaurus lentiginosus*, state special concern) were observed and the Odawa DNR documented Virginia rail (*Rallus limicola*) and sora (*Porzana carolina*) within this marsh during marsh bird surveys.

Species composition and ecological zonation of the marsh are patterned by water depth and variability of the substrate. Ecological zones within this marsh include an emergent zone and a meadow zone. Areas of emergent marsh are typically inundated with 50 to 150 cm of water and are characterized by variable dominance patterns with Baltic rush (*Juncus balticus*), threesquare (*Schoenoplectus pungens*), hardstem bulrush (*Schoenoplectus acutus*), and twig-rush (*Cladium mariscoides*) occurring as local dominants. The bulrush species are more prevalent in the deeper water marsh (50-150 cm) and the Baltic rush and twig-rush are more prevalent where the water is shallower (30-60 cm). The meadow zone ranges from saturated to inundated (0-30 cm of water) and is typically dominated by sedges (*Carex lasiocarpa* and *Carex stricta*) and blue-joint (*Calamagrostis canadensis*) with an increased diversity of associate forbs and graminoids. Characteristic species within the marsh include Ohio goldenrod (*Solidago ohioensis*), Kalm's lobelia (*Lobelia kalmii*), limestone calamint (*Clinopodium arkansanum*), grass-of-Parnassus (*Parnassia glauca*), broad-leaved cat-tail (*Typha latifolia*), false asphodel (*Triantha glutinosa*), reed (*Phragmites australis* subsp. *americanus*, native), and silverweed (*Potentilla anserina*). A narrow margin of scattered shrubs and trees occurs along the inland edge of the marsh and characteristic woody species include northern white-cedar, paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), tamarack

(*Larix laricina*), trembling aspen (*Populus tremuloides*), willows (*Salix* spp.), Kalm's St. John's-wort (*Hypericum kalmianum*), ninebark (*Physocarpus opulifolius*), red-osier dogwood (*Cornus sericea*), and shrubby cinquefoil (*Dasiphora fruticosa*).

Threats: Species composition and zonation are patterned by natural processes. Narrow-leaved cat-tail (*Typha angustifolia*) and reed (*Phragmites australis* subsp. *australis*, invasive) occur locally within the marsh and numerous invasive species occur along the sandy shoreline adjacent to the marsh including white sweet-clover (*Melilotus albus*) and wild parsnip (*Pastinaca sativa*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, maintain a natural community buffer surrounding the shoreline, control invasive plant species (i.e., narrow-leaved cat-tail and reed), and monitor for invasive species.

Indian Harbor Great Lakes marsh. Photo by Bill Parsons.

Aerial photograph of Indian Harbor Great Lakes marsh.


Indian Harbor Great Lakes marsh. Photo by Joshua G. Cohen.

17. Taganing Marsh
Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: A
Size: 225 acres
Location: Garden Island
Element Occurrence Identification Number: 20450 (New EO)

Site Description: The Taganing Marsh is a Great Lakes marsh that occupies the outer margins of Jensen Harbor and Sturgeon Bay along Garden Island. Taganing Marsh is one of nine A-ranked Great Lakes marshes in the state. Inland from the Great Lakes marsh at Jensen Harbor is an extensive, high-quality coastal fen (Jensen Harbor, EO ID 7888). Inland from the Great Lakes marsh at Sturgeon Bay is a small wooded dune and swale complex (Taganing Dune and Swale, EO ID 20451). In both Jensen Harbor and Sturgeon Bay, Great Lakes marsh grades to coastal fen and limestone cobble shore locally and the margin between these communities shifts from year to year with fluctuations of the Great Lakes. Further inland the shoreline is backed by rich conifer swamp and boreal forest.

This extensive marsh has variable dominance patterns. Prevalent zones within the Great Lakes marsh include an emergent zone and a sand and gravel flat. The Great Lakes marsh is dominated by emergent graminoid vegetation with Baltic rush (*Juncus balticus*), threesquare (*Schoenoplectus pungens*), and twig-rush (*Cladium mariscoides*). Additional species include blue-joint (*Calamagrostis canadensis*), spike-rush (*Eleocharis rostellata*), beak-rush (*Rhynchospora capillacea*), Indian paintbrush (*Castilleja coccinea*), reed (*Phragmites australis* subsp. *americanus*, native), three-way sedge (*Dulichium arundinaceum*), Ohio goldenrod (*Solidago ohioensis*), fringed gentian (*Gentianopsis crinita*), false asphodel (*Triantha glutinosa*), grass-of-Parnassus (*Parnassia glauca*), horned bladderwort (*Utricularia cornuta*), and Kalm's lobelia (*Lobelia kalmii*). Beak-rush is locally dominant in the sand and gravel flats. The transitional margin between Great Lakes marsh and coastal fen and sand and cobble spits that protrude into areas of marsh support scattered shrubs and trees and include northern white-cedar (*Thuja occidentalis*), balsam poplar (*Populus balsamifera*), tamarack (*Larix laricina*), paper birch (*Betula papyrifera*), willows (*Salix* spp.), red-osier dogwood (*Cornus sericea*), and shrubby cinquefoil (*Dasiphora fruticosa*).

Threats: Species composition and zonation are patterned by natural processes. No threats were observed during the survey.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, maintain a natural community buffer surrounding the shoreline, and monitor for invasive species.

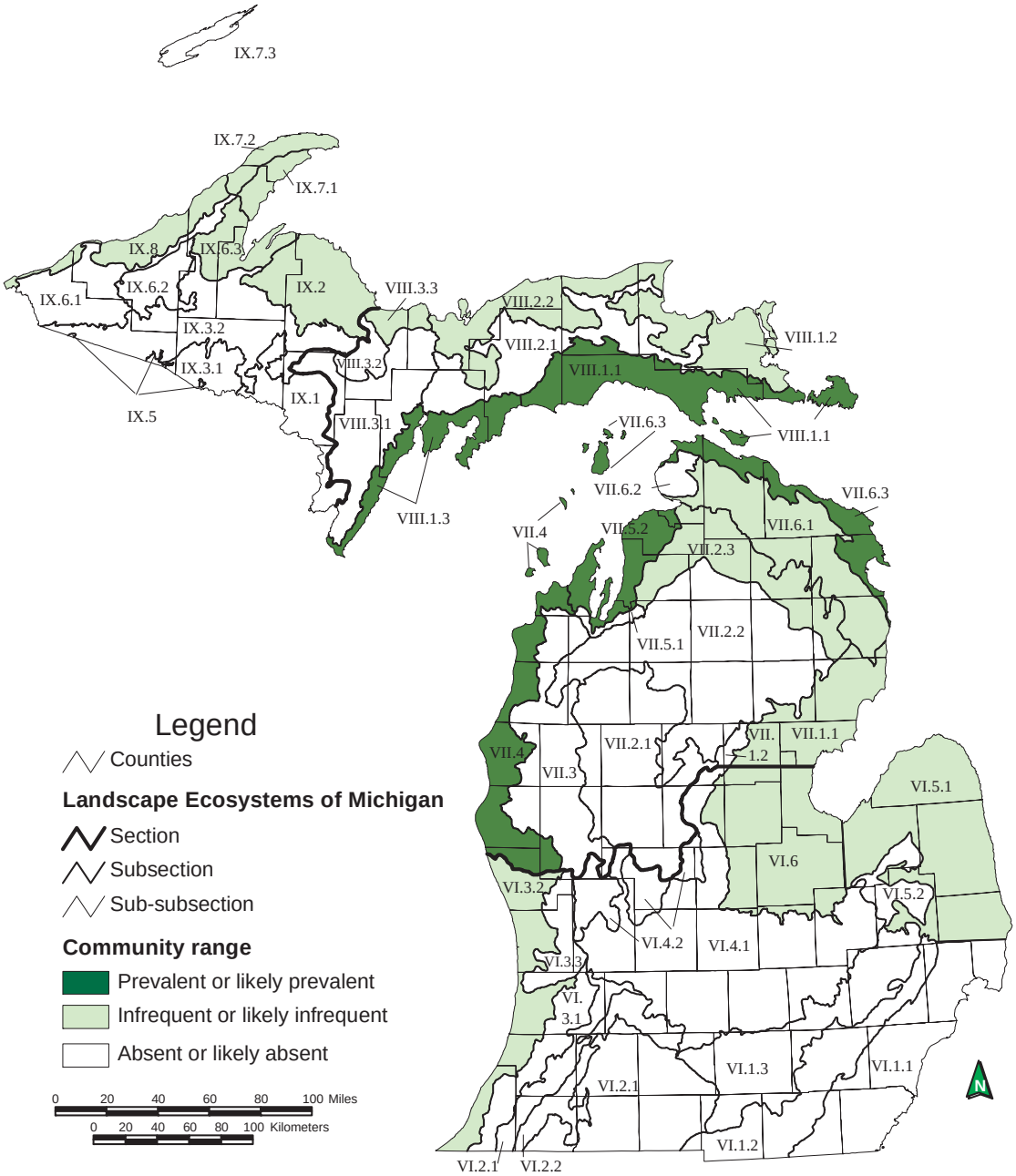
Taganing Marsh Great Lakes marsh. Photos by Joshua G. Cohen.

Aerial photograph of Taganing Marsh Great Lakes marsh.


Taganing Marsh Great Lakes marsh. Photo by Joshua G. Cohen.

INTERDUNAL WETLAND

Overview: Interdunal wetland is a rush-, sedge-, and shrub-dominated wetland situated in depressions within open dunes or between beach ridges along the Great Lakes. This system is patterned by a dynamic water table that fluctuates seasonally and yearly in synchrony with lake level changes (Kost et al. 2007, Cohen et al. 2015).



Map 7. Distribution of interdunal wetland in Michigan (Albert et al. 2008).

18. Little Sand Bay
Natural Community Type: Interdunal Wetland
Rank: G2? S2, imperiled throughout range
Element Occurrence Rank: BC
Size: 17 acres
Location: Beaver Island
Element Occurrence Identification Number: 6089 (EO Update)

Site Description: This interdunal wetland occurs along the Lake Michigan shoreline and is found along the northeastern shore of Beaver Island along Little Sand Bay. In addition to interdunal wetland, the sandy bay supports a low foredune with open dunes vegetation. Rich conifer swamp and boreal forest occur inland from the interdunal wetland. Interdunal wetlands are dynamic systems that change seasonally and annually depending on the fluctuations of the adjacent Great Lake. Interdunal wetlands are formed when water levels of the Great Lakes drop, creating a swale or linear depression between the inland foredune and the newly formed foredune along the water's edge. When Great Lakes water levels rise or during storm events, the interdunal wetland closest to the shoreline can be partially or completely buried by sand. Summer heating and evaporation can result in warm, shallow water or even complete drying within the swale. Numerous swales occur along this half-mile stretch of shoreline. More recently formed swales occur along the sand and gravel beach, and based on air photo interpretation, appear to have formed within the last ten years. Swales also occur between the low dune ridges. Vegetative cover is greater in these swales set back from the active lakeshore and water depth and coverage are greater in the swales adjacent to the active lakeshore. The swales within this complex tend to be narrow (2-5 feet wide). Water depth within the nearshore swales was observed to be 10 to 20 cm. Soils of the interdunal wetlands are wet, alkaline (pH 8.0) sands.

This interdunal wetland is graminoid dominated. Common graminoids include threesquare (*Schoenoplectus pungens*), Baltic rush (*Juncus balticus*), beak-rush (*Rhynchospora capillacea*), and twig-rush (*Cladium mariscoides*). Ground cover associates include Kalm's lobelia (*Lobelia kalmii*), grass-of-Parnassus (*Parnassia glauca*), Ohio goldenrod (*Solidago ohioensis*), grass-leaved goldenrod (*Euthamia graminifolia*), silverweed (*Potentilla anserina*), false asphodel (*Triantha glutinosa*), slender bog arrow-grass (*Triglochin palustris*), and butterwort (*Pinguicula vulgaris*, state special concern). Scattered shrubs include Kalm's St. John's-wort (*Hypericum kalmianum*), shrubby cinquefoil (*Dasiphora fruticosa*), and willows (*Salix* spp.). Stunted northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), tamarack (*Larix laricina*), and white pine (*Pinus strobus*) occur sporadically along the margins of the wetlands. Shrub and tree cover is more prevalent in the swales that are further from the active shoreline. The low foredunes adjacent to the interdunal wetland are characterized by open dunes vegetation with dominant ground cover species including marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*) and common herbaceous species including wormwood (*Artemisia campestris*), white camas (*Anticlea elegans*), Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened), and Lake Huron tansy (*Tanacetum bipinnatum*, state special concern). Low shrubs common along the low dune ridges include bearberry (*Arctostaphylos uva-ursi*), creeping juniper (*Juniperus horizontalis*), and Kalm's St. John's-wort, and common tree saplings include balsam poplar, tamarack, northern white-cedar, and white spruce (*Picea glauca*). Michigan monkey flower (*Mimulus michiganensis*, state and federally endangered) occurs along the mouth of a small stream feeding into Lake Michigan passing through the southern poriton of the site.

Threats: The interdunal wetland is impacted by hikers along the shore. In addition, dead zebra mussel shells are accumulating in some of the newly formed swales and may be limiting vegetation establishment. No invasive species were documented during the course of this survey but non-native species could potentially impact this dynamic system.

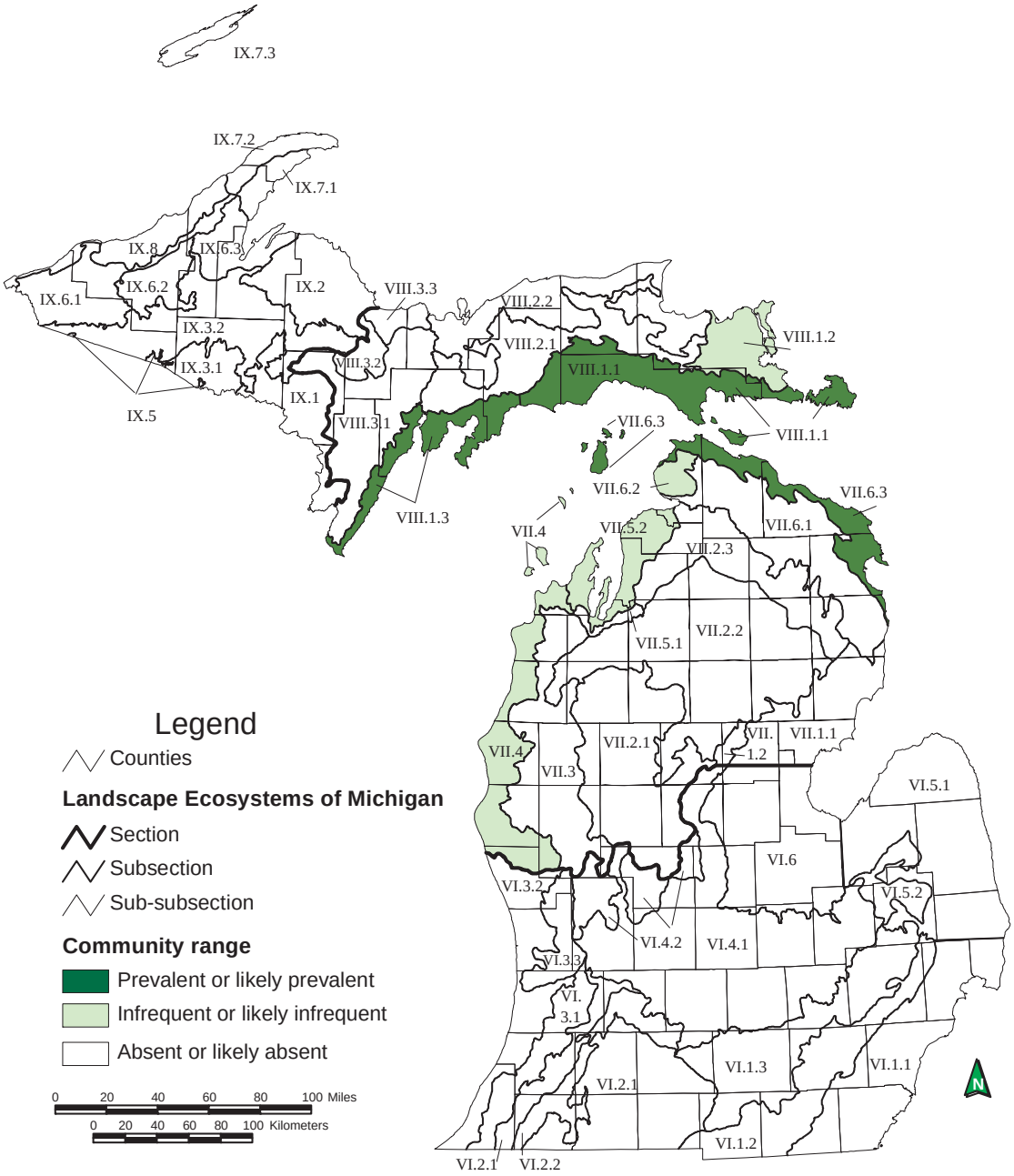
Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to monitor for invasive plants along the shoreline.

Little Sand Bay interdunal wetland. Photos by Joshua G. Cohen (above) and Bill Parsons (below).

Aerial photograph of Little Sand Bay interdunal wetland.

LIMESTONE COBBLE SHORE

Overview: Limestone cobble shore occurs along gently sloping shorelines of Lake Michigan and Lake Huron. The community is studded with cobbles and boulders and is frequently inundated by storms and periods of high water. Limestone cobble shore is typically sparsely vegetated, because cobbles cover most of the surface and storm waves prevent the development of a diverse, persistent plant community. Soils are neutral to slightly alkaline mucks and sands that accumulate between cobbles and boulders (Kost et al. 2007, Cohen et al. 2015).



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

19. High Island
Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: AB
Size: 214 acres
Location: High Island
Element Occurrence Identification Number: 6527 (EO update)

Site Description: The High Island limestone cobble shore consists of two polygons occupying the southern and northwestern shoreline of High Island. Surveys in 2015 expanded the existing element occurrence. Limestone cobble shore 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 limestone cobble shore, reconfiguring the substrate and removing fine mineral sediments and organic soils. Long-term cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of limestone cobble shore, with vegetation and organic soils becoming well established during low-water periods and reduced or eliminated during high-water periods. This limestone cobble shore was surveyed after two consecutive high water years. Many woody stems were submerged under water. The limestone cobble shore ranges from narrow (15-25ft) to wide (40-60ft). Along the lake margin of the limestone cobble shore, marsh plant debris and driftwood have accumulated. The driftwood along the shoreline provides important habitat for insects and herptiles and the plant debris provides organic matter for soil development. Rocks along this stretch of shoreline range from small cobble to large boulders. Inclusions of sand and gravel beach, low foredune, and Great Lakes marsh occur locally within the limestone cobble shore. Localized areas along the inland margin of the complex grade towards coastal fen with seepage from the upland and patchy accumulation of sphagnum moss. Where wind and wave action is the most prevalent, narrow and sloping cobble storm beaches have formed locally. The soils of the limestone cobble shore are characterized by gravelly, alkaline (pH 8.0) sands mixed with organics occurring between and beneath the limestone cobble.

Vegetation within the limestone cobble shore is sparse, occurring patchily between cobbles and concentrated along the upper margin of the shore. Characteristic ground cover species include silverweed (*Potentilla anserina*), grass-of-Parnassus (*Parnassia glauca*), Baltic rush (*Juncus balticus*), sedges (*Carex* spp.), wild strawberry (*Fragaria virginiana*), common bog arrow-grass (*Triglochin maritima*), Indian paintbrush (*Castilleja coccinea*), beak-rush (*Rhynchospora capillacea*), Ohio goldenrod (*Solidago ohioensis*), wormwood (*Artemisia campestris*), bird's-eye primrose (*Primula mistassinica*), blue-joint (*Calamagrostis canadensis*), yarrow (*Achillea millefolium*), twig-rush (*Cladium mariscoides*), and false asphodel (*Triantha glutinosa*). Non-natives are locally common along the shoreline and include Canada bluegrass (*Poa compressa*) and mossy stonecrop (*Sedum acre*). Pockets of Great Lakes marsh are characterized by one to two feet of standing water and local dominance by Baltic rush. The patchy but diverse low shrub layer of the limestone cobble shore supports Kalm's St. John's-wort (*Hypericum kalmianum*), red-osier dogwood (*Cornus sericea*), shrubby cinquefoil (*Dasiphora fruticosa*), bearberry (*Arctostaphylos uva-ursi*), northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), sand cherry (*Prunus pumila*), soapberry (*Shepherdia canadensis*), ninebark (*Physocarpus opulifolius*), and balsam fir (*Abies balsamea*). Scattered saplings occur along the margins of the limestone cobble shore and include northern white-cedar, balsam fir, balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), tamarack (*Larix laricina*), and trembling aspen.

Threats: Species composition and structure are driven primarily by natural processes. Non-natives are locally common along the limestone cobble shore and include Canada bluegrass (*Poa compressa*) and mossy stonecrop (*Sedum acre*). Additional invasives found along the shoreline include narrow-leaved cat-tail (*Typha angustifolia*), reed (*Phragmites australis* subsp. *australis*), and white sweet-clover (*Melilotus albus*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the limestone cobble shore and nearby areas of shoreline. Control efforts should be followed by monitoring for these invasive species.

High Island limestone cobble shore. Photo by Joshua G. Cohen.

Aerial photograph of High Island limestone cobble shore.

High Island limestone cobble shore. Photo by Joshua G. Cohen.

20. Hog Island
Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: AB
Size: 60 acres
Location: Hog Island
Element Occurrence Identification Number: 20447 (New EO)

Site Description: This limestone cobble shore occurs along the western and southern shoreline of Hog Island. The limestone cobble shore grades to coastal fen and Great Lakes marsh locally. The margin between these communities shifts from year to year with fluctuations of the Great Lakes. The coastal complex is backed by rich conifer swamp and boreal forest. Limestone cobble shore 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 limestone cobble shore, reconfiguring the substrate and removing fine mineral sediments and organic soils. Long-term cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of limestone cobble shore, with vegetation and organic soils becoming well established during low-water periods and reduced or eliminated during high-water periods. The Great Lakes marsh, coastal fen, and limestone cobble shore complex was surveyed in 2015 and 2017, both high-water years. As a result of the high water, portions of the limestone cobble shore are shifting to Great Lakes marsh. Many woody stems were submerged under water including 2 to 5 cm DBH and 1 to 3 m tall northern white-cedar (*Thuja occidentalis*) and paper birch (*Betula papyrifera*).

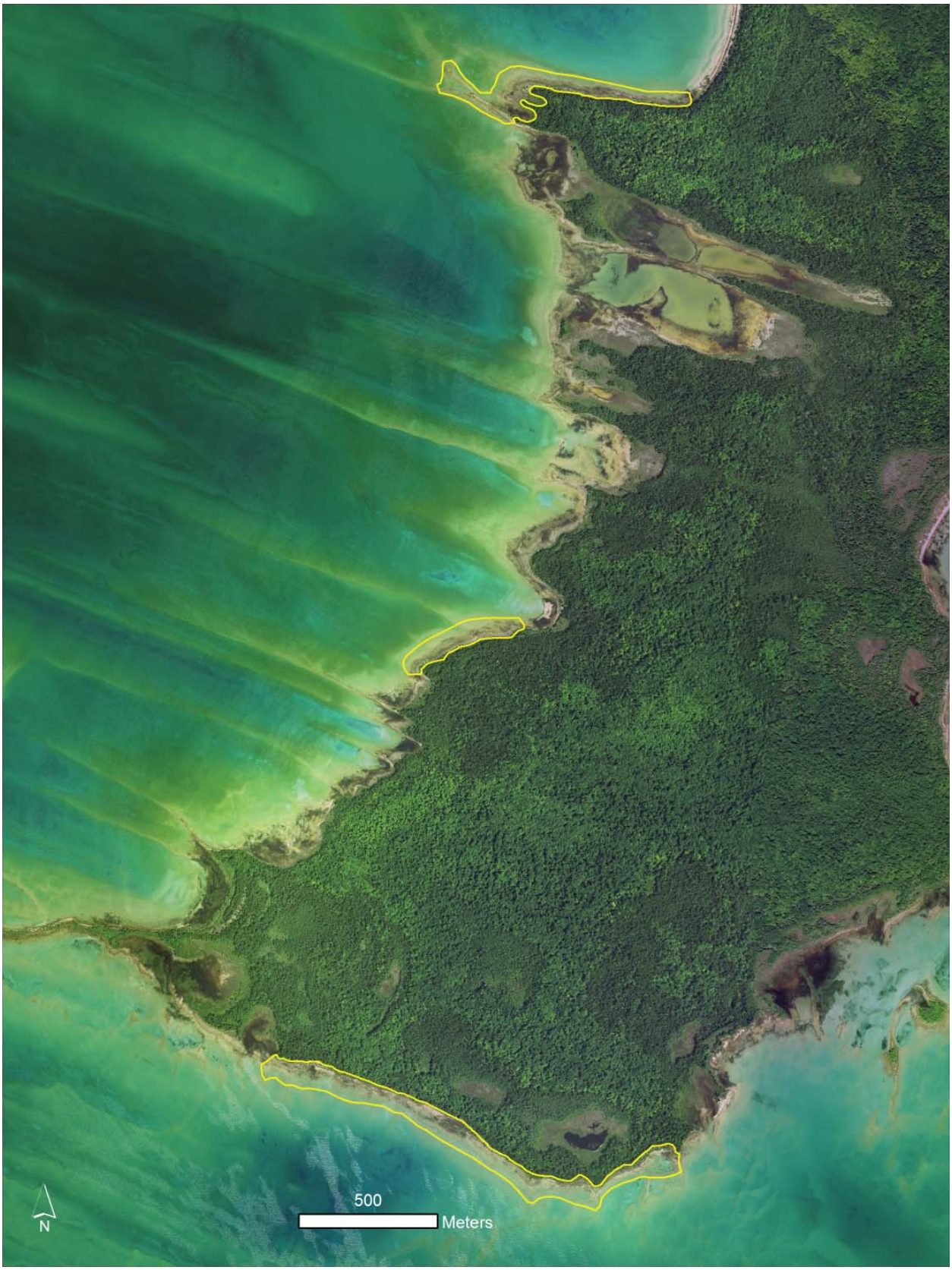
Along the lake margin of the limestone cobble shore lots of marsh plant debris and driftwood have accumulated. The driftwood along the shoreline provides important habitat for insects and herptiles and the plant debris provides organic matter for soil development. Rocks along this stretch of shoreline range from small cobble to large boulders. The soils are characterized as shallow, wet, alkaline (pH 8.0), gravelly sands mixed with organics occurring between and beneath limestone cobble.

Vegetation within the limestone cobble shore is sparse, occurring patchily between cobbles and concentrated along the upper margin of the shore. Characteristic ground cover species include silverweed (*Potentilla anserina*), grass-of-Parnassus (*Parnassia glauca*), Baltic rush (*Juncus balticus*), common bog arrow-grass (*Triglochin maritima*), beak-rush (*Rhynchospora capillacea*), Ohio goldenrod (*Solidago ohioensis*), Kalm's lobelia (*Lobelia kalmii*), limestone calamint (*Clinopodium arkansanum*), bird's-eye primrose (*Primula mistassinica*), twig-rush (*Cladium mariscoides*), false asphodel (*Triantha glutinosa*), and wild strawberry (*Fragaria virginiana*). Canada bluegrass (*Poa compressa*) occurs locally along the shore. The scattered understroy layer is characterized by northern white-cedar, paper birch, and trembling aspen (*Populus tremuloides*). The patchy low shrub layer supports red-osier dogwood (*Cornus sericea*), Kalm's St. John's-wort (*Hypericum kalmianum*), shrubby cinquefoil (*Dasiphora fruticosa*), bearberry (*Arctostaphylos uva-ursi*), ninebark (*Physocarpus opulifolius*), northern white-cedar, and tamarack (*Larix laricina*).

Threats: Species composition and structure are driven primarily by natural processes. Canada bluegrass (*Poa compressa*) is locally common within the limestone cobble shore and spotted knapweed (*Centaurea stoebe*) was observed infrequently. A lone scotch pine (*Pinus sylvestris*) was observed along the western shoreline of Hog Island along a sandy stretch of shoreline (not within the limestone cobble shore EO).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the limestone cobble shore and nearby areas of shoreline. Control efforts should be followed by monitoring for these invasive species.

Hog Island limestone cobble shore. Photo by Joshua G. Cohen.



Aerial photograph of Hog Island limestone cobble shore.

21. Monatou Bay
Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: A
Size: 156 acres
Location: Garden Island
Element Occurrence Identification Number: 20448 (New EO)

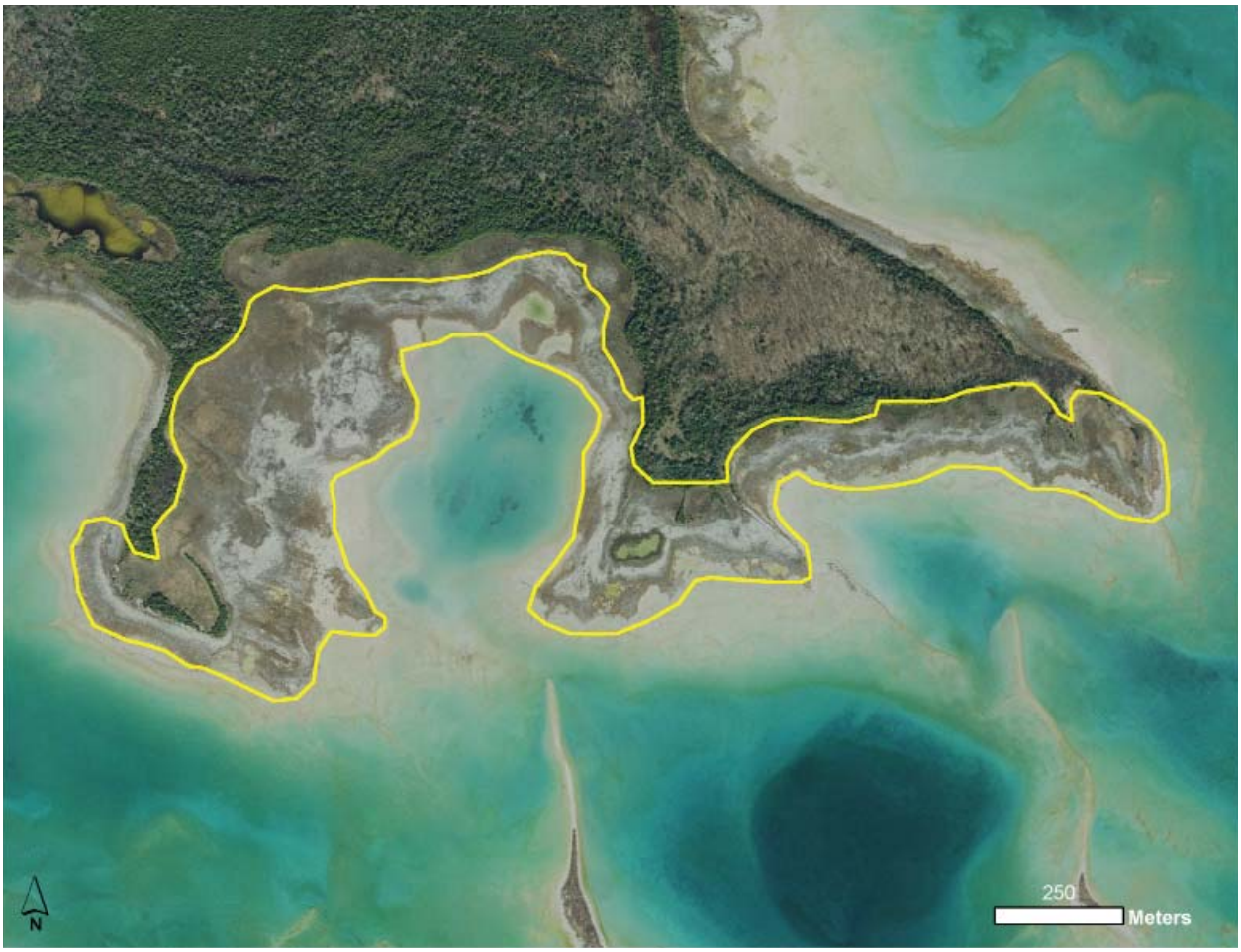
Site Description: The Monatou Bay limestone cobble shore occurs along Monatou Bay on Garden Island. Monatou Bay is the only A-ranked limestone cobble shore in the state. This limestone cobble shore grades to coastal fen inland and Great Lakes marsh lakeward. The margin between these communities shifts from year to year with fluctuations of the Great Lakes. Limestone cobble shore 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 limestone cobble shore, reconfiguring the substrate and removing fine mineral sediments and organic soils. Long-term cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of limestone cobble shore, with vegetation and organic soils becoming well established during low-water periods and reduced or eliminated during high-water periods. This site was surveyed in 2015 after two consecutive high water years. Many woody stems were submerged under water during the survey. Along the lake margin of the limestone cobble shore, marsh plant debris and driftwood have accumulated. The driftwood along the shoreline provides important habitat for insects and herptiles and the plant debris provides organic matter for soil development. Rocks along this stretch of shoreline range from small cobble to large boulders. Inclusions of coastal fen and Great Lakes marsh occur locally within the limestone cobble shore. Pockets of Great Lakes marsh are characterized by one to two feet of standing water and local dominance by Baltic rush (*Juncus balticus*) and bulrushes spp. (*Schoenoplectus* spp.). Several cobble spits occur within the site. Soils within the limestone cobble shore are characterized by wet, gravelly, alkaline (pH 8.0) sands mixed with organics occurring between and beneath limestone cobble.

Vegetation within the limestone cobble shore is sparse, occurring patchily between cobbles and concentrated along the upper margin of the shore. Characteristic ground cover species include Baltic rush, Ohio goldenrod (*Solidago ohioensis*), blue-joint (*Calamagrostis canadensis*), limestone calamint (*Clinopodium arkansanum*), mountain blue-eyed-grass (*Sisyrinchium montanum*), and panic grass (*Dicanthelium lindheimeri*). The patchy, low shrub layer supports Kalm's St. John's-wort (*Hypericum kalmianum*), shrubby cinquefoil (*Dasiphora fruticosa*), and northern white-cedar (*Thuja occidentalis*). Scattered trees and shrubs occur along the margins of the limestone cobble shore and include northern white-cedar, willows (*Salix* spp.), and paper birch (*Betula papyrifera*).

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

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to monitor for invasive species.

Monatou Bay limestone cobble shore. Photos by Joshua G. Cohen.



Aerial photograph of Monatou Bay limestone cobble shore.


Monatou Bay limestone cobble shore. Photo by Joshua G. Cohen.

22. Taganing Shore
Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: B
Size: 117 acres
Location: Garden Island
Element Occurrence Identification Number: 20449 (New EO)

Site Description: The Taganing Shore limestone cobble shore occurs along the western shore of Garden Island and includes shoreline associated with Ninneegoes Bay, Bamways Bay, and Graham's Point. Limestone cobble shore locally grades to coastal fen inland and Great Lakes marsh lakeward. The margin between these communities shifts from year to year with fluctuations of the Great Lakes. Limestone cobble shore 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 limestone cobble shore, reconfiguring the substrate and removing fine mineral sediments and organic soils. Long-term cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of limestone cobble shore, with vegetation and organic soils becoming well established during low-water periods and reduced or eliminated during high-water periods. This site was surveyed in 2015 after two consecutive high water years and surveyors observed many woody stems submerged under water. Along the lake margin of the limestone cobble shore, marsh plant debris and driftwood have accumulated. The driftwood along the shoreline provides important habitat for insects and herptiles and the plant debris provides organic matter for soil development. Rocks along this stretch of shoreline range from small cobble to large boulders. Inclusions of coastal fen and Great Lakes marsh occur locally within the limestone cobble shore. Inclusions of Great Lakes marsh and coastal fen are most prevalent in Bamways Bay and Ninneegoes Bay. Several cobble spits occur within the site. The soils of the limestone cobble shore are characterized by wet, gravelly, alkaline (pH 8.0) sands mixed with organics occurring between and beneath limestone cobble.

The vegetation within the limestone cobble shore is sparse, occurring patchily between cobbles and concentrated along the upper margin of the shore. Characteristic ground cover species include Baltic rush (*Juncus balticus*), limestone calamint (*Clinopodium arkansanum*), Indian paintbrush (*Castilleja coccinea*), bastard-toadflax (*Comandra umbellata*), sedges (*Carex* spp.), and wild columbine (*Aquilegia canadensis*). Non-native species are common to locally abundant and include Canada bluegrass (*Poa compressa*), mossy stonecrop (*Sedum acre*), spotted knapweed (*Centaurea stoebe*), and red clover (*Trifolium pratense*). The patchy but diverse low shrub layer is characterized by Kalm's St. John's-wort (*Hypericum kalmianum*), red-osier dogwood (*Cornus sericea*), shrubby cinquefoil (*Dasiphora fruticosa*), northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), sand cherry (*Prunus pumila*), soapberry (*Shepherdia canadensis*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), and willows (*Salix* spp.). Scattered saplings occur along the margins of the limestone cobble shore and include northern white-cedar, balsam poplar, paper birch, and tamarack (*Larix laricina*).

Threats: Species composition and structure are driven primarily by natural processes. Non-native species are common to locally abundant and include Canada bluegrass (*Poa compressa*), spotted knapweed (*Centaurea stoebe*), mossy stonecrop (*Sedum acre*), and red clover (*Trifolium pratense*).

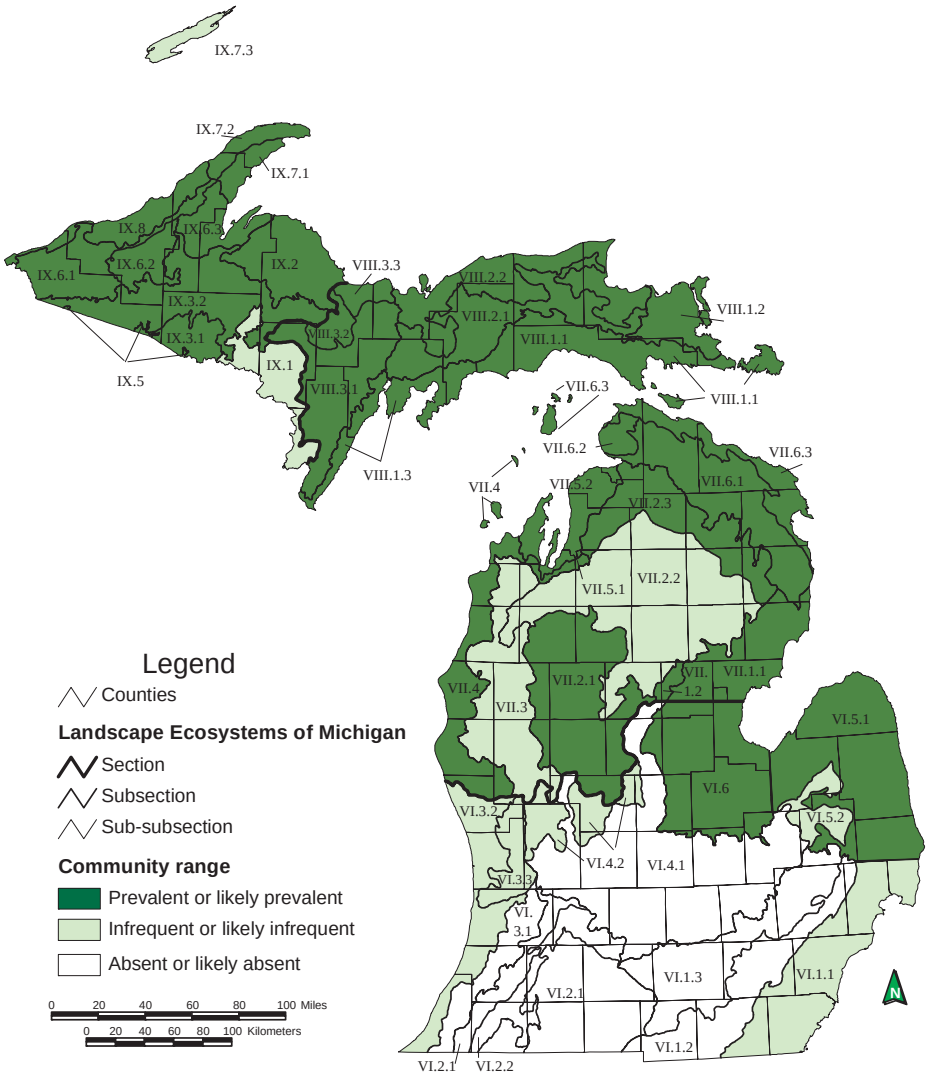
Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the limestone cobble shore and nearby areas of shoreline. Control efforts should be followed by monitoring for these invasive species.

Taganing limestone cobble shore. Photo by Joshua G. Cohen.

Aerial photograph of Taganing limestone cobble shore.

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

23. Hog Island
Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 895 acres
Location: Hog Island
Element Occurrence Identification Number: 7843 (EO Update)

Site Description: The Hog Island mesic northern forest occurs on the southern and northern ends of Hog Island on mild to rolling topography of former cobble and low dune shoreline. The mesic northern forest ranges from mature to old-growth with some pockets of younger forest. Within the northern polygon, the canopy trees are from the same cohort and of a species mix (red oak and white pine) that suggest establishment after a stand-leveling fire. A 66.7 cm red oak (*Quercus rubra*) was cored and estimated to be over 203 years old. A 92.6 cm sugar maple (*Acer saccharum*) was cored and estimated to be over 200 years old. A 104.5 cm red oak was cored and 120 years were counted on two-thirds of the core, also corroborating an estimate of over 200. The younger portions of mesic northern forest were likely selectively logged over 150 years ago. A 55.5 cm white ash (*Fraxinus americana*) in the southern part of the island was cored and estimated to be over 146 years old. Scattered old-growth trees occur in the southern polygon, which does not appear to have experienced the same fire event that the northern polygon experienced. Given the proximity of this forest to Lake Michigan, the climate is moderated and windthrow occurs throughout the forest. This forest is starting to accrue many attributes of an old-growth forest including a canopy dominated by large diameter trees (60-100 cm DBH), coarse woody debris and snags represented by large diameter trees of diverse size classes and species, and pit-and-mound topography. Where yew (*Tacus canadensis*) is an overwhelming dominant in the understory, this species is likely impacting species diversity and regeneration through competition for light resources. Soils are variable with mull hummus occurring over dune sands and also over cobble locally. One soil sample in the northern polygon was characterized by a 10 cm A horizon (pH 5.5) that was overlying fine-textured and acidic (pH 4.5-5.0) dune sands. In the southern polygon, the acidic (pH 5.0-5.5) mull hummus occurs over medium-textured sands. A localized area in the northern polygon appears to have shallow acidic (pH 4.5-5.0) soils overlying fire-baked sandstone cobble.

The species composition of the mesic northern forest is variable. The southern polygon is dominated by sugar maple, which is also prevalent in the understory, low shrub layer, and ground cover. Red oak occurs as a canopy associate. Many of the boles of the large diameter canopy maples are moss covered. Yew is also dominant in the low shrub layer. Characteristic ground cover species include blue cohosh (*Caulophyllum thalictroides*), purple meadow-rue (*Thalictrum dasycarpum*), wild leek (*Allium tricoccum*), jack-in-the-pulipt (*Arisaema triphyllum*), hairy sweet cicely (*Osmorhiza claytonii*), woodferns (*Dryopteris* spp.), round-lobed hepatica (*Hepatica americana*), blue-bead lily (*Clintonia borealis*), downy Solomon seal (*Polygonatum pubescens*), violets (*Viola* spp.), and bloodroot (*Sanguinaria canadensis*).

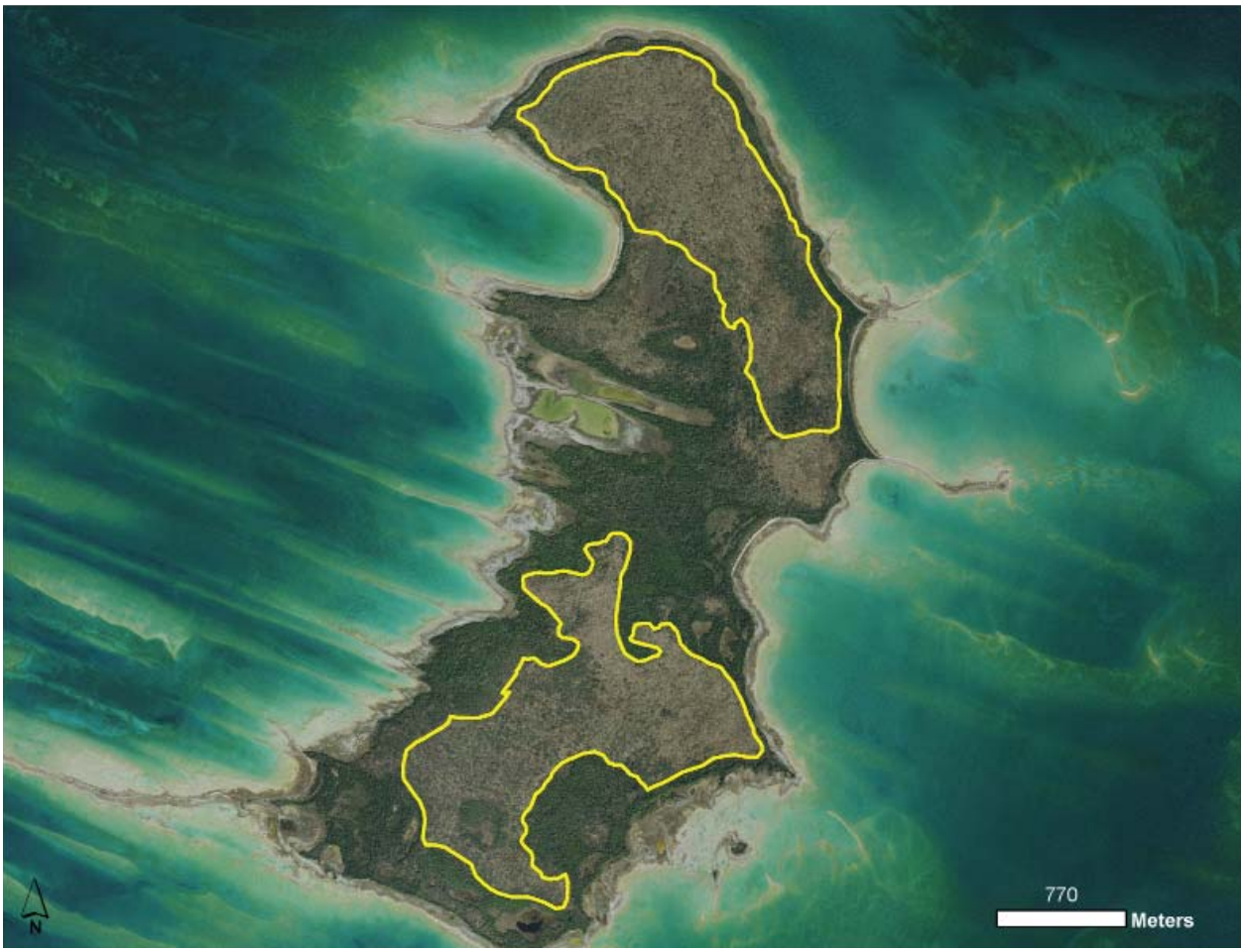
The canopy of the northern polygon is dominated by red oak with canopy associates including white pine (*Pinus strobus),* sugar maple, white ash, red maple (*Acer rubrum*), basswood (*Tilia american*), and paper birch (*Betula papyrifera*). Throughout the forest, the overstory ranges from 80 to 100%. Canopy trees typically range in DBH from 60 to 100 cm. Closer to the shoreline northern white-cedar (*Thuja occidentalis*) and paper birch become more prevalent in the canopy. Supercanopy white pines occur locally, reaching 90 to 100 feet tall. Prevalent understory species include red maple and yew with associates including mountain maple (*Acer spicatum*), balsam fir (*Abies balsamea*), red elderberry (*Sambucus racemosa*), beaked hazelnut (*Corylus cornuta*), choke cherry (*Prunus virginiana*), and basswood (*Tilia americana*). Yew is locally dominant in the low shrub layer and additional characteristic

low shrubs include Canadian fly honeysuckle (*Lonicera canadensis*), wild red raspberry (*Rubus strigosus*), common blackberry (*R. allegheniensis*), and balsam fir. The ground cover is most developed where yew is less prevalent. Characteristic ground cover species include starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), blue-bead lily, downy Solomon seal, round-lobed hepatica, false spikenard (*Maianthemum racemosum*), partridge berry (*Mitchella repens*), purple meadow-rue, sedge (*Carex pedunculata*), white baneberry (*Actaea pachypoda*), hairy sweet cicely, violets, maidenhair fern (*Adiantum pedatum*), jack-in-the-pulpit, herb Robert (*Geranium robertianum*), wild leek, rose twisted-stalk (*Streptopus lanceolatus*), woodferns, and large-leaved aster (*Eurybia macrophylla*). Ostrich fern (*Matteuccia struthiopteris*) is locally common in low areas within the forest complex. Diverse mosses are prevalent on the boles of the old-growth trees.

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

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the mesic northern forest, and monitor for invasive species.

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



Aerial photograph of Hog Island mesic northern forest.

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

24. Martin's Bluff
Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 42 acres
Location: Beaver Island
Element Occurrence Identification Number: 626 (EO Update)

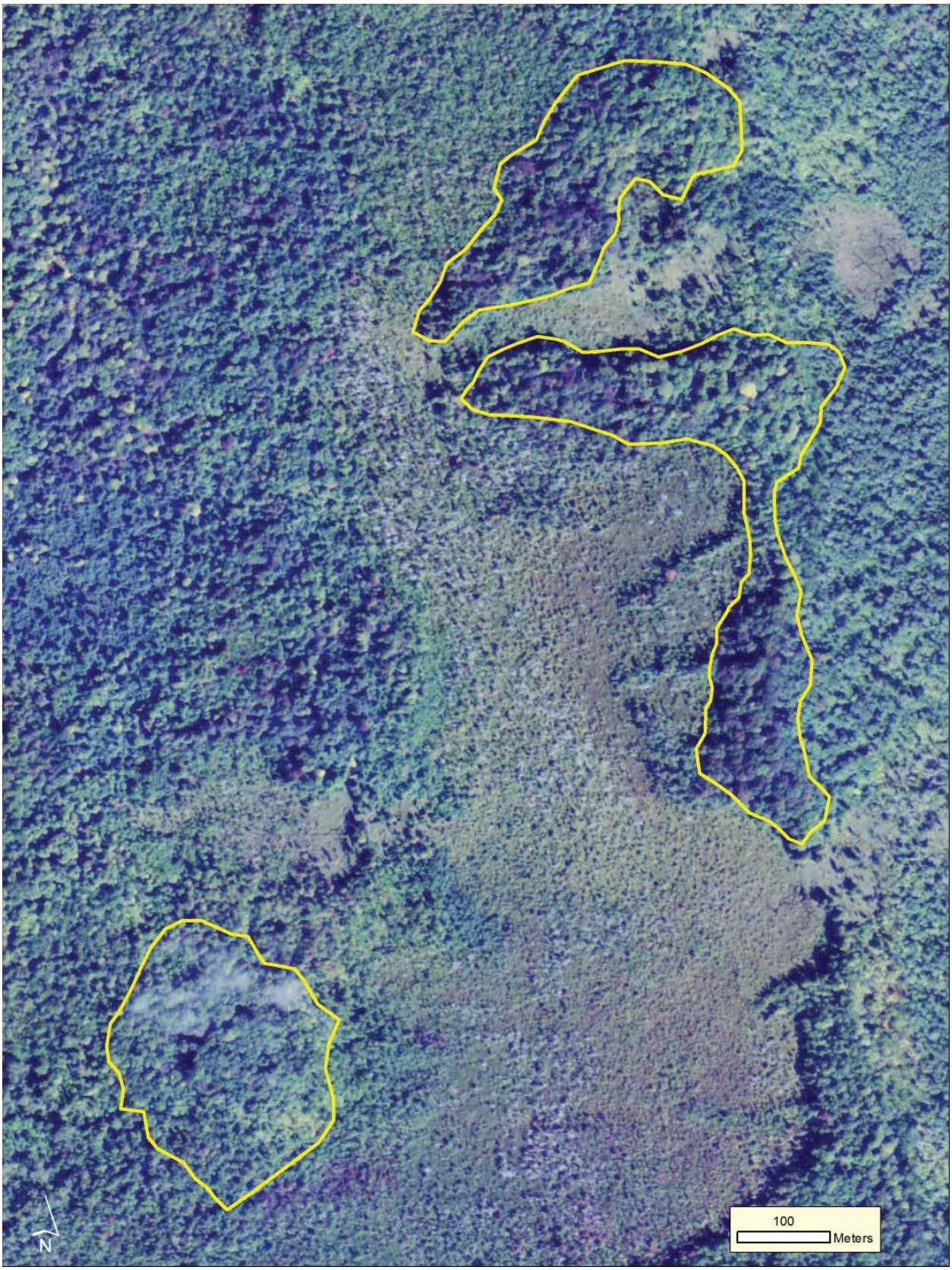
Site Description: Three small islands of uneven-aged, old-growth mesic northern forest occur on rolling ground moraine with fine- to medium-textured loamy sands that range from acidic to alkaline. The site is characterized by well-developed pit and mound topography but only moderate levels of coarse woody debris and snags were observed. The forest is surrounded by beaver-influenced wetlands, conifer swamp, and paper birch (*Betula papyrifera*) and aspen (*Populus* spp.) forest that likely established following turn-of-the-century logging. Soils vary with canopy dominance. In areas dominated by sugar maple, the soils have a mull humus over acidic (pH 5.0-6.0) sandy clay loams and sandy loams. In hemlock-dominated areas, the soils are characterized by an acidic mor humus over leeched sands (pH 4.5) over loamy sands (pH 4.5-5.0).

The canopy is dominated by large-diameter (> 60 cm), old-growth (250+ years old) sugar maple (*Acer saccharum*), hemlock (*Tsuga canadensis*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*). Mature beech trees within this forest are beginning to die from beech bark disease. Canopy dominance varies locally with hemlock dominant in the northern island and sugar maple dominant in the southern two polygons. The forest is characterized by uneven-aged structure with sugar maple, hemlock, yellow birch, balsam fir (*Abies balsamea*), and red maple (*Acer rubrum*) in the subcanopy. Canopy associates include pockets of mid-tolerant species, such as green ash (*Fraxinus pennsylvanica*) and shade-intolerant species, such as paper birch and quaking aspen (*Populus tremuloides*), which occur along the edges of the forest and in larger light gaps. Numerous canopy gaps of diverse age, size, and shape are found throughout the site. The tall shrub layer is dominated by sugar maple with balsam fir as a local dominant and striped maple (*Acer pensylvanicum*), beaked hazelnut (*Corylus cornuta*), beech, and red maple characteristic. Canadian fly honeysuckle (*Lonicera canadensis*) is prevalent in the low shrub layer with seedlings of sugar maple, white ash (*Fraxinus americana*), and balsam fir common. The ground cover is dominated by sugar maple seedlings with characteristic species including starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), violets (*Viola* spp.), spinulose woodfern (*Dryopteris carthusiana*), Indian cucumber root (*Medeola virginiana*), Canada mayflower (*Maianthemum canadense*), sedge (*Carex pedunculata*), goldthread (*Coptis trifolia*), gay-wings (*Polygala paucifolia*), bunchberry (*Cornus canadensis*), partridge berry (*Mitchella repens*), blue-bead lily (*Clintonia borealis*), and stiff clubmoss (*Spinulum annotinum*). Areas along the ecotonal edge of the mesic northern forest and the adjacent wetland are dominated by hemlock with yellow birch, red maple, and occasional northern white-cedar (*Thuja occidentalis*).

Threats: Deer herbivory is likely impacting the site's species composition and structure (i.e., eliminating hemlock regeneration). Browsed sugar maple saplings and jewelweed (*Impatiens capensis*) were noted during the survey. Mature beech trees within the forest are beginning to die from beech bark disease. In the northern block of the forest there is a hunting blind with a wood stove. Hunters are cutting coarse woody debris for firewood and clearing trails with a chainsaw. One non-native earthworm was observed while digging a soil pit. Earthworms could potentially alter the soil decomposition rates and nutrient dynamics. Finally, the private portion of the old-growth forest could be logged.

Martin's Bluff mesic northern forest. Photo by Joshua G. Cohen.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging). Private lands within and surrounding the site could be acquired or protected through conservation easements. The old-growth forest could be buffered by unmanaged forest and swamp. If the surrounding forest is managed, extending the rotation and maintaining late-successional features of the forest are recommended. Reducing deer densities on the island could be accomplished through culling and/or increasing late-successional habitat by allowing early-successional stands to senesce and succeed to more mature, shade-tolerant systems. In addition, establishment of deer exclosures within the site will foster conifer seedling and sapling regeneration. Placement of exclosures should be located around concentrations of large-diameter coarse woody debris or nurse logs since these microsites provide important establishment sites for hemlock, as well as yellow birch. The impacts of deer herbivory should be monitored, especially if exclosures are erected.



Aerial photograph of Martin's Bluff mesic northern forest.

25. Nezewabegon Forest
Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Size: 456 acres
Location: High Island
Element Occurrence Identification Number: 20452 (New EO)

Site Description: The Nezewabegon Forest is a mesic northern forest that occurs in the northwestern portion of High Island on undulating to rugged topography of former dune shoreline. Due to the proximity of this forest to Lake Michigan, the climate is moderated and windthrow is common throughout the forest. This large block of mesic northern forest ranges from mature to old-growth, and throughout the forest species composition and vegetative structure are patterned by natural processes. A 98.5 cm red oak (*Quercus rubra*) was cored and 230 growth rings were counted on the two-thirds of the core that was extracted. This tree and many of the canopy dominants within this uneven-aged system are likely at least 250 years old and likely over 300 years old. In addition, a 73.6 cm hemlock (*Tsuga canadensis*) was cored and estimated to be over 300 years old (100 growth rings were counted on the partial core). This block of forest is starting to accrue many attributes of an old-growth forest including a canopy dominated by large diameter trees (60-100 cm), coarse woody debris and snags represented by large diameter trees of diverse size classes and species, and pit and mound topography. Pit and mound topography is most pronounced in the areas with flat to gently rolling topography. Numerous ravines and steep dune slopes occur throughout the forest. Interestingly a 5 cm understory yew (*Taxus canadensis*) was cored and estimated to be over 70 years old. Where yew is an overwhelming dominant in the understory, it is likely impacting species diversity and regeneration through competition for light resources. Soils within the mesic northern forest are characterized by a typically shallow (5-15 cm) A horizon with acidic loamy sands (pH 5.0-5.5) over medium-textured acidic sand and loamy sand (pH 5.0-5.5).

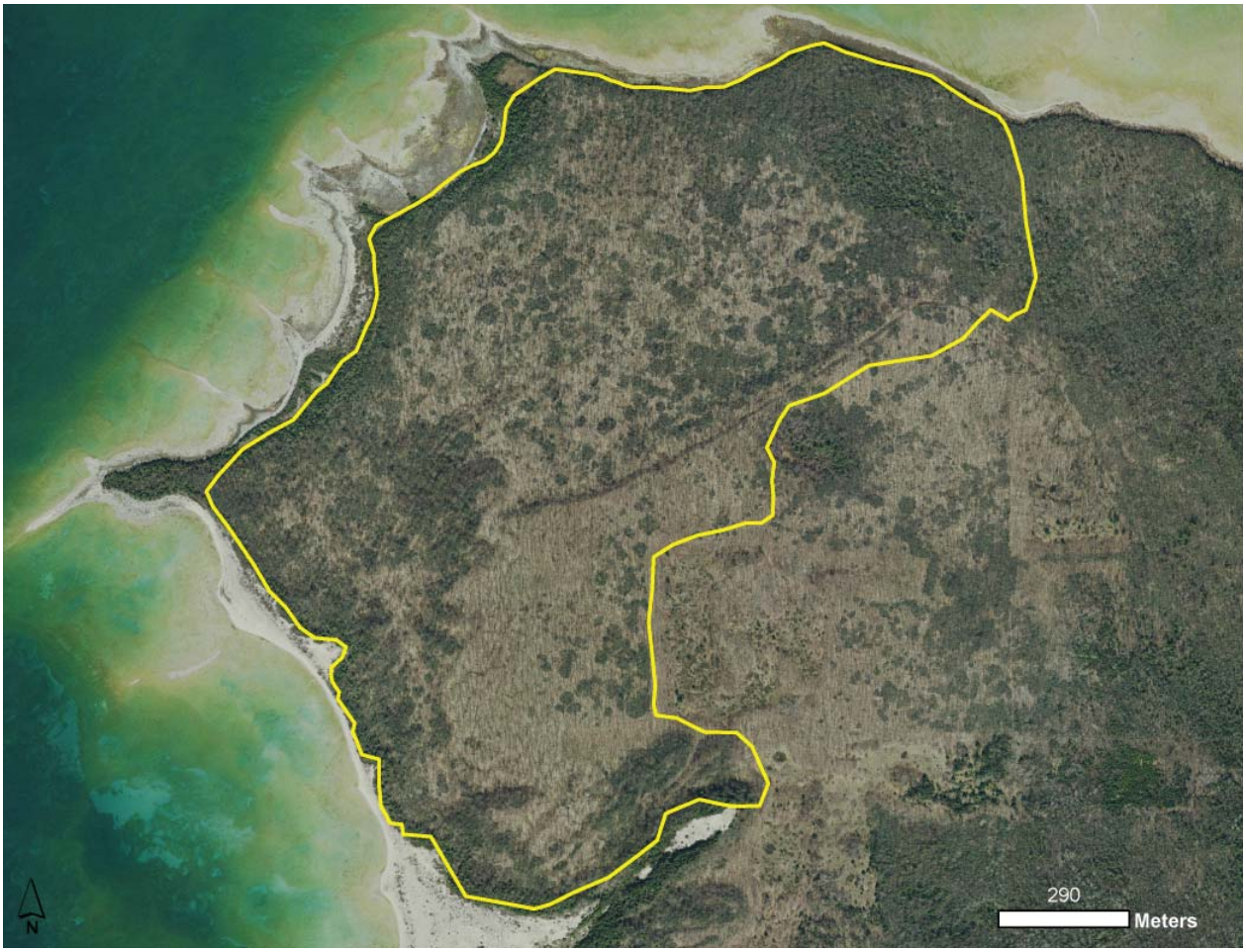
The overstory ranges from 75 to 100% and the canopy is dominated by sugar maple (*Acer saccharum*) with canopy associates including yellow birch (*Betula alleghaniensis*), hemlock, red oak, and northern white-cedar (*Thuja occidentalis*), which is concentrated closer to the shore. Canopy trees typically range in DBH from 60 to 100 cm. Scattered subcanopy trees include sugar maple, northern white-cedar, and American mountain-ash (*Sorbus americana*). The understory ranges from 10 to 20% and characteristic species include sugar maple, round-leaved dogwood (*Cornus rugosa*), mountain maple (*Acer spicatum*), red elderberry (*Sambucus racemosa*), beaked hazelnut (*Corylus cornuta*), American mountain-ash, choke cherry (*Prunus virginiana*), and yew (*Taxus canadensis*). The low shrub layer ranges from sparse (15-30%) to dense (80-90%) with yew locally dominant. Additional species in the low shrub layer include mountain maple, sugar maple, and beaked hazelnut. The ground cover is most developed where yew is less prevalent. Characteristic ground cover species include Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), woodferns (*Dryopteris* spp.), sedges (*Carex* spp.), blue-bead lily (*Clintonia borealis*), yellow violet (*Viola pubescens*), blue cohosh (*Caulophyllum thalictroides*), common trillium (*Trillium grandiflorum*), false spikenard (*Maianthemum racemosum*), downy Solomon seal (*Polygonatum pubescens*), partridge berry (*Mitchella repens*), wild leek (*Allium tricoccum*), jack-in-the-pulipt (*Arisaema triphyllum*), large-flowered bellwort (*Uvularia grandiflora*), bedstraw (*Galium triflorum*), oak fern (*Gymnocarpium dryopteris*), purple meadow-rue (*Thalictrum dasycarpum*), cow-parsnip (*Heracleum maximum*), bloodroot (*Sanguinaria canadensis*), round-lobed hepatica (*Hepatica americana*), rose twisted-stalk (*Streptopus lanceolatus*), and white baneberry (*Actaea pachypoda*). Diverse mosses are prevalent on the boles of the old-growth trees.

The absence of deer on High Island provides a unique research opportunity to study the floristic composition of forested ecosystems that have not been impacted by high deer browse pressure.

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

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the mesic northern forest, and monitor for invasive species.

Nezewabegon Forest mesic northern forest. Photo by Joshua G. Cohen.



Aerial photograph of Nezewabegon Forest mesic northern forest.

Nezewabegon Forest mesic northern forest. Photo by Joshua G. Cohen.

26. Red Oak Garden
Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 81 acres
Location: Garden Island
Element Occurrence Identification Number: 10496 (EO Update)

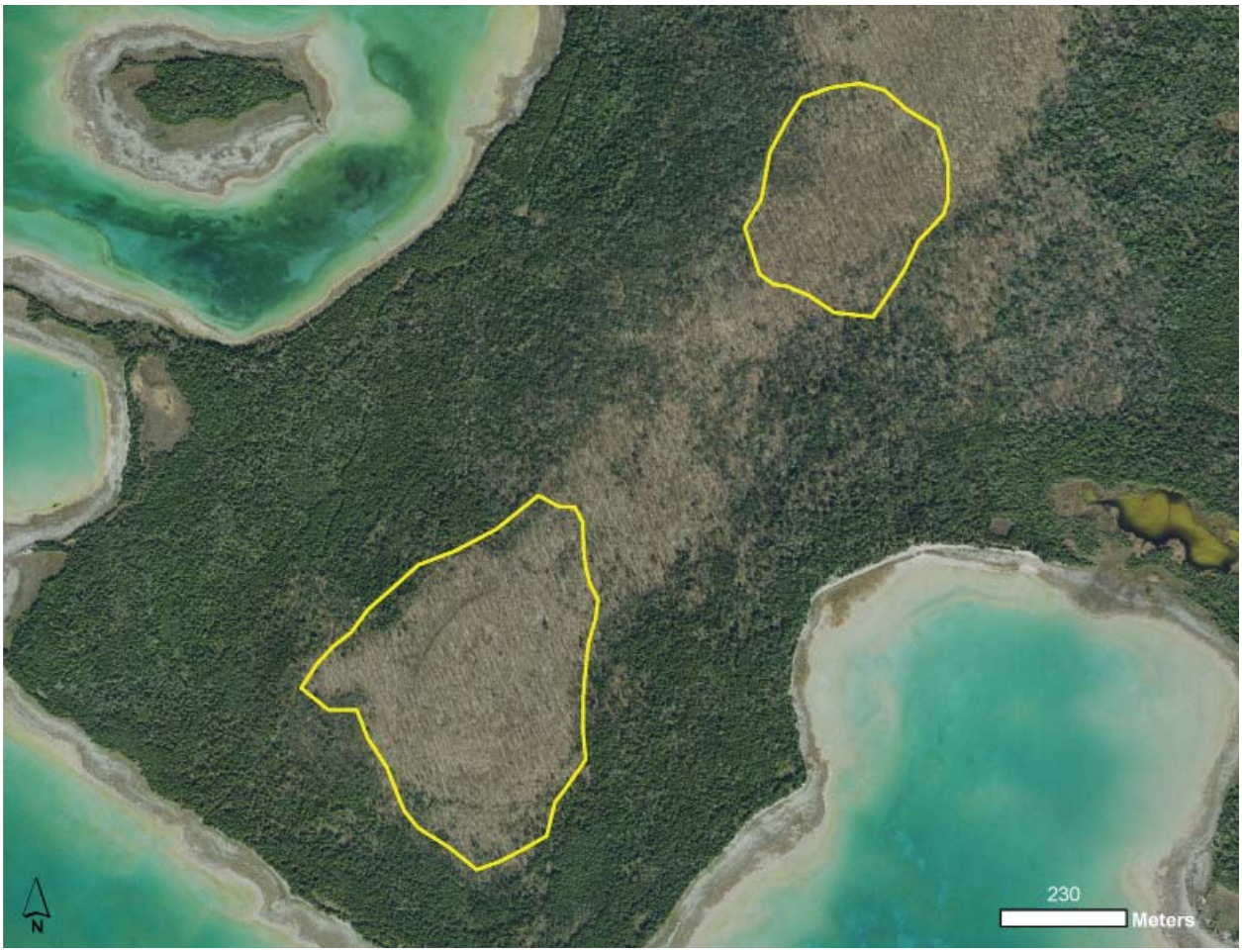
Site Description: The Red Oak Garden mesic northern forest consists of two polygons of uneven-aged forest occurring on rolling topography in the southern portion of Garden Island. Surveys in 2015 significantly expanded the element occurrence. The mesic northern forest is characterized by pit and mound topography and is starting to accrue older and larger coarse woody debris. A 52.5 cm white ash (*Fraxinus americana*) was cored in the southern polygon and estimated to be over 137 years old. A 72.7 cm red oak (*Quercus rubra*) was cored in the northern polygon and estimated to be over 155 years old. The soils in the southern polygon are characterized by shallow (5-10 cm), alkaline (pH 7.5) loams overlying limestone cobble. The soils in the northern polygon are characterized by deeper sands (50-60cm) overlying cobble. The A horizon (10-30 cm) of organics mixed with sands (pH 4.5-5.0) overlies medium-textured, acidic, sands (pH 5.5-6.0).

The canopy of the Red Oak Garden mesic northern forest is dominated by sugar maple (*Acer saccharum*) with canopy associates including red oak, yellow birch (*Betula alleghaniensis*), white ash, and paper birch (*Betula papyrifera*). Canopy trees typically range in DBH from 40 to 60 cm with larger red oak (60-80 cm) occurring in the northern oak-dominated polygon. Canopy closure ranges from 75 to 95%. The subcanopy is scattered with sugar maple, ironwood (*Ostrya virginiana*), and yellow birch. The understory is characterized by sugar maple, ironwood, striped maple (*Acer pensylvanicum*), white ash, round-leaved dogwood (*Cornus rugosa*), red elderberry (*Sambucus racemosa*), and beaked hazelnut (*Corylus cornuta*). Prevalent species in the low shrub layer include Canadian fly honeysuckle (*Lonicera canadensis*), balsam fir (*Abies balsamea*), wild red raspberry (*Rubus strigosus*), ironwood, and red oak. Characteristic ground cover species include blue cohosh (*Caulophyllum thalictroides*), false spikenard (*Maianthemum racemosum*), downy Solomon seal (*Polygonatum pubescens*), jack-in-the-pulipt (*Arisaema triphyllum*), bedstraw (*Galium triflorum*), oak fern (*Gymnocarpium dryopteris*), purple meadow-rue (*Thalictrum dasycarpum*), cow-parsnip (*Heracleum maximum*), round-lobed hepatica (*Hepatica americana*), hairy sweet cicely (*Osmorhiza claytonii*), large-leaved aster (*Eurybia macrophylla*), zigzag goldenrod (*Solidago flexicaulis*), and white baneberry (*Actaea pachypoda*).

Threats: Species composition and vegetative structure are patterned by natural processes and past logging history (cut stumps occur within the forest). A trail passes through the northern portion of the occurrence.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the mesic northern forest, and monitor for invasive species.

Red Oak Garden mesic northern forest. Photos by Joshua G. Cohen.



Aerial photograph of Red Oak Garden mesic northern forest.

Red Oak Garden mesic northern forest. Photo by Joshua G. Cohen.

27. Southwest Old Growth
Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 91 acres
Location: Beaver Island
Element Occurrence Identification Number: 10493 (EO Update)

Site Description: This uneven-aged mesic northern forest is starting to accrue old-growth attributes and occurs on rolling ground moraine on the southwestern end of Beaver Island. The forest includes portions both above and below a steep nearshore terrace. Portions of the forest on top of the terrace are characterized by rolling terrain and are dominated by deciduous species. Below the terrace, the forest is dominated by hemlock on rolling to moderate terrain. The site is characterized by well-developed pit and mound topography, moderate levels of coarse woody debris, and numerous large canopy gaps. Canopy trees are large with many trees being greater than 70 cm DBH and many supporting a diverse array of funguses and mosses on their boles. An 82 cm hemlock (*Tsuga canadensis*) was cored and estimated to be 250 to 300 years old. Along the base of the steep terrace where there is significant groundwater discharge, old-growth mesic northern forest intergrades with old-growth hardwood-conifer swamp. In hemlock-dominated areas the soils are characterized by an acidic mor humus (5 cm deep and pH 4.5) over leached sands (pH 4.5-5.0) over loamy sands (pH 5.0-5.5).

The canopy is dominated by large-diameter (> 70 cm), old-growth (250+ years old) sugar maple (*Acer saccharum*), hemlock, American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*). Northern white-cedar (*Thuja occidentalis*) occurs locally as a canopy associate. Canopy dominance varies locally with hemlock dominant bellow the terrace and deciduous species dominant on top of the terrace. The forest is characterized by uneven-aged structure with sugar maple, beech, hemlock, balsam fir (*Abies balsamea*), and yellow birch in the subcanopy. Numerous canopy gaps of diverse age, size, and shape are found throughout the site. Many canopy gaps have recently formed due to the mortality of canopy beech from beech bark disease. Many class 1 (recently dead with fine branching) beech snags occur throughout the site. The tall shrub and low shrub layers are sparse (both 5-10%) with characteristic species including sugar maple, balsam fir, striped maple (*Acer pensylvanicum*), beech, and hemlock (uncommon). The ground cover is dominated by sugar maple seedlings with characteristic species including starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), oak fern (*Gymnocarpium dryopteris*), naked miterwort (*Mitela nuda*), ground-pine (*Dendrolycopodium obscurum*), running ground-pine (*Lycopodium clavatum*), and spinulose woodfern (*Dryopteris carthusiana*).

Threats: West Side Drive passes through a portion of this element occurrence. Deer herbivory is likely impacting the site's species composition and structure (i.e., eliminating hemlock regeneration). Mature beech trees within the element occurrence are succumbing to beech bark disease. Large areas of blowdown are correlated with the recent mortality of beech from beech bark disease. These blowdowns are susceptible to invasive species incursions. The invasive multiflora rose (*Rosa multiflora*) was documented locally in the understory. Finally, the private portion of the old-growth forest could be logged.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging). Private lands within and surrounding the site could be acquired or protected through conservation easements. The old-growth forest could be buffered by unmanaged forest. If the surrounding forest is managed, extending the rotation and maintaining late-successional features of the forest are recommended. Reducing deer densities on the island could be accomplished through culling and/or increasing late-successional habitat in the surrounding landscape by allowing early-successional stands to senesce and succeed to more mature, shade-tolerant systems. In addition, establishment of deer exclosures within the site will foster conifer seedling and sapling regeneration. Placement of exclosures should be located around concentrations of large-diameter coarse woody debris or nurse logs since these microsites provide important establishment sites for hemlock, as well as white pine and yellow birch. The impacts of deer herbivory should be monitored, especially if exclosures are erected. Monitoring for invasive species should also be implemented.

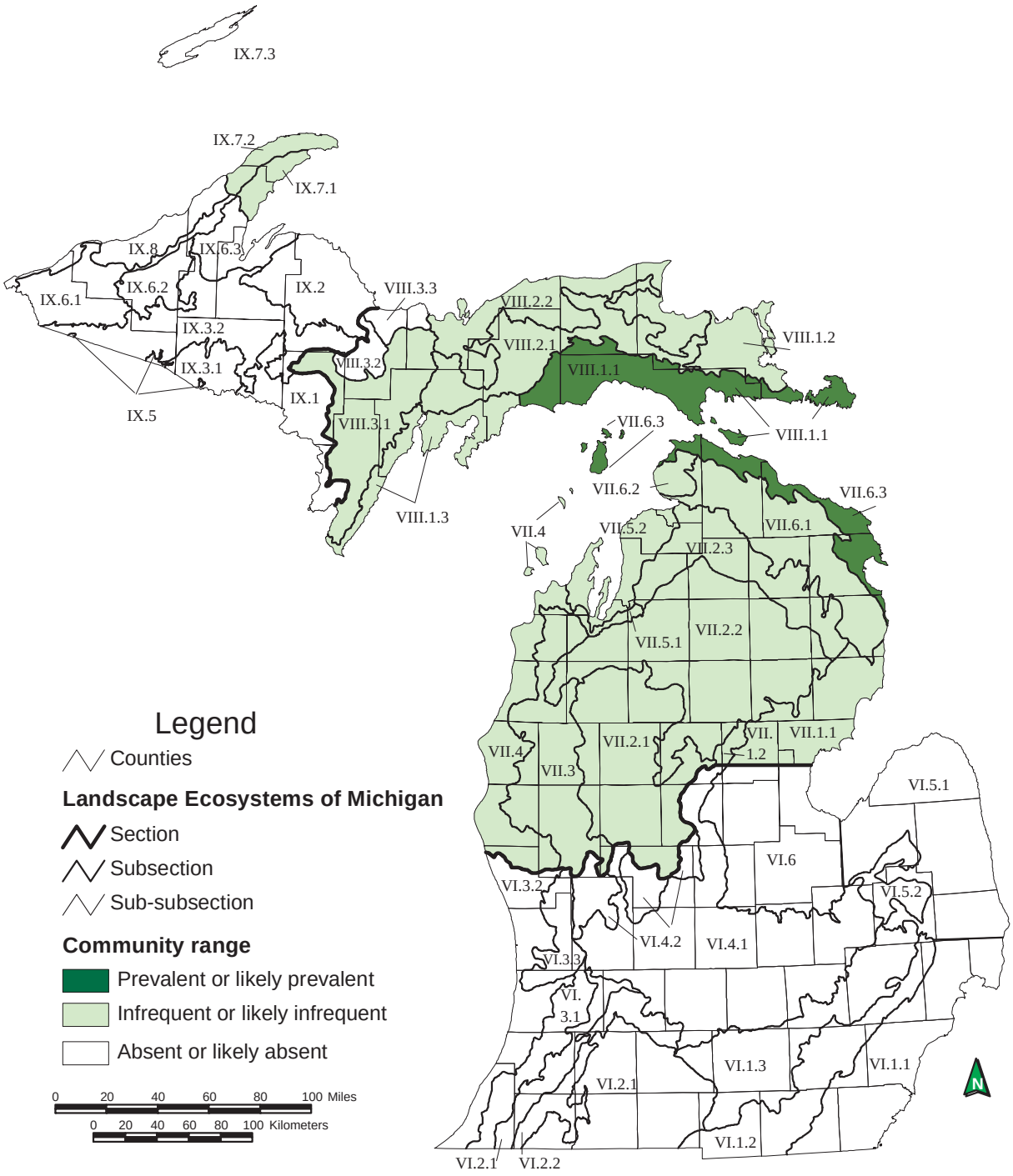
Southwest Old Growth mesic northern forest. Photo by Joshua G. Cohen.

Southwest Old Growth mesic northern forest. Photos by Bill Parsons.

Aerial photograph of Southwest Old Growth mesic northern forest.

NORTHERN FEN

Overview: Northern fen is a sedge- and rush-dominated wetland occurring on neutral to moderately alkaline saturated peat and/or marl influenced by groundwater rich in calcium and magnesium carbonates. The community occurs north of the climatic tension zone and is found primarily where calcareous bedrock underlies a thin mantle of glacial drift on flat areas or shallow depressions of glacial outwash and glacial lakeplains and also in kettle depressions on pitted outwash and moraines (Kost et al. 2007, Cohen et al. 2015).



Map 10. Distribution of northern fen in Michigan (Albert et al. 2008).

28. Hog Island
Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: AB
Size: 20 acres
Location: Hog Island
Element Occurrence Identification Number: 20446 (New EO)

Site Description: Five polygons of relatively young northern fen occur in the southern portion of Hog Island. These fens are relatively young and were likely formed through lake-filling as mats of wiregrass sedge (*Carex lasiocarpa*) invaded shallow ponds. Sphagnum hummocks are just starting to develop. As a result of their recent development, these fens are relatively simple floristically. The soils are saturated circumneutral to alkaline (pH 7.0-7.5) peats of variable depth.

The fen polygons are primarily graminoid-dominated northern fen but the margins of the fens also include shrubby fen and a prevalent wiregrass sedge mat occurs in the southernmost polygon, ringing a small pond. Characteristic ground cover species throughout the fens include wiregrass sedge, twig-rush (*Cladium mariscoides*), white beak-rush (*Rhynchospora alba*), pitcher-plant (*Sarracenia purpurea*), bog buckbean (*Menyanthes trifoliate*), horned bladderwort (*Utricularia cornuta*), small cranberry (*Vaccinium oxycoccos*), large cranberry (*V. macrocarpon*), reed (*Phragmites australis* subsp. *americanus*, native), and bog goldenrod (*Solidago uliginosa*). Common shrubs and trees on the fen margins include slender willow (*Salix petiolaris*), sweet gale (*Myrica gale*), green ash (*Fraxinus pennsylvanica*), tamarack (*Larix laricina*), and northern white-cedar (*Thuja occidentalis*).

Threats: Species composition and zonation are patterned by natural processes. No threats were observed during the survey.

Management Recommendations: The main management recommendations are to retain an intact buffer of natural communities surrounding the wetland and monitor for invasive species.

Hog Island northern fen. Photo by Joshua G. Cohen.

Hog Island northern fen. Photo by Joshua G. Cohen.

Aerial photograph of Hog Island northern fen.

29. Garden Island Harbor
Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: AB
Size: 66 acres
Location: Garden Island
Element Occurrence Identification Number: 11804 (EO Update)

Site Description: This large young northern fen occurs adjacent to a shallow inland lake. While primarily characterized by an expansive floating mat, the fen includes marl pools, marl flats, and a shrubby fen zone. The fen is characterized by high floristic diversity and distinct ecological zonation due to gradients in soil and water chemistry. Species composition and zonation are patterned by natural processes. The development of sphagnum hummocks and hollows in the older portion of fen generates fine-scale gradients in soil moisture and soil chemistry. Groundwater seepage generates nutrient rich growing conditions suitable for fen species. Beaver activity was noted throughout the wetland complex. The soils of the fen are variable with areas of floating mat characterized by 30 to 40 cm of peat over water. Where the fen is grounded, alkaline (pH 8.0) peat and marl were measured to be 10 to 20 cm deep and overlying wet sands. The peats are saturated with inundated peats occurring locally in the marl pools. Crayfish burrows were noted scattered within the fen. This site was formerly classified as northern wet meadow. The majority of the wetland complex is young northern fen but it does include pockets of northern wet meadow.

Much of the fen is characterized by a floating mat dominated by wiregrass sedge (*Carex lasiocarpa*) with reed (*Phragmites australis* subsp. *americanus*, native) prevalent along with twig-rush (*Dulichium arundinaceum*) and sweet gale (*Myrica gale*). Marl flats are dominated by spike-rush (*Eleocharis rostellata*). Characteristic ground cover species throughout the fen include twig-rush, white beak-rush (*Rhynchospora alba*), beak-rush (*R. capillacea*), Kalm's lobelia (*Lobelia kalmii*), false asphodel (*Triantha glutinosa*), grass-of-Parnassus (*Parnassia glauca*), common bog arrow-grass (*Triglochin maritima*), tufted bulrush (*Trichophorum cespitosum*), pitcher-plant (*Sarracenia purpurea*), and sedges (*Carex flava*, *C. livida*, and *C. exilis*).

Common low shrubs include shrubby cinquefoil (*Dasiphora fruticosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), alder-leaved buckthorn (*Rhamnus alnifolia*), bog rosemary (*Andromeda glaucophylla*), and sweet gale (*Myrica gale*). Scattered and stunted conifers in the understory and overstory include northern white-cedar (*Thuja occidentalis*) and tamarack (*Larix laricina*).

Threats: Species composition and zonation are patterned by natural processes. Glossy buckthorn (*Frangula alnus*) was observed just west of the northern fen along a beaver dam.

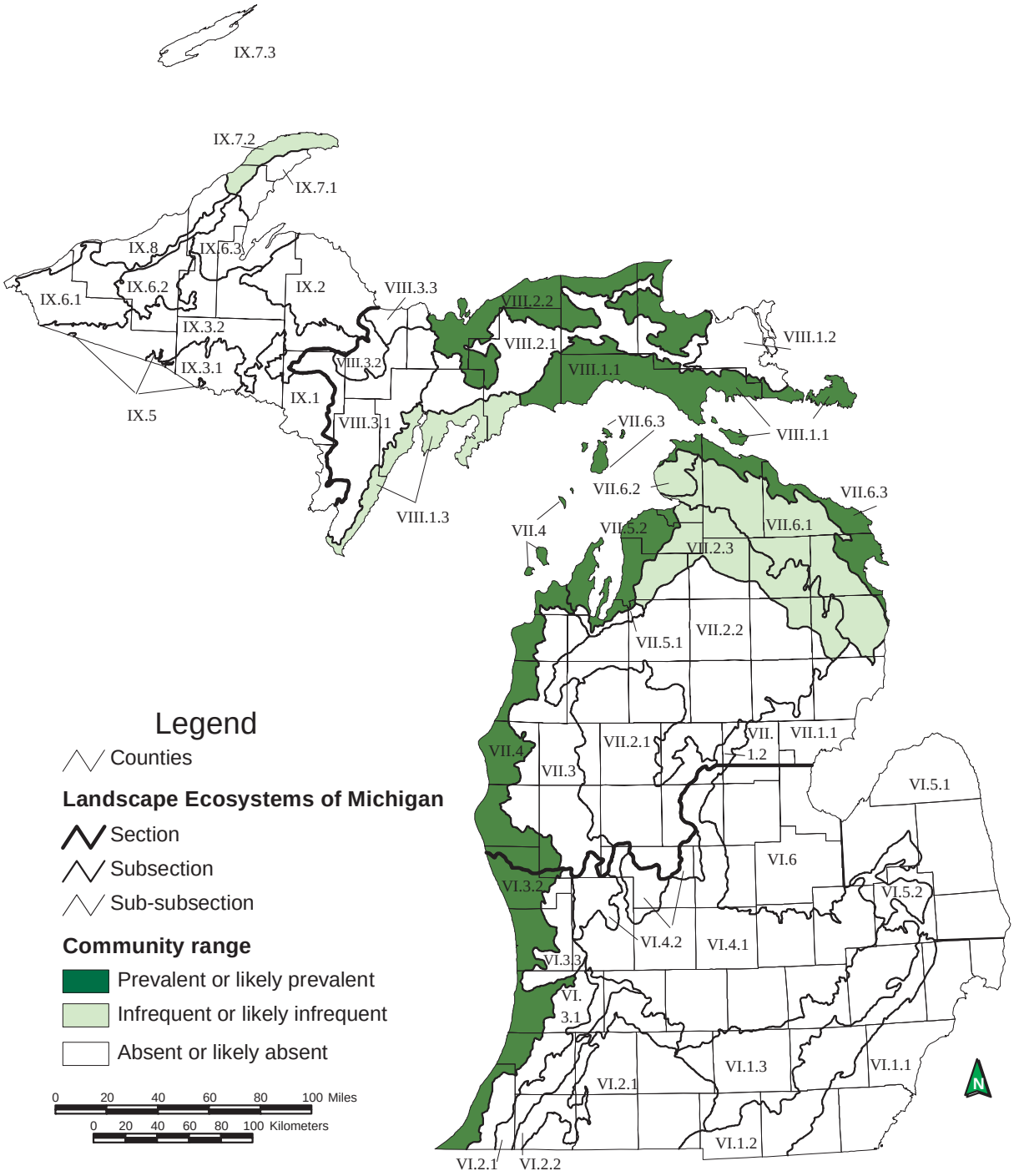
Management Recommendations: The main management recommendations are to retain an intact buffer of natural communities surrounding the wetland, monitor for invasive species within the fen, and control and monitor the glossy buckthorn found in the vicinity of the fen. In addition, older portions of the fen should be surveyd for Hine's emerald dragonfly (*Somatochlora hineana*, state and federally threatened).

Garden Island Harbor northern fen. Photos by Joshua G. Cohen.

Aerial photograph of Garden Island Harbor northern fen.

OPEN DUNES

Overview: Open dunes is a grass- and shrub-dominated multi-seral community located on wind-deposited sand formations near the shorelines of the Great Lakes. Dune formation and the patterning of vegetation are strongly affected by lake-driven winds. The greatest concentration of open dunes occurs along the eastern and northern shorelines of Lake Michigan, with the largest dunes occurring along the eastern shoreline due to the prevailing southwest winds (Kost et al. 2007, Cohen et al. 2015).



Map 11. Distribution of open dunes in Michigan (Albert et al. 2008).

30. Cable Bay
Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 30 acres
Location: Beaver Island
Element Occurrence Identification Number: 530 (EO update)

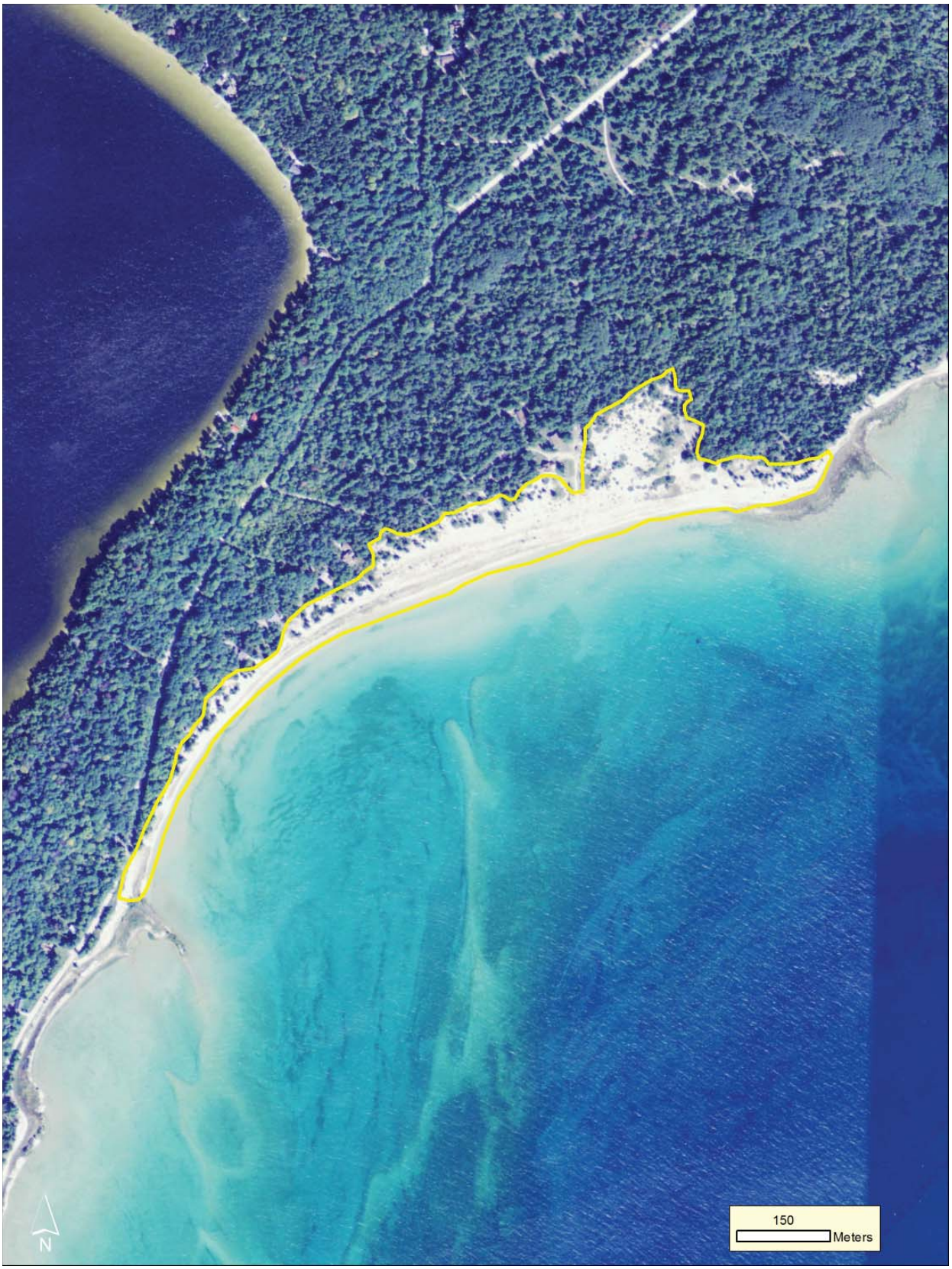
Site Description: This site is characterized by low parabolic dunes and a low foredune that occurs along the southeastern shore of Beaver Island. The soils are fine-textured, wind-blown and wave-worked, alkaline (pH 8.0) sands. The parabolic dunes and associated blowout are found in the northeastern portion of the site. Low foredunes form a long tail to the southwest.

The ground cover of the open dunes is dominated by marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*). Prevalent ground cover species include wormwood (*Artemisia campestris*), white camas (*Anticlea elegans*), Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened), Lake Huron tansy (*Tanacetum bipinnatum*, state special concern), beach pea (*Lathyrus japonicus*), plains puccoon (*Lithospermum caroliniense*), harebell (*Campanula rotundifolia*), wheat grass (*Elymus lanceolatus*), June grass (*Koeleria macrantha*), common horsetail (*Equisetum arvense*), Gillman's goldenrod (*Solidago simplex*), and common milkweed (*Asclepias syriaca*). Lake Huron tansy is concentrated in areas of low foredune. Invasive species are locally common and include spotted knapweed (*Centaurea stoebe*), Canada bluegrass (*Poa compressa*), and bladder campion (*Silene vulgaris*). The low shrub layer ranges from 20 to 50% with prevalent low shrubs including common juniper (*Juniperus communis*), soapberry (*Shepherdia canadensis*), creeping juniper (*Juniperus horizontalis*), and bearberry (*Arctostaphylos uva-ursi*). The understory is scattered (3-12%) with characteristic species including balsam poplar (*Populus balsamifera*), northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), sandbar willow (*Salix exigua*), and choke cherry (*Prunus virginiana*). Infrequent scattered overstory trees include northern white-cedar, white pine (*Pinus strobus*), paper birch, trembling aspen, red pine (*Pinus resinosa*), and balsam fir (*Abies balsamea*) with canopy coverage ranging between 1 and 10%.

Threats: The primary threat to these dunes is posed by continued residential development and ensuing correlated anthropogenic impacts, especially dune erosion and devegetation caused by foot traffic. On the private portions of this complex, numerous houses occur on the margins of the dunes and even within the open dunes. Bare sand increases in areas near residences due to devegetation and erosion from foot traffic. Invasive species are locally common and include spotted knapweed, Canada bluegrass, and bladder campion. Deer trails and browse were noted throughout the dunes. Along the nearshore areas, concentrations of dead zebra mussel shells are potentially limiting vegetative establishment and growth.

Management Recommendations: The main management recommendation is to limit human traffic in the dunes by posting signs about the fragile nature of dune ecosystems. Portions of the complex occurring on private lands could be acquired or protected through conservation easements. Spotted knapweed, Canada bluegrass, and bladder campion should be removed now while they are confined to small portions of the occurrence and control efforts should be monitored.

Cable Bay open dunes. Photos by Joshua G. Cohen.



Aerial photograph of Cable Bay open dunes.

31. High Island
Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: A
Size: 142 acres
Location: High Island
Element Occurrence Identification Number: 10698 (EO update)

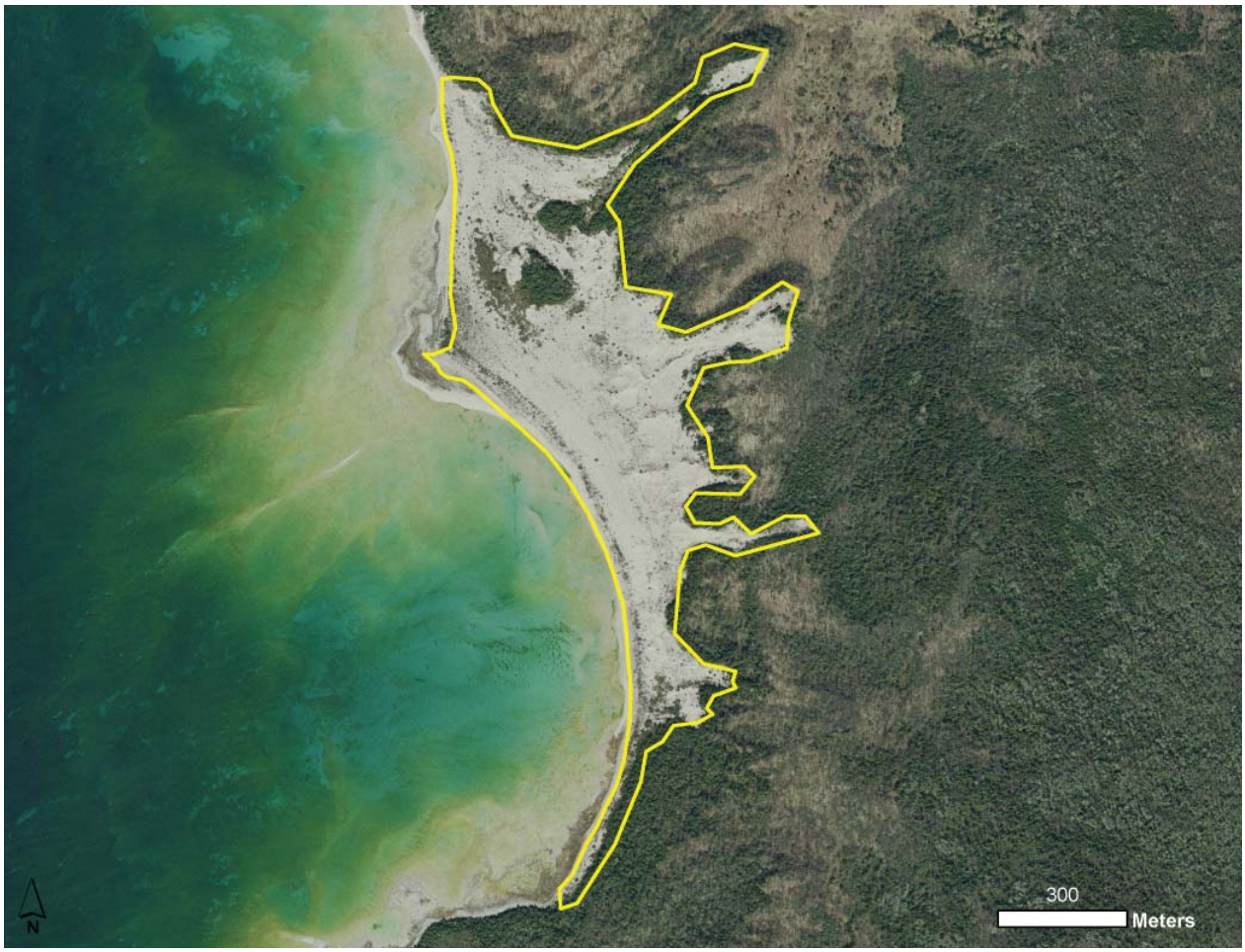
Site Description: The High Island open dunes consists of two miles of pristine open dunes extending along the western side of High Island adjacent to the Lake Michigan shoreline. The High Island dunes is one of four A-ranked open dunes in the state. This site is an extensive parabolic dune complex with a low foredune, a broad flat dune field, and four fingers of rolling to rugged high dunes with blowouts occurring locally. In addition, a narrow band of Great Lakes barrens occurs within the southern portion of the dunes. Old northern white-cedar (*Thuja occidentalis*) snags occur along the margins of some of the blowouts demonstrating the dynamic nature of these dunes: over hundreds of years, the open dunes have encroached on former forested dunes. An 18 cm red pine (*Pinus resinosa*) was cored and estimated to be over 25 years old. Tens of thousands of Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened) occur throughout the dunes. In addition, Lake Huron locust (*Trimerotropis huroniana*) also occurs throughout the dunes. The soils of the open dunes are fine-textured, wind-blown and wave-worked, alkaline (pH 8.0) dune sands.

The low foredune is dominated by marram grass (*Ammophila breviligulata*) with ground cover associates including wormwood (*Artemisia campestris*), pitcher's thistle, wheat grass (*Elymus lanceolatus*), beach pea (*Lathyrus japonicus*), Gillman's goldenrod (*Solidago simplex*), and common evening-primrose (*Oenothera biennis*). Prevalent shrubs and trees in the low foredune include balsam poplar (*Populus balsamifera*), willows (*Salix* spp.), sand cherry (*Prunus pumila*), and red-osier dogwood (*Cornus sericea*). The broad flat dune field has 10 to 15% ground cover with sand reed grass (*Calamovilfa longifolia*), little bluestem (*Schizachyrium scoparium*), white camas (*Anticlea elegans*), and wormwood. Prevalent low shrubs include bearberry (*Arctostaphylos uva-ursi*), shrubby cinquefoil (*Dasiphora fruticosa*), common juniper (*Juniperus communis*), sand cherry, and balsam poplar. The scattered understory contains paper birch (*Betula papyrifera*), balsam poplar, and northern white-cedar. Areas of high parabolic dunes are characterized by sand reed grass, wormwood, white camas, little bluestem, Gillman's goldenrod, plains puccoon (*Lithospermum caroliniense*), starry false Solomon-seal (*Maianthemum stellatum*), common milkweed (*Asclepias syriaca*), harebell (*Campanula rotundifolia*), yarrow (*Achillea millefolium*), and Pitcher's thistle. Common low shrubs include common juniper, bearberry, and sand cherry. The scattered understory contains balsam poplar, blueleaf willow (*Salix myricoides*), and northern white-cedar. Overstory northern white-cedar and paper birch occur infrequently. The backside of the high dunes supports thickets of red-osier dogwood and climbing bittersweet (*Celastrus scandens*) winding on the dogwoods. A narrow band of Great Lakes barrens occurs in the southern portion of the dune complex. Canopy coverage here ranges from 2 to 5% and canopy trees include white pine (*Pinus strobus*) and white spruce (*Picea glauca*). Common understory species include white pine, white spruce, and red-osier dogwood. The low shrub layer is dense (80-90%) and dominated by common juniper, creeping juniper (*Juniperus horizontalis*), bearberry, and sand cherry. Characteristic ground cover species include white camas, starry false Solomon-seal, sand reed grass, and poison ivy (*Toxicodendron radicans*).

Threats: Species composition and structure are driven by natural processes. Invasives found along the shoreline nearby include mossy stonecrop (*Sedum acre*), narrow-leaved cat-tail (*Typha angustifolia*), reed (*Phragmites australis* subsp. *australis*), spotted knapweed (*Centaurea stoebe*), and white sweet-clover (*Melilotus albus*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, to control invasive species along the adjacent shoreline, and monitor for invasive species.

High Island open dunes. Photos by Joshua G. Cohen.



Aerial photograph of High Island open dunes.


High Island open dunes. Photo by Joshua G. Cohen.

32. Lookout Point
Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: CD
Size: 21 acres
Location: Beaver Island
Element Occurrence Identification Number: 6701 (EO update)

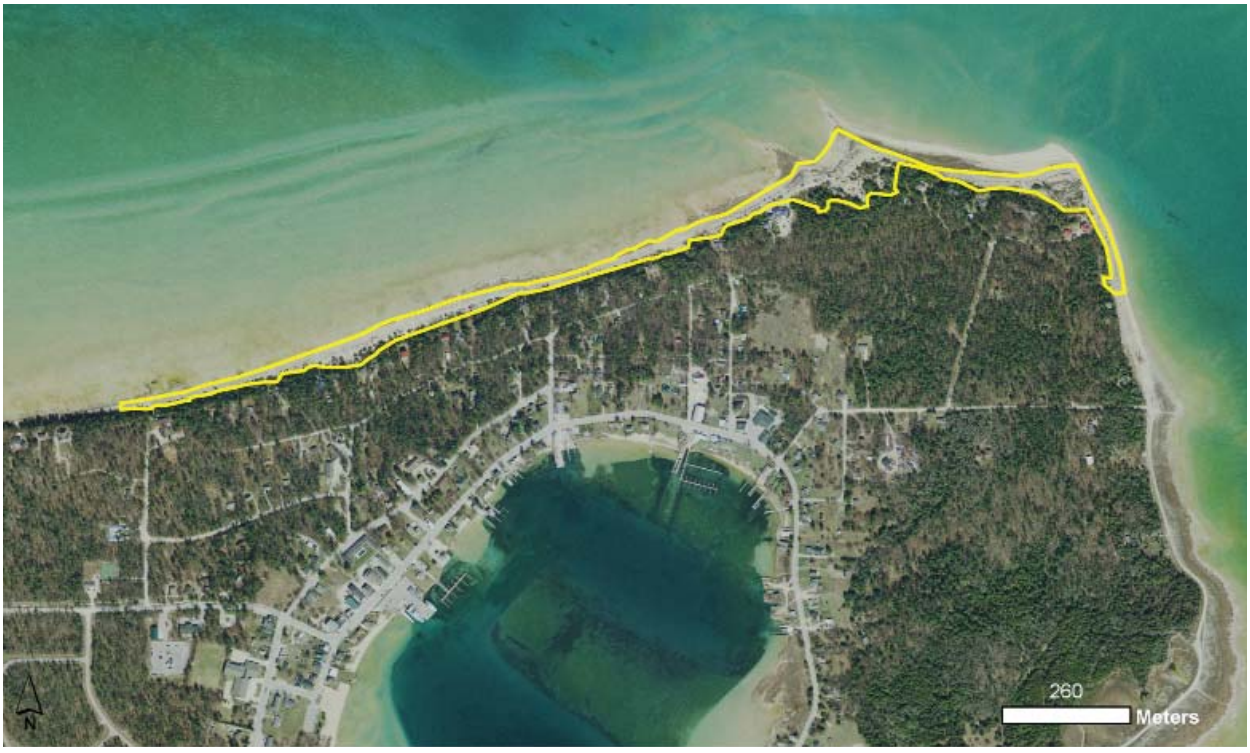
Site Description: Lookout Point consists of a mile of open dunes along the northern shore of Beaver Island. This site is characterized by low parabolic dunes and a low foredune with an active nearshore area with beach strands and interdunal wetlands. Along the Lake Michigan shoreline changes in water levels drive formation, destruction, and reformation of beach strands and beach flats supporting interdunal wetland, both well-established and incipient. The soils of the open dunes are fine-textured, wind-blown and wave-worked, alkaline (pH 8.0) sands. The parabolic dunes are found in the northeastern portion of the site and the low foredunes form a long tail stretching to the west.

Characteristic herbaceous species of the open dunes include sand reed grass (*Calamovilfa longifolia*), plains puccoon (*Lithospermum caroliniense*), wormwood (*Artemisia campestris*), white camas (*Anticlea elegans*), Gillman's goldenrod (*Solidago simplex*), wheat grass (*Elymus lanceolatus*), common milkweed (*Asclepias syriaca*), Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened), and Lake Huron tansy (*Tanacetum bipinnatum*, state special concern). Significant populations of Pitcher's thistle and Lake Huron tansy occur in the foredunes. Prevalent low shrubs within the dunes, especially near the upland margin, include bearberry (*Arctostaphylos uva-ursi*), creeping juniper (*Juniperus horizontalis*), sand cherry (*Prunus pumila*), and common juniper (*Juniperus communis*). Scattered trees and tall shrubs within the dunes include white pine (*Pinus strobus*), and willows (*Salix cordata*, *Salix myricoides*, and *Salix exigua*). The beach strand supports patchy, locally dense thickets of willows. The inclusions of interdunal wetland are characterized by Baltic rush (*Juncus balticus*), shrubby cinquefoil (*Dasiphora fruticosa*), and Kalm's lobelia (*Lobelia kalmii*).

Threats: The primary threat to these dunes is posed by continued residential development and associated anthropogenic impacts, especially dune erosion and devegetation caused by foot traffic. Bare sand increases in areas near residences due to devegetation and erosion. Several invasive species were noted within this stretch of shoreline including spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*) in the open dunes and white sweet-clover (*Melilotus albus*) and bluegrasses (*Poa* spp.) in moist beach flats near Lake Michigan.

Management Recommendations: The main management recommendations are to control invasive species and limit human traffic in the dunes to sanctioned trails by posting signs about the fragile nature of dune ecosystems. Monitoring for invasive species should also be implemented.

Lookout Point open dunes. Photo by Bradford S. Slaughter.



Aerial photograph of Lookout Point open dunes.

33. McCauley Point
Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 30 acres
Location: Beaver Island
Element Occurrence Identification Number: 20737 (New EO)

Site Description: This small site is characterized by a low parabolic dune and a low foredune that occur along the northwestern shore of Beaver Island along McCauley Point. The soils are fine-textured, wind-blown, and wave-worked, alkaline (pH 8.0) sands. The parabolic dune and associated blowout are found in the north-central portion of the site. The blowout contains snags of ancient cedars indicating that the blowout occurs where there was a former forested dune. Low foredunes form a tail to the south and pockets of interdunal wetland and a gravel dune field that is punctuated by small dune mounds occur in the northern portion of the complex.

The ground cover of the open dunes is dominated by marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*). Marram grass is especially dominant along the blowout. Prevalent ground cover species include wormwood (*Artemisia campestris*), common milkweed (*Asclepias syriaca*), Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened), beach pea (*Lathyrus japonicus*), Gillman's goldenrod (*Solidago simplex*), plains puccoon (*Lithospermum caroliniense*), wheat grass (*Elymus lanceolatus*), white camas (*Anticlea elegans*), harebell (*Campanula rotundifolia*), June grass (*Koeleria macrantha*), and little bluestem (*Schizachyrium scoparium*). The non-native bladder campion (*Silene vulgaris*) was noted locally within the open dunes. The low shrub layer ranges from 30 to 50% with prevalent low shrubs including bearberry (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*), creeping juniper (*J. horizontalis*), sand cherry (*Prunus pumila*), soapberry (*Shepherdia canadensis*), snowberry (*Symphoricarpus albus*), and silky dogwood (*Cornus amomum*) along with sapling balsam poplar (*Populus balsamifera*) and white spruce (*Picea glauca*). The understory is scattered (5-10%) with characteristic species including choke cherry (*Prunus virginiana*), northern white-cedar (*Thuja occidentalis*), balsam poplar, paper birch (*Betula papyrifera*), and blue-leaf willow (*Salix myricoides*). Infrequent scattered overstory trees include northern white-cedar, white pine (*Pinus strobus*), paper birch, and balsam fir (*Abies balsamea*) with canopy coverage ranging from 1 to 3%. Areas of low foredune are characterized by marram grass, wormwood, common evening-primrose (*Oenothera biennis*), common milkweed, Pitcher's thistle, and plains puccoon with scattered woody species including balsam poplar, silky dogwood, and sand cherry.

Threats: The primary threat to these dunes is posed by continued residential development and ensuing correlated anthropogenic impacts, especially dune erosion and devegetation caused by foot traffic. On the private portions of this complex, numerous houses occur on the margins of the dunes. Bare sand increases in areas near residences due to devegetation and erosion. Invasive species are locally common along the shoreline of Beaver Island and include spotted knapweed (*Centaurea stoebe*), Canada bluegrass (*Poa compressa*), and bladder campion, which was noted within this site.

Management Recommendations: The main management recommendations are to control invasive species and limit human traffic in the dunes by posting signs about the fragile nature of dune ecosystems. Portions of the complex occurring on private lands could be acquired or protected through conservation easements. Monitoring for invasive species should be implemented. Bladder campion should be removed now while it is confined to small portions of the occurrence and control efforts should be monitored.

McCauley Point open dunes. Photos by Joshua G. Cohen (above) and Bill Parsons (below).

Aerial photograph of McCauley Point open dunes.

34. McFadden Point
Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 102 acres
Location: Beaver Island
Element Occurrence Identification Number: 10808 (EO update)

Site Description: This site is characterized by high parabolic dunes and a low foredune that occur along the western shore of Beaver Island. The soils are fine-textured, wind-blown and wave-worked, alkaline (pH 8.0) sands. The high parabolic dunes are found in the northern portion of the site with a steep foredune adjacent to the sand and gravel beach. Within this northern portion of the dune complex, the foredune is backed by a significant dune field characterized by an extensive area of gravel flats. Within the parabolic dunes, one of the more extensive blowouts or dune fingers is approximately 0.25 miles in length. An area with low foredunes forms a long tail to the south and is adjacent to limestone cobble shore. Houses are scattered throughout the forested dunes just behind the low foredunes.

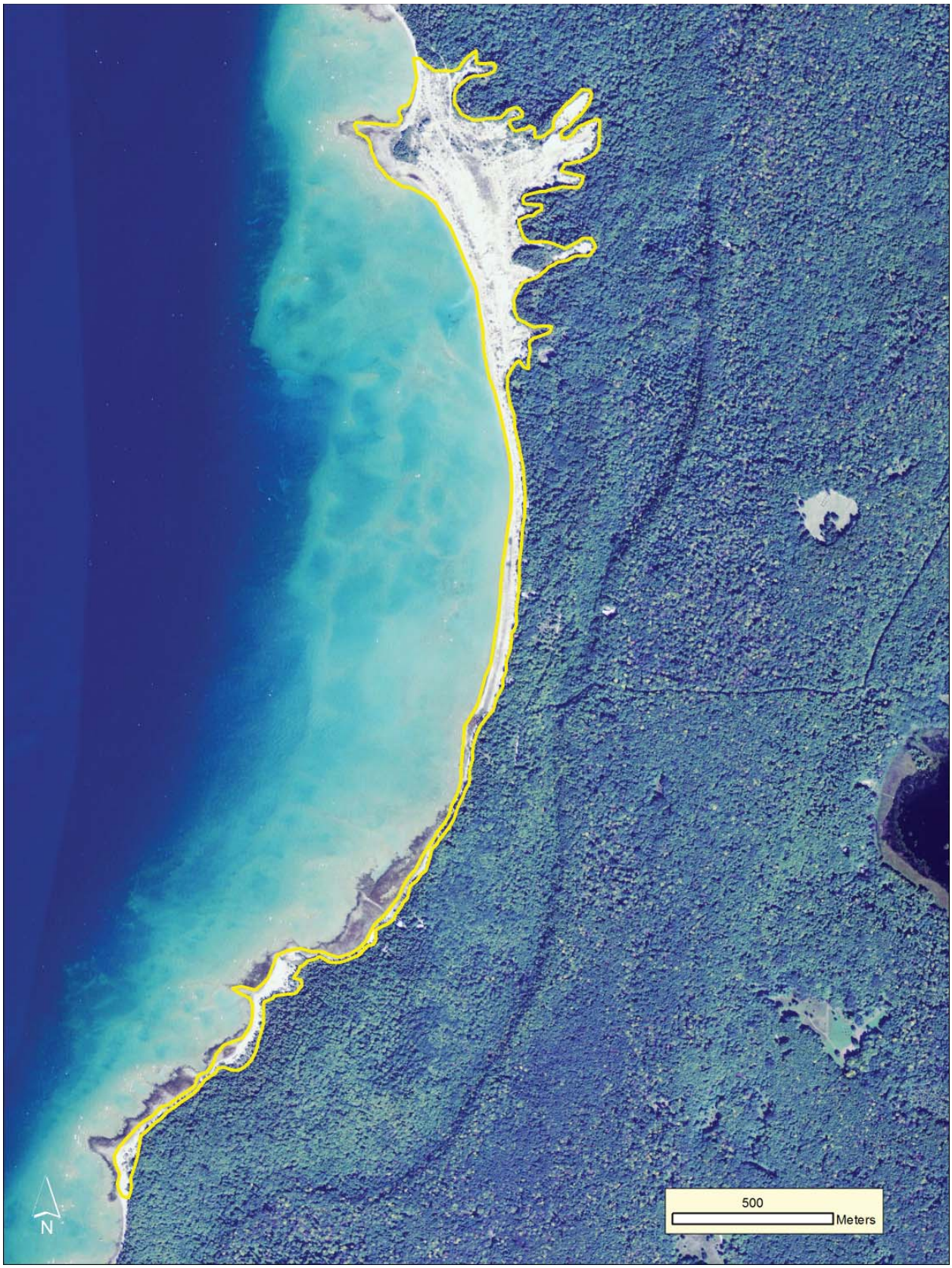
Marram grass (*Ammophila breviligulata*), sand reed grass (*Calamovilfa longifolia*), and little bluestem (*Schizachyrium scoparium*) are prevalent on the dunes. Characteristic herbaceous species include beach pea (*Lathyrus japonicus*), Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened), wormwood (*Artemisia campestris*), white camas (*Anticlea elegans*), plains puccoon (*Lithospermum caroliniense*), harebell (*Campanula rotundifolia*), common horsetail (*Equisetum arvense*), Gillman's goldenrod (*Solidago simplex*), and common milkweed (*Asclepias syriaca*). Lake Huron tansy (*Tanacetum bipinnatum*, state special concern) is uncommon but concentrated in areas of low foredune. Dune fields and back dunes support scattered patches of bearberry (*Arctostaphylos uva-ursi*) and common juniper (*Juniperus communis*). Additional low shrubs include sand cherry (*Prunus pumila*), shrubby cinquefoil (*Dasiphora fruticosa*), creeping juniper (*Juniperus horizontalis*), and soapberry (*Shepherdia canadensis*). Scattered (5-10%) understory species include balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), northern white-cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), sandbar willow (*Salix exigua*), sand-dune willow (*S. cordata*), choke cherry (*Prunus virginiana*), and silky dogwood (*Cornus amomum*). Infrequent, scattered overstory trees include northern white-cedar, paper birch, white pine, white spruce, balsam fir, and balsam poplar. An 18 cm red pine (*Pinus resinosa*) was cored and estimated to be 25 years old.

Threats: The primary threat to these dunes is posed by continued residential development and ensuing correlated anthropogenic impacts, especially dune erosion and devegetation caused by foot traffic and off-road vehicle impacts. Spotted knapweed (*Centaurea stoebe*) was noted along portions of the low dunes but is currently uncommon and has not yet impacted species composition and structure.

Management Recommendations: It is imperative to eliminate off-road vehicle traffic along the beach and limit human traffic in the parabolic dunes. Posting signs about the fragile nature of dune ecosystems may help reduce vehicular and foot traffice. Portions of the complex occurring on private lands, especially the areas of parabolic dunes in the northern end of the site, could be acquired or protected through conservation easements. Spotted knapweed should be removed now while it is confined to small portions of the occurrence and control efforts should be monitored.

McFadden Point open dunes. Photos by Joshua G. Cohen.

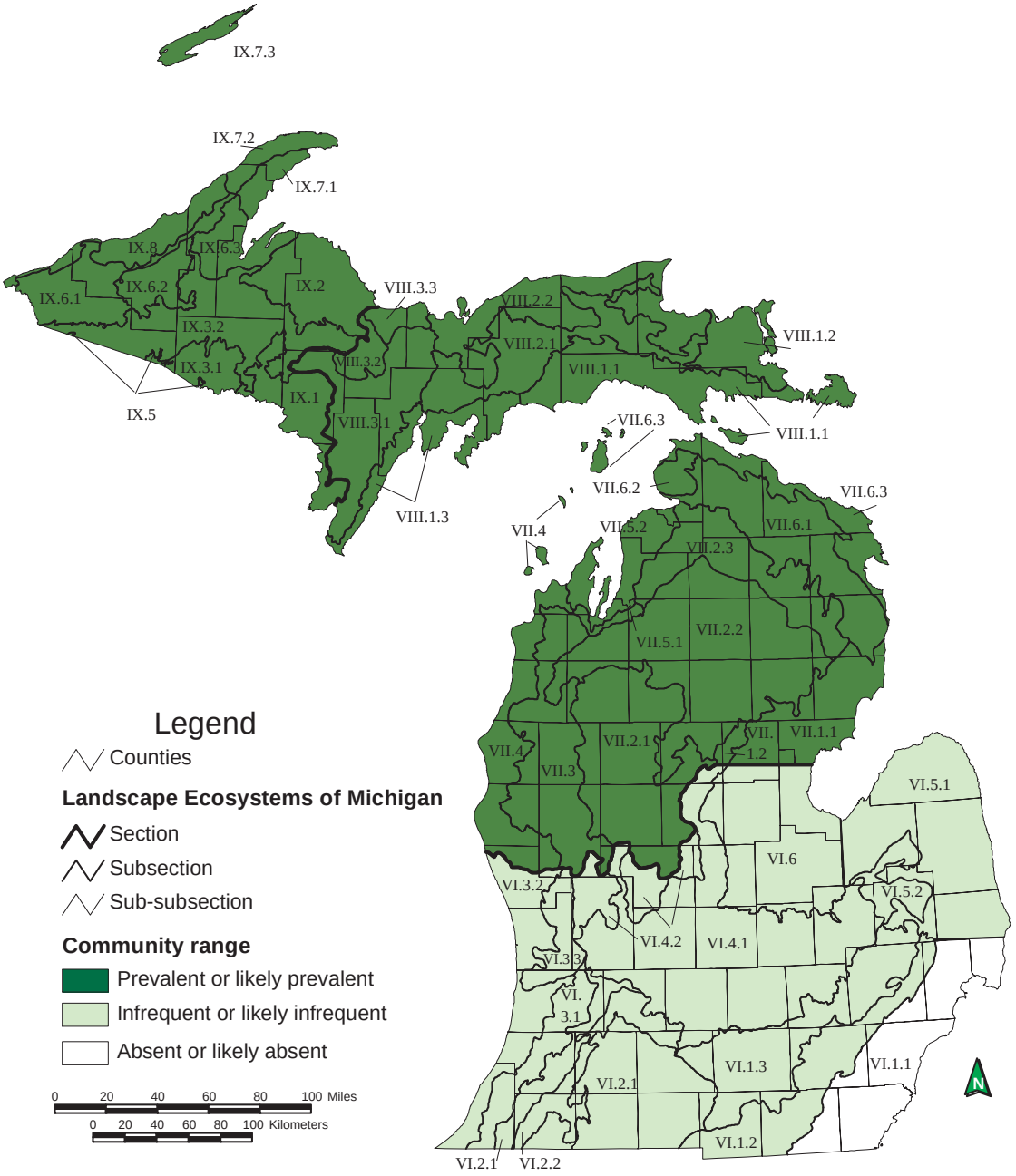
McFadden Point open dunes. Photos by Bill Parsons.



Aerial photograph of McFadden Point open dunes.

POOR CONIFER SWAMP

Overview: Poor conifer swamp is a nutrient-poor forested peatland that occurs most commonly in the Upper Peninsula and northern Lower Peninsula and infrequently in the southern Lower Peninsula. Poor conifer swamp develops on extremely acidic, saturated peat in depressions on glacial outwash plains, moraines, and sandy glacial lakeplains, and within kettles on pitted outwash plains and ice-contact topography. Natural processes that influence species composition and community structure include windthrow, flooding by beaver, insect outbreaks, peat accumulation, and occasional fires. The community is characterized by the prevalence of coniferous trees, ericaceous shrubs, and sphagnum mosses (Kost et al. 2007, Cohen et al. 2015).



Map 12. Distribution of poor conifer swamp in Michigan (Albert et al. 2008).

35. Greene's Lake Swamp
Natural Community Type: Poor Conifer Swamp
Rank: G4 S4, apparently secure globally and within the state
Element Occurrence Rank: AB
Size: 121 acres
Location: Beaver Island
Element Occurrence Identification Number: 20688 (New EO)

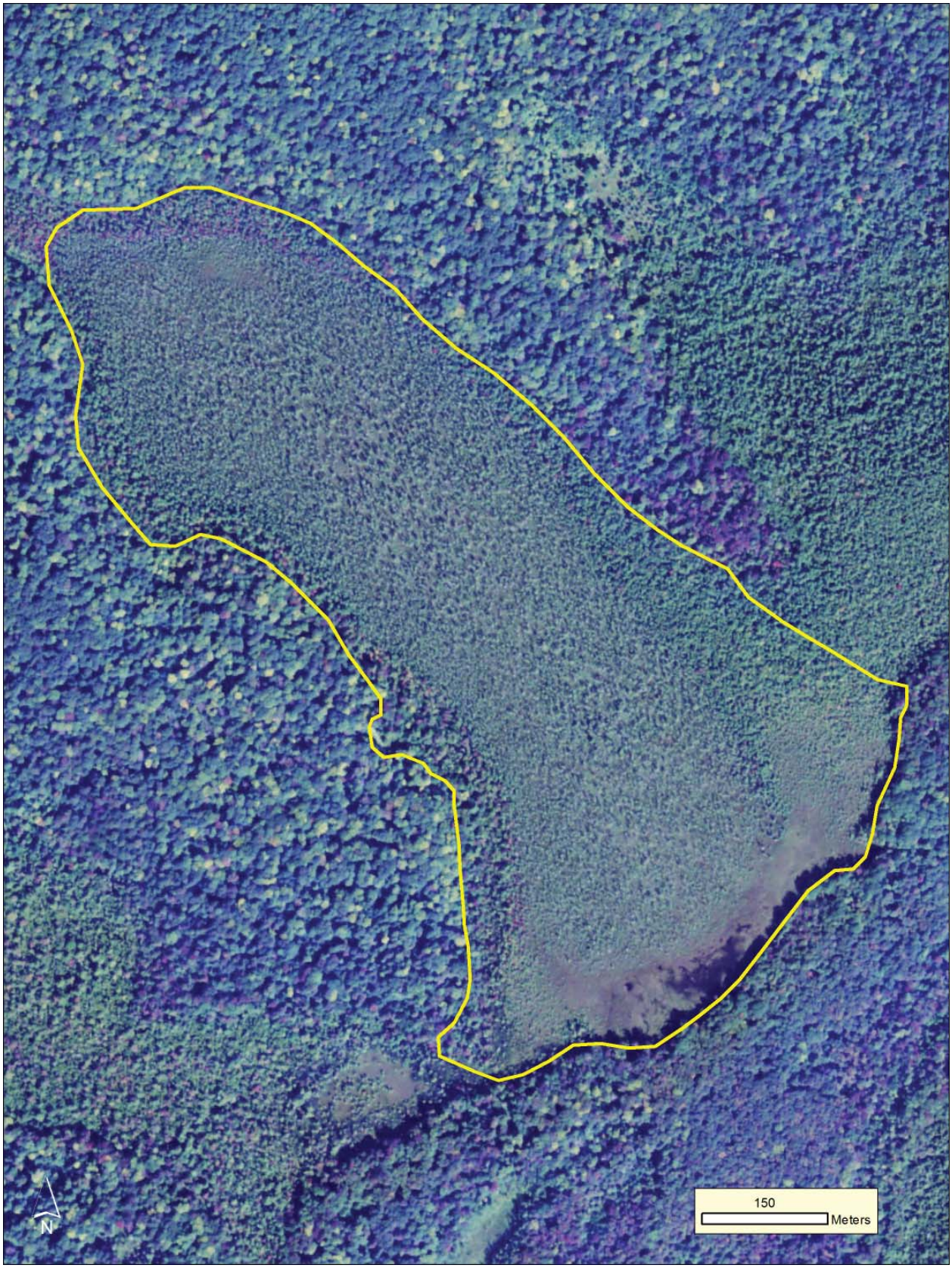
Site Description: This poor conifer swamp is part of large peatland complex associated with Greene's Lake. Poor conifer swamp, rich conifer swamp, and bog occupy a former lake basin associated with Greene's Lake. This peatland formed through lake filling or terrestrialization. The bog occurs just south of Greene's Lake and transitions to poor conifer swamp in the central lobe of the basin to the south. The two lobes flanking this central lobe are minerotrophic and dominated by rich conifer swamp. Sphagnum hummock and hollow microtopography and animal trails generate fine-scale gradients in soil moisture and soil chemistry, which contribute to floristic diversity. Where the poor conifer swamp narrows and along the swamp margins there is a shift in species composition due to the minerotrophic influence of groundwater seepage from the adjacent upland. The peatland experiences significant water level fluctuations, indicated by the pronounced hummock-hollow microtopography and depth of late spring inundation in the hollows. The fine-textured and apparently clay-rich till landform likely impedes drainage, resulting in significant increases in water level in the wetland basin during wet periods. The complex drains to the southeast. A 13.1 cm black spruce (*Picea mariana*) was cored and estimated to be 112 years old. A 19.3 cm tamarack (*Larix laricina*) was cored and estimated to be 65 years old with fast growth for the first 35 years. The soils of the poor conifer swamp are characterized as deep (> 1 meter), acidic (pH 4.5) fibric to hemic peats.

The canopy is dominated by tamarack and black spruce with scattered white pine (*Pinus strobus*). Canopy trees typically range in DBH from 10 to 20 cm DBH and 20 to 40 ft in height with canopy closure ranging from 50 to 60%. Characteristic understory species include scattered (20-40%) sapling black spruce and tamarack. Ericaceous species dominate the dense (80-95%) low shrub layer with leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), Labrador tea (*Rhododendron groenlandicum*), bog rosemary (*Andromeda glaucophylla*), Canada blueberry (*Vaccinium myrtilloides*), and stunted black spruce. Characteristic ground cover species include cottongrasses (*Eriophorum* spp.), small cranberry (*Vaccinium oxycoccos*), pitcher-plant (*Sarracenia purpurea*), creeping snowberry (*Gaultheria hispidula*), and false mayflower (*Maianthemum trifolium*). The swamp is characterized by a sphagnum carpet and well-developed sphagnum hummock and hollow microtopography. Along the margins and in the narrows of the swamp where groundwater influence is evident, floristic diversity increases and minerotrophic indicators are prevalent including winterberry (*Ilex verticillata*), mountain holly (*I. mucronata*), red maple (*Acer rubrum*), and yellow birch (*Betula alleghaniensis*). Ground cover species in this zone include lake sedge (*Carex lacustris*), royal fern (*Osmunda regalis*), and mad-dog skullcap (*Scutellaria lateriflora*). The bog margin along the southern edge of the swamp is characterized by leatherleaf, twig-rush (*Dulichium arundinaceum*), and native reed (*Phragmites australis* subsp. *americanus*).

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

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the poor conifer swamp, and monitor for invasive species.

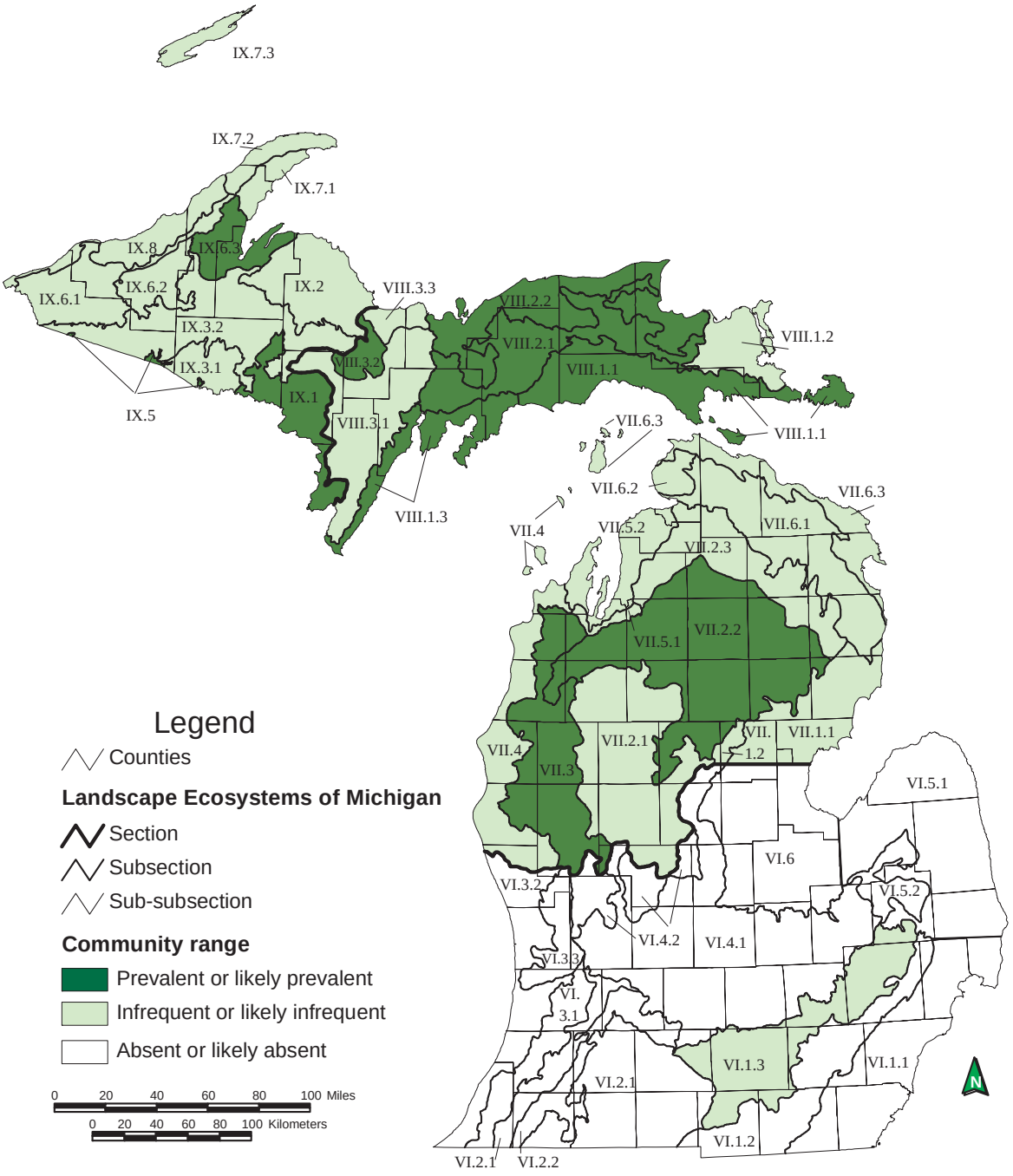
Greene’s Lake Swamp poor conifer swamp. Photos by Bill Parsons (above) and Joshua G. Cohen (below).



Aerial photograph of Greene's Lake Swamp poor conifer swamp.

POOR FEN

Overview: Poor fen is a wetland dominated by sedges, shrubs, and stunted conifers, and moderately influenced by groundwater. The community occurs within kettle depressions in outwash plains and moraines, and in mild depressions on glacial outwash plains and glacial lakeplain primarily in the Upper Peninsula and northern Lower Peninsula and rarely in the southern Lower Peninsula. Poor fen typically develops on slightly acidic to strongly acidic peat. Natural processes that influence species composition and community structure include groundwater seepage and lateral flow, peat accumulation, flooding by beaver, insect outbreaks, and occasional fires (Kost et al. 2007, Cohen et al. 2015).



Map 13. Distribution of poor fen in Michigan (Albert et al. 2008).

36. Egg Lake
Natural Community Type: Poor Fen
Rank: G3 S3, rare globally and within the state
Element Occurrence Rank: B
Size: 40 acres
Location: Beaver Island
Element Occurrence Identification Number: 2988 (EO Update)

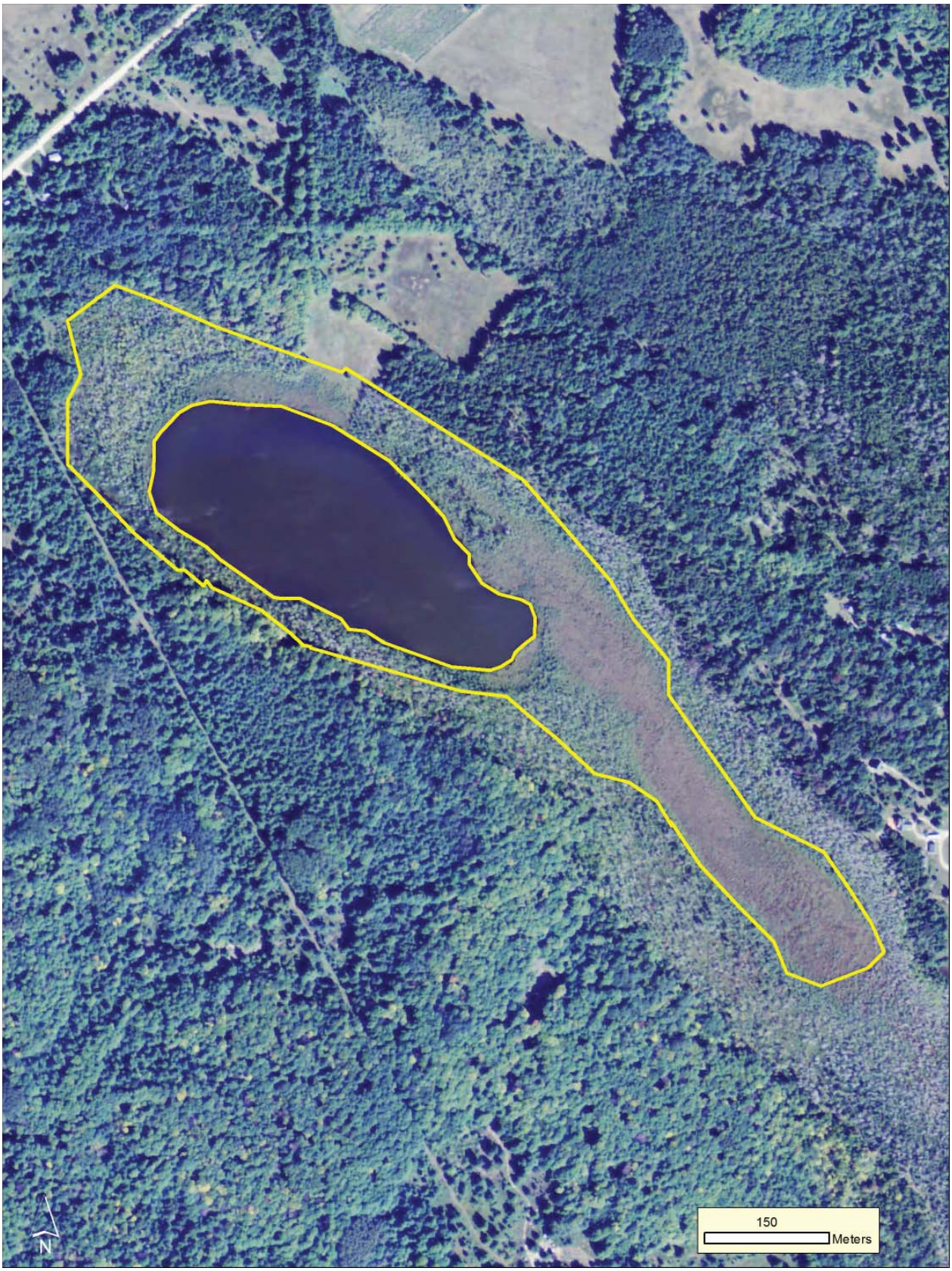
Site Description: This open peatland system occurs on a poorly drained flat lakeplain with saturated and inundated sphagnum and sedge peats that range from weakly minerotrophic to ombrotrophic. Groundwater influence creates weakly minerotrophic conditions along the peatland margin. A peat sample from the minerotrophic peatland margin was > 1 meter in depth and slightly acidic throughout the profile (pH 6.5-6.8). A peat sample from the central portion of the fen was also > 1 meter in depth but was more acidic with very strongly acidic conditions found on the sphagnum hummocks (pH 4.5) and the peat throughout the rest of the profile was strongly acidic (pH 5.5). On areas of floating mat, peat depths were observed to be 50 cm over water. Fine-scale gradients in soil moisture and chemistry are also generated by sphagnum hummock and hollow development. These gradients in soil and water chemistry generate complex ecological zonation and high floristic diversity (over 60 species were noted during the 2006 survey).

The graminoid dominated portions of fen are dominated by twig-rush (*Cladium mariscoides*), sedges (*Carex lasiocarpa*, *C. sterilis*, and *C. limosa*), white beak-rush (*Rhynchospora alba*), and golden-seeded spike-rush (*Eleocharis elliptica*). Characteristic ground cover species include pitcher-plant (*Sarracenia purpurea*), marsh fern (*Thelypteris palustris*), dwarf raspberry (*Rubus pubescens*), cranberries (*Vaccinium* spp.), rose pogonia (*Pogonia ophioglossoides*), marsh cinquefoil (*Comarum palustre*), bog buckbean (*Menyanthes trifoliate*), cottongrasses (*Eriophorum* spp.), round-leaved sundew (*Drosera rotundifolia*), false asphodel (*Triantha glutinosa*), bog goldenrod (*Solidago uliginosa*), horned bladderwort (*Utricularia cornuta*), and bluejoint grass (*Calamagrostis canadensis*). The fen is characterized by clumps of ericaceous shrubs including leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), Labrador tea (*Rhododendron groenlandicum*), and bog rosemary (*Andromeda glaucophylla*). Additional shrubs include alder-leaved buckthorn (*Rhamnus alnifolia*), sweet gale (*Myrica gale*), Canada blueberry (*Vaccinium myrtilloides*), bog willow (*Salix pedicellaris*), and huckleberry (*Gaylussacia baccata*). Sweet gale is prevalent along the margin of Egg Lake. Tree saplings and understory shrubs occur scattered throughout the fen and include tamarack (*Larix laricina*), black spruce (*Picea mariana*), northern white-cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), winterberry (*Ilex verticillata*), mountain holly (*I. mucronata*), and black chokeberry (*Aronia prunifolia*). Shrub and tree cover increases with proximity to the upland margin where the groundwater influence is more prevalent.

Threats: The species composition and structure of the fen is patterned by natural processes. Reed canary grass (*Phalaris arundinacea*) was observed locally along the lake margin. However, this species is currently not altering the hydrology or reducing species diversity. The site contains several private inholdings that could be developed in the future.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Adjacent forest and swamp should be left uncut. Maintaining a forested buffer surrounding the poor fen will help ensure the stability of the fen's hydrologic regime. The population of reed canary grass should be monitored and controlled if necessary. Portions of the wetland complex occurring on private lands could be acquired or protected through conservation easements.

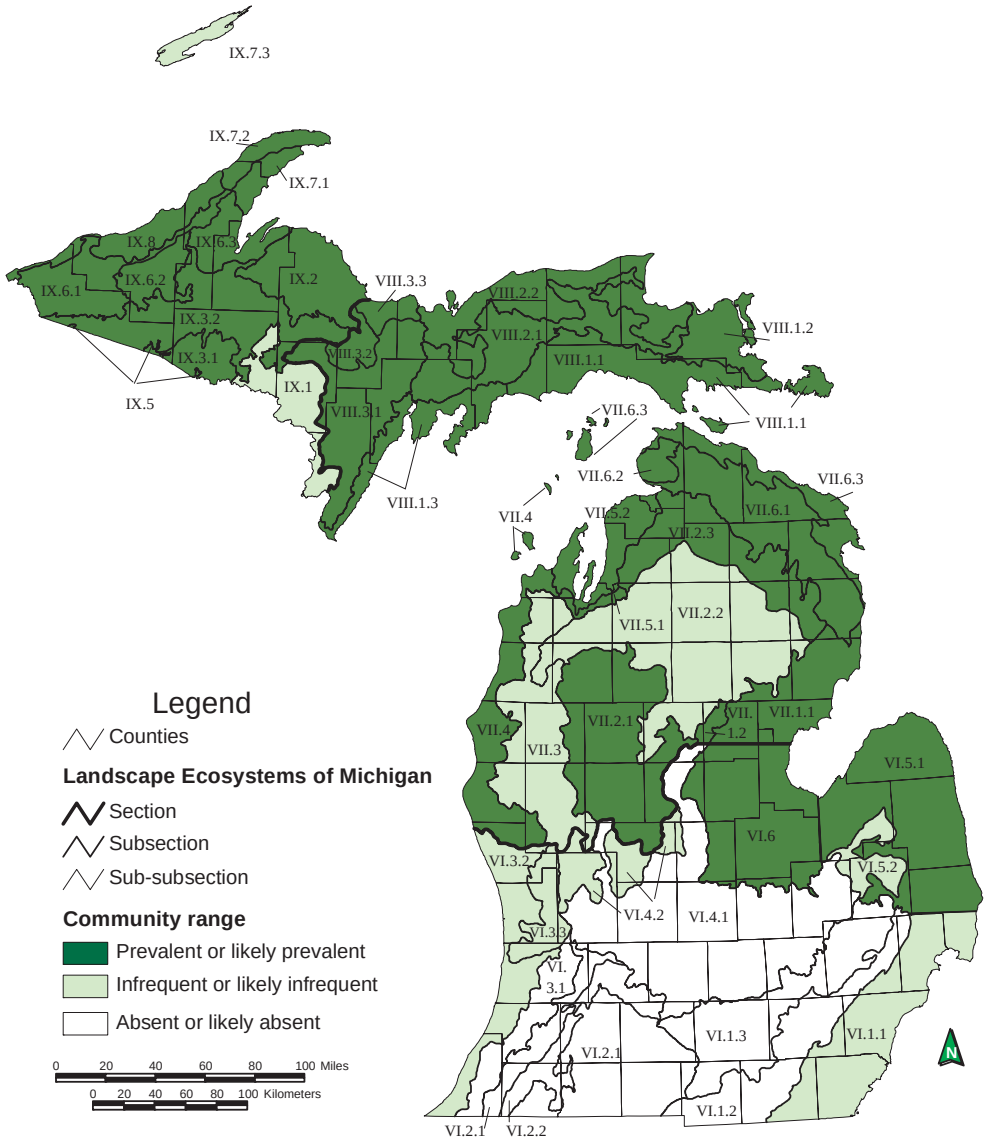
Egg Lake poor fen. Photos by Joshua G. Cohen.



Aerial photograph of Egg Lake poor fen.

RICH CONIFER SWAMP

Overview: Rich conifer swamp is a groundwater-influenced, minerotrophic, forested wetland dominated by northern white-cedar (*Thuja occidentalis*) that occurs on organic soils (i.e., peat) primarily north of the climatic tension zone in the northern Lower and Upper Peninsulas. Rich conifer swamp occurs in outwash channels, outwash plains, glacial lakeplains, and in depressions on coarse- to medium-textured ground moraines. It is common in outwash channels of drumlin fields and where groundwater seeps occur at the bases of moraines. Rich conifer swamp typically occurs in association with lakes and cold, groundwater-fed streams. It also occurs along the Great Lakes shoreline in old abandoned embayments and in swales between former beach ridges where it may be part of a wooded dune and swale complex. Windthrow is common, especially on broad, poorly drained sites. Fire was historically infrequent. Rich conifer swamp is characterized by diverse microtopography and ground cover. The community is also referred to as cedar swamp (Kost et al. 2007, Cohen et al. 2015).



Map 14. Distribution of rich conifer swamp in Michigan (Albert et al. 2008).

37. Doty's Swamp
Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 118 acres
Location: Beaver Island
Element Occurrence Identification Number: 20690 (New EO)

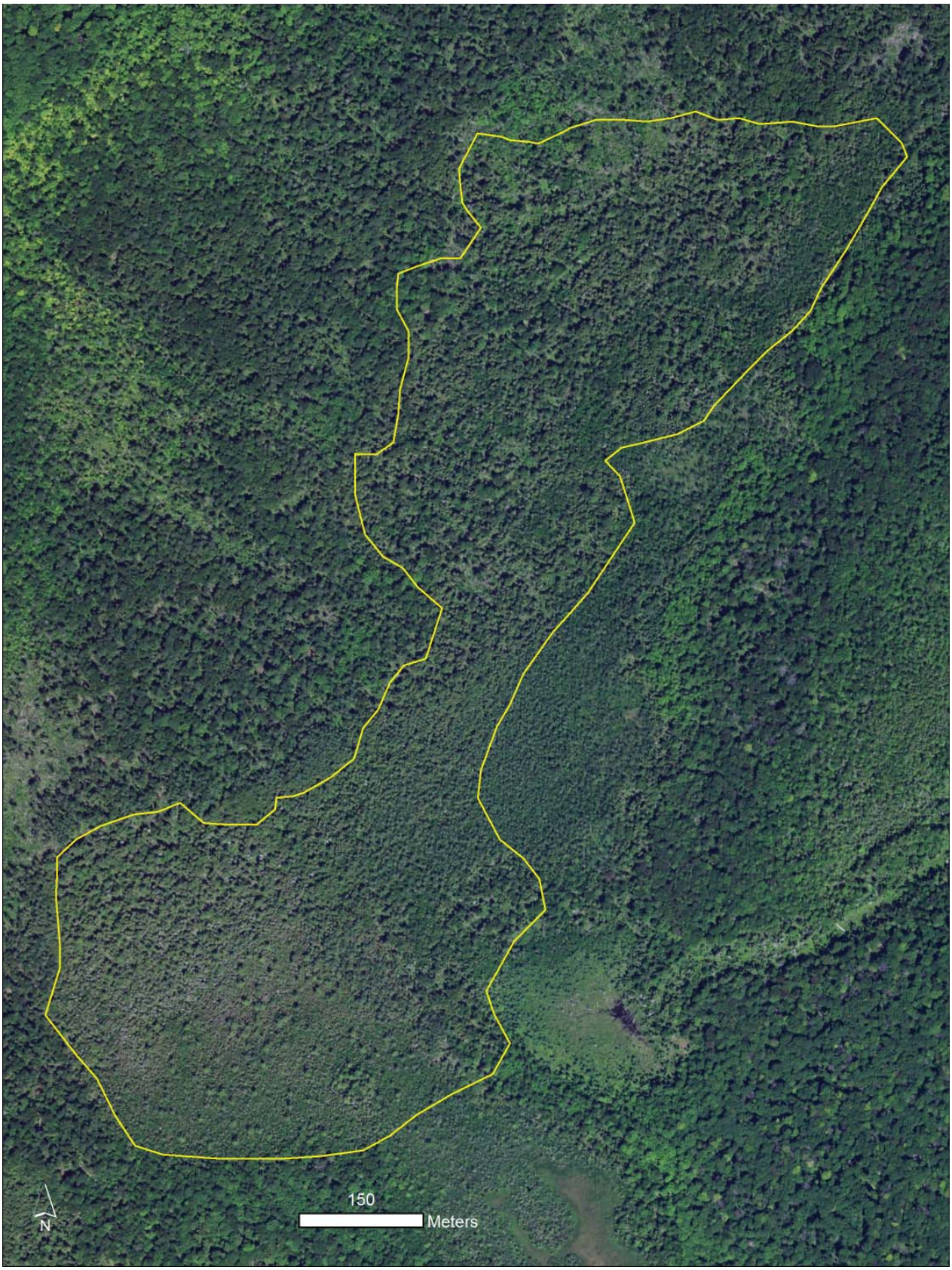
Site Description: This rich conifer swamp is part of large swamp complex northwest of Lake Geneserath. Portions of this swamp likely established following a wildfire. Charcoal was observed within the soil profile. A 30.1 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be 108 years old, and a 38.1cm northern white-cedar was cored and estimated to be 123 years old. The soils of the rich conifer swamp are shallow (10-40 cm), slightly acidic to alkaline (pH 6.5-8.0) hemic to sapric peats over wet, medium-textured sands that are slightly acidic to alkaline (pH 6.8-8.0). Sphagnum hummock and hollow microtopography is developing locally. Windthrow is prevalent throughout the swamp with numerous areas of heavy blowdown. Cedar are reproducing primarily by layering which contributes to the structural complexity of the swamp. Islands of old-growth hemlock (*Tsuga canadensis*) with 50 to 60 cm DBH canopy hemlock occur within the swamp. A 67 cm hemlock was cored and estimated to be over 284 years old. This swamp was surveyed in 2016 and 2017. Additional surveys in 2017 resulted in increasing the total acreage of the element occurrence from 82 to 118 acres and an increase in the element occurrence rank from C to BC.

The canopy is dominated by northern white-cedar and locally by tamarack (*Larix laricina*). Canopy associates throughout the swamp include paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), balsam poplar (*P. balsamifera*), black ash (*Fraxinus nigra*), black spruce (*Picea mariana*), hemlock (*Tsuga canadensis*), and white pine (*Pinus strobus*). Canopy trees typically range in DBH from 20 to 40 cm. Characteristic understory species include balsam fir (*Abies balsamea*), mountain maple (*Acer spicatum*), winterberry (*Ilex verticillata*), and black ash. Common species in the low shrub layer include alder-leaved buckthorn (*Rhamnus alnifolia*), Labrador tea (*Rhododendron groenlandicum*), Canadian fly honeysuckle (*Lonicera canadensis*), and swamp fly honeysuckle (*L. oblongifolia*). Characteristic ground cover species include sedges (*Carex trisperma*, *C. disperma,* and *C. flava*), starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), goldthread (*Coptis trifolia*), dwarf raspberry (*Rubus pubescens*), bunchberry (*Cornus canadensis*), blue-bead lily (*Clintonia borealis*), oak fern (*Gymnocarpium dryopteris*), large-leaved aster (*Eurybia macrophylla*), naked miterwort (*Mitela nuda*), creeping snowberry (*Gaultheria hispidula*), royal fern (*Osmunda regalis*), cinnamon fern (*Osmunda cinnamomea*), and dwarf scouring rush (*Equisetum scirpoides*). Areas with a more open canopy are dominated by tamarack and have a more prevalent graminoid component in the ground cover.

Threats: Species composition and vegetative structure are patterned by natural processes and also influenced by deer browse pressure. Deer browse pressure is likely limiting cedar regeneration and impacting floristic composition and vegetative structure.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the swamp, and monitor for invasive species and deer browse. Reducing local deer densities in the surrounding landscape would help reduce deer browse pressure.

Doty's Swamp rich conifer swamp. Photos by Joshua G. Cohen.



Aerial photograph of Doty's Swamp rich conifer swamp.

38. Greene's Lake Swamp
Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 134 acres
Location: Beaver Island
Element Occurrence Identification Number: 20689 (New EO)

Site Description: This rich conifer swamp is part of large peatland complex associated with Greene's Lake. Rich conifer swamp, poor conifer swamp, and bog occupy the former lake basin associated with Greene's Lake. This peatland formed through lake filling or terrestrialization. The nearby bog occurs just south of Greene's Lake and transitions to poor conifer swamp in the central lobe of the complex to the south. The two lobes flanking this central lobe are minerotrophic and dominated by rich conifer swamp. Sphagnum hummock and hollow microtopography and animal trails generate fine-scale gradients in soil moisture and soil chemistry, which contribute to floristic diversity. The peatland experiences significant water level fluctuations, indicated by the pronounced hummock-hollow microtopography and depth of late spring inundation in the hollows. The fine-textured and apparently clay-rich till landform likely impedes drainage, resulting in significant increases in water level in the wetland basin during wet periods. The complex drains to the southeast. A 32 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be 180 years old; a 16.5 cm northern white-cedar was cored and estimated to be 159 years old; a 46 cm northern white-cedar was cored and estimated to be over 210 years old (the center of this tree was rotten); and a 38 cm northern white-cedar was cored and estimated to be over 150 years old. In addition, a 68 cm hemlock (*Tsuga canadensis*) was cored and estimated to be over 275 years old. Windthrow is prevalent throughout and contributes to the complex vertical structure of the swamp. In addition, cedars are reproducing primarily by layering which also contributes to the structural complexity of the swamp. Coarse woody debris occurs throughout the swamp due to the prevalence of blowdown and the senescence of younger-lived species (i.e., balsam fir and paper birch). A > 60 cm yellow birch (*Betula alleghaniensis*) snag was noted within the swamp. Based on the high number of deer trails, scat, and evidence of winter browse, this portion of the swamp is likely used as a winter deer yard. Beaver activity was noted to the north of the rich conifer swamp and beaver have likely impacted the peatland complex. The soils of the rich conifer swamp are variable, ranging from shallow (30 cm) to deep (> 1 meter), slightly acidic to alkaline (pH 6.8-8.0) hemic to sapric peat overlying alkaline sands (pH 7.8-8.0). This swamp was surveyed in 2016 and 2017. Surveys in 2017 resulted in increasing the total acreage of the element occurrence from 93 to 134 acres.

The canopy of the rich conifer swamp is dominated by northern white-cedar and locally by tamarack (*Larix laricina*). Tamarack tends to dominate in wetter portions of the swamp where the canopy is more open. Canopy associates throughout the swamp include black ash (*Fraxinus nigra*), red maple (*Acer rubrum*), black spruce (*Picea mariana*), and yellow birch (*Betula alleghaniensis*). Supercanopy white pine (*Pinus strobus*) and hemlock are locally prevalent. Canopy trees typically range in DBH from 20 to 40 cm with canopy closure ranging from 50 to 85% and larger supercanopy white pine and hemlock reaching 50 to 60 cm. Tree diameter and height is typically greater closer to the upland slope margin. Heights of canopy trees are typically between 30 and 40 ft with supercanopy trees reaching 80 to 100 ft and areas closer to the upland margin supporting taller 60 to 80 ft trees.

Characteristic understory species include scattered (10-30%) sapling balsam fir (*Abies balsamea*) and black ash with winterberry (*Ilex verticillata*) occurring locally. Additional understory species include mountain maple (*Acer spicatum*), striped maple (*A. pensylvanicum*), and balsam poplar (*Populus balsamifera*). Common species in the low shrub layer include alder-leaved buckthorn (*Rhamnus alnifolia*), Labrador tea (*Rhododendron groenlandicum*), mountain maple, Canadian fly honeysuckle (*Lonicera canadensis*), and wild red raspberry (*Rubus strigosus*) with balsam fir and black ash.

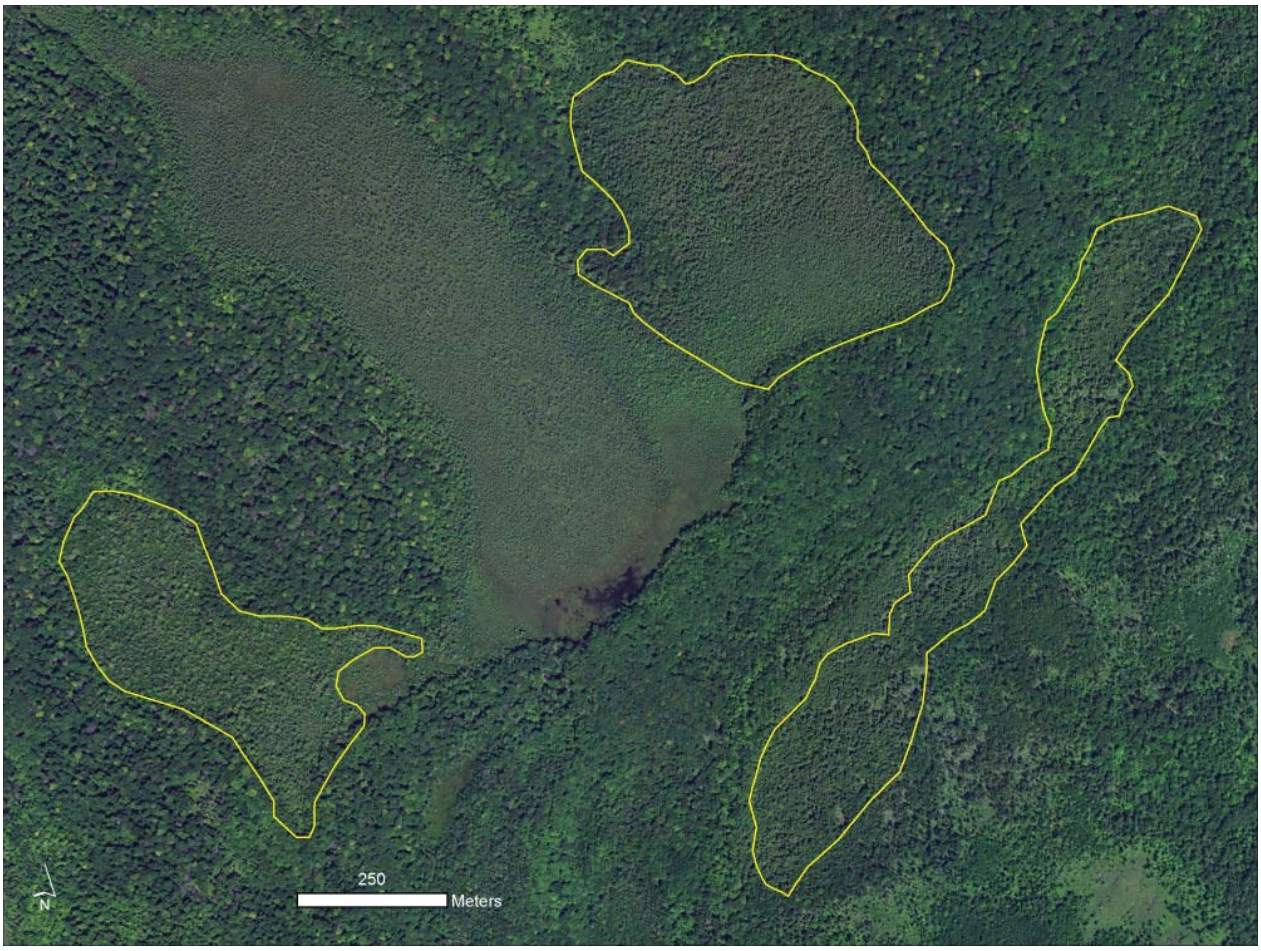
Characteristic ground cover species include sedges (*Carex trisperma, C. disperma, C. pedunculata,* and *C. stricta*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), dwarf raspberry (*Rubus pubescens*), bunchberry (*Cornus canadensis*), wild sarsaparilla (*Aralia nudicaulis*), creeping snowberry (*Gaultheria hispidula*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), skunk-cabbage (*Symplocarpus foetidus*), false mayflower (*Maianthemum trifolium*), northern bugle weed (*Lycopus uniflorus*), fowl manna grass (*Glyceria striata*), Jack-in-the-pulpit (*Arisaema triphyllum*), naked miterwort (*Mitela nuda*), gay-wings (*Polygala paucifolia*), goldthread (*Coptis trifolia*), oak fern (*Gymnocarpium dryopteris*), and bulblet fern (*Cystopteris bulbifera*). A dense sphagnum carpet occurs throughout the swamp. Sphagnum hummock and hollow microtopography is localized. Areas with a more open canopy dominated by tamarack have a more prevalent graminoid component in the ground cover.

Threats: Species composition and vegetative structure are patterned by natural processes and also influenced by deer browse pressure. The rich conifer swamp is likely used as a deer yard. Deer trails and deer browse were noted throughout the swamp. Deer browse pressure is likely limiting cedar regeneration and impacting floristic composition and vegetative structure. Scattered cut stumps in the rich conifer swamp indicate that the site was historically logged.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the swamp, and monitor for invasive species and deer browse. Reducing local deer densities throughout the landscape would help reduce deer browse pressure.

Greene’s Lake Swamp rich conifer swamp. Photo by Joshua G. Cohen.

Greene's Lake Swamp rich conifer swamp. Photos by Joshua G. Cohen.



Aerial photograph of Greene’s Lake Swamp rich conifer swamp.

39. Hog Island
Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Size: 129 acres
Location: Hog Island
Element Occurrence Identification Number: 9639 (EO Update)

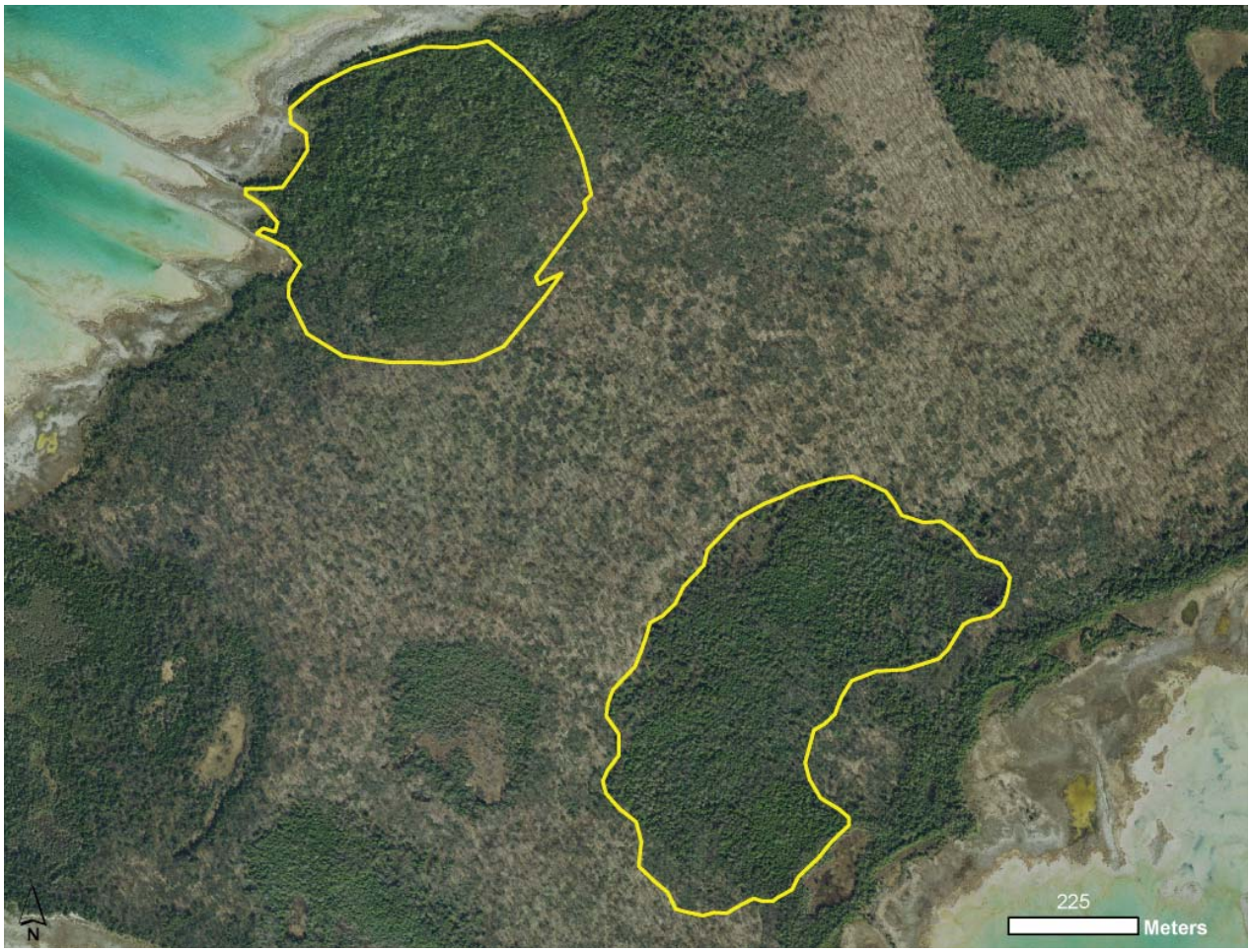
Site Description: Two polygons of rich conifer swamp occur in the southern portion of Hog Island. Rich conifer swamp occurs inland from high-quality coastal ecosystems including Great Lakes marsh, coastal fen, and limestone cobble shore. The southern polygon of rich conifer swamp occurs immediately adjacent to high-quality northern fen. In the interior of the island, rich conifer swamp occurs adjacent to high-quality mesic northern forest and hardwood-conifer swamp. Sphagnum hummock and hollow microtopography and tip-ups from windthrow generate fine-scale gradients in soil moisture and soil chemistry, which contribute to floristic diversity. Windthrow and subsequent layering of cedar have created a very complex horizontal and vertical structure within the swamp. Coarse woody debris is common throughout the swamp in the form of standing snags and downed logs. A 69 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be over 300 years old. The soils of the rich conifer swamp are characterized by shallow, circumneutral (pH 7.0) organics (10 cm) over wet, medium-textured alkaline (pH 8.0) sands.

The canopy of the rich conifer swamp is dominated by northern white-cedar with paper birch (*Betula papyrifera*) as a canopy associate. Canopy trees typically range in DBH from 25 to 45 cm. Characteristic understory species include balsam fir (*Abies balsamea*), mountain maple (*Acer spicatum*), and green ash (*Fraxinus pennsylvanica*). Common species in the low shrub layer include Canadian fly honeysuckle (*Lonicera canadensis*), yew (*Tacus canadensis*), mountain maple, and green ash. Characteristic species of the diverse ground cover include starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), royal fern (*Osmunda regalis*), wild sarsaparilla (*Aralia nudicaulis*), naked miterwort (*Mitela nuda*), goldthread (*Coptis trifolia*), cinnamon fern (*Osmunda cinnamomea*), blue-bead lily (*Clintonia borealis*), and oak fern (*Gymnocarpium dryopteris*). Well-developed sphagnum hummock and hollow microtopography occurs locally within the swamp.

Threats: Species composition and vegetative structure are patterned by natural processes. No current threats were observed during the course of the survey. Scattered cut stumps occur within the swamp.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the rich conifer swamp, and monitor for invasive species and deer browse.

Hog Island rich conifer swamp. Photo by Joshua G. Cohen.



Aerial photograph of Hog Island rich conifer swamp.

40. Little Sand Bay
Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 17 acres
Location: Beaver Island
Element Occurrence Identification Number: 20692 (New EO)

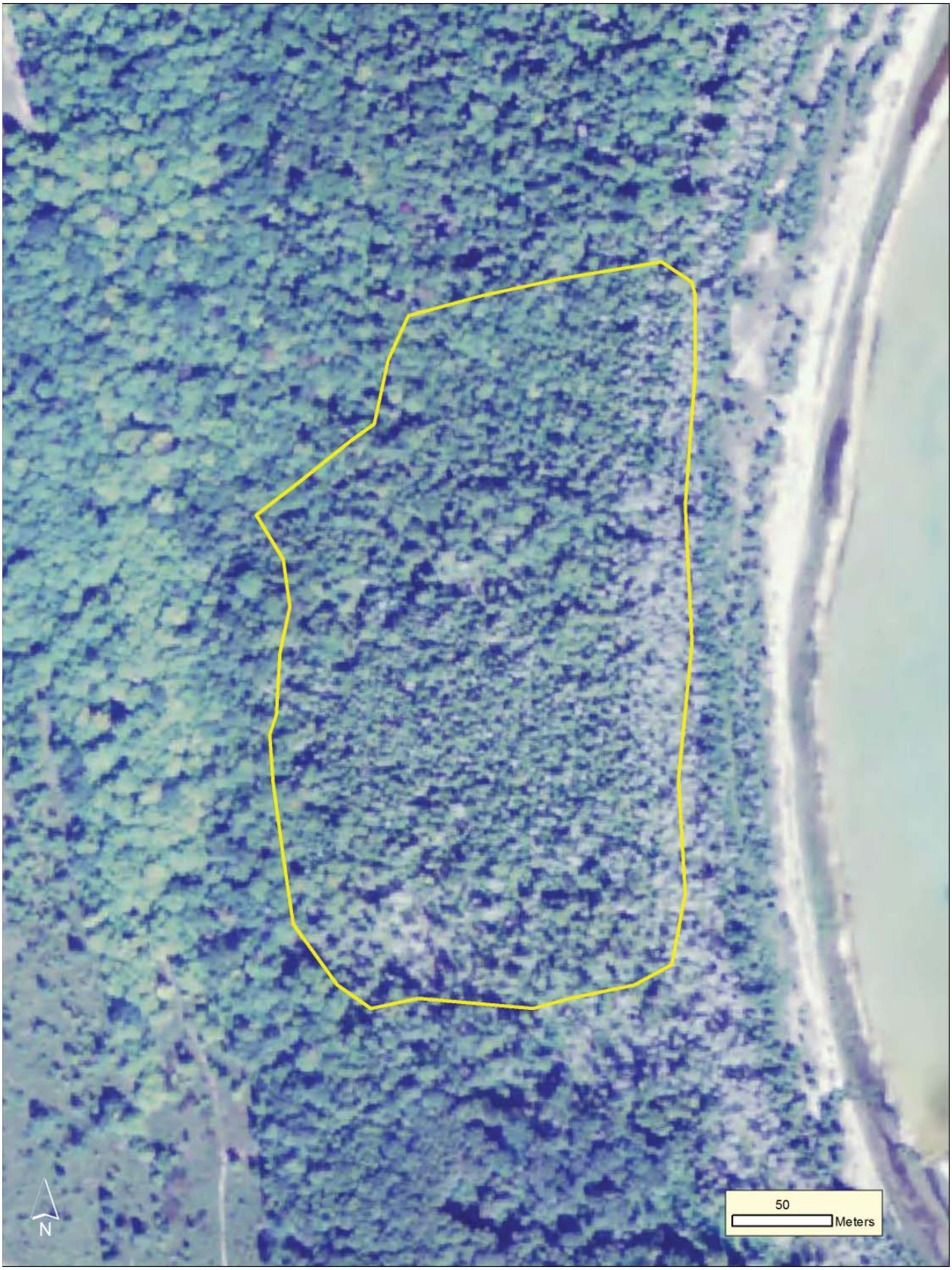
Site Description: This rich conifer swamp occurs along with boreal forest along the northeastern shoreline of Beaver Island adjacent to Little Sand Bay. The rich conifer swamp occurs inland from a sandy bay that supports interdunal wetland and a low foredune with open dunes vegetation. To the north of the rich conifer swamp is a small pocket of boreal forest. Immediately adjacent to the rich conifer swamp to the east is a narrow forested swale that has been flooded by beaver and as a result, the canopy of northern white-cedars (*Thuja occidentalis*) is flood-killed. Inland from the rich conifer swamp is managed northern hardwoods. Fine-scale gradients in hydrology and soils make precisely mapping this rich conifer swamp and the adjacent boreal forest difficult. Windthrow is prevalent throughout the forested wetland, and as a result, the rich conifer swamp is characterized by high levels of coarse woody debris and uneven-aged stand patterning at multiple scales. Large areas of blowdown occur throughout the swamp as do small-scale windthrow gaps. A 42 cm northern white-cedar was cored and estimated to be 135 years old. Beaver sign and deer browse occur throughout. The soils of the rich conifer swamp are characterized by shallow (20-50 cm), slightly acidic to circumneutral (pH 6.8-7.0) peats over circumneutral (pH 7.0) sands.

The canopy is dominated by northern white-cedar with canopy associates including paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), white spruce (*Picea glauca*), and tamarack (*Larix laricina*). Canopy trees typically range in DBH from 15 to 40 cm with some localized areas with larger northern white-cedar (> 50 cm). Characteristic understory species include balsam fir (*Abies balsamea*) and mountain maple (*Acer spicatum*). Common species in the low shrub layer include balsam fir, black ash (*Fraxinus nigra*), and green ash (*F. pennsylvanica*). Characteristic ground cover species include dwarf raspberry (*Rubus pubescens*), creeping snowberry (*Gaultheria hispidula*), twinflower (*Linnaea borealis*), starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), sedge (*Carex pedunculata*), wild sarsaparilla (*Aralia nudicaulis*), oak fern (*Gymnocarpium dryopteris*), skunk-cabbage (*Symplocarpus foetidus*), Canada mayflower (*Maianthemum canadense*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), false mayflower (*Maianthemum trifolium*), northern bugle weed (*Lycopus uniflorus*), Jack-in-the-pulpit (*Arisaema triphyllum*), gay-wings (*Polygala paucifolia*), bulblet fern (*Cystopteris bulbifera*), blue-bead lily (*Clintonia borealis*), goldthread (*Coptis trifolia*), cinnamon fern (*Osmunda cinnamomea*), wild blue flag (*Iris versicolor*), and small enchanter's-nightshade (*Circaea alpina*).

Threats: Species composition and vegetative structure are patterned by natural processes but have been influenced by past logging, deer herbivory, and beaver flooding. Deer browse and cut stumps were noted throughout.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the swamp, and monitor for invasive species and deer browse. Reducing local deer densities throughout the landscape would help reduce deer browse pressure.

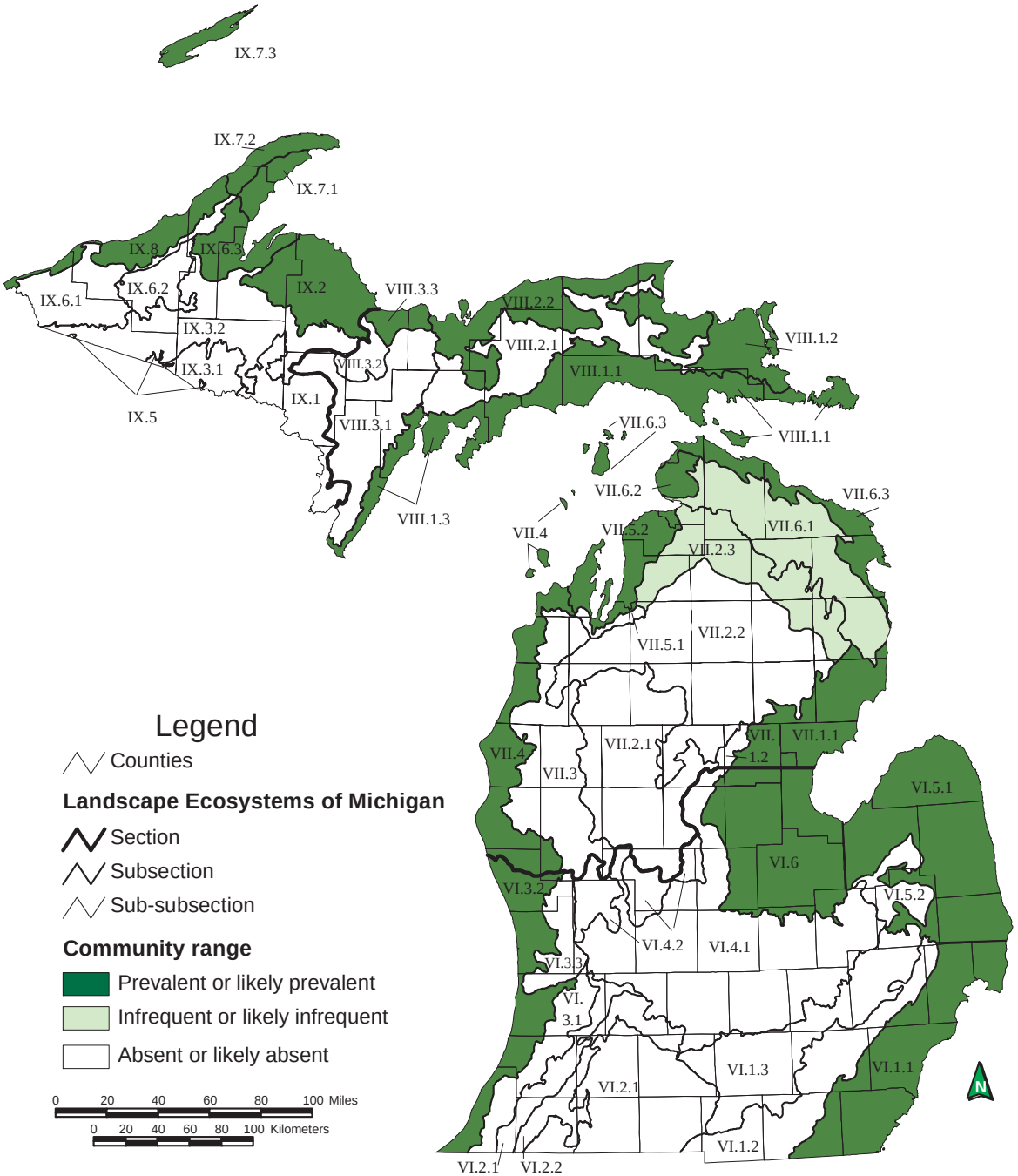
Little Sand Bay rich conifer swamp. Photo by Joshua G. Cohen.



Aerial photograph of Little Sand Bay rich conifer swamp.

SAND AND GRAVEL BEACH

Overview: Sand and gravel beaches occur along the shorelines of the Great Lakes and on some of Michigan's larger freshwater lakes, where wind, waves, and winter ice cause the shoreline to be too unstable to support aquatic vegetation. Because of the high levels of disturbance, these beaches are typically quite open, with sand and gravel sediments and little or no vegetation (Kost et al. 2007, Cohen et al. 2015).



Map 15. Distribution of sand and gravel beach in Michigan (Albert et al. 2008).

41. High Island
Natural Community Type: Sand and Gravel Beach
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: A
Size: 15 acres
Location: High Island
Element Occurrence Identification Number: 13026 (EO update)

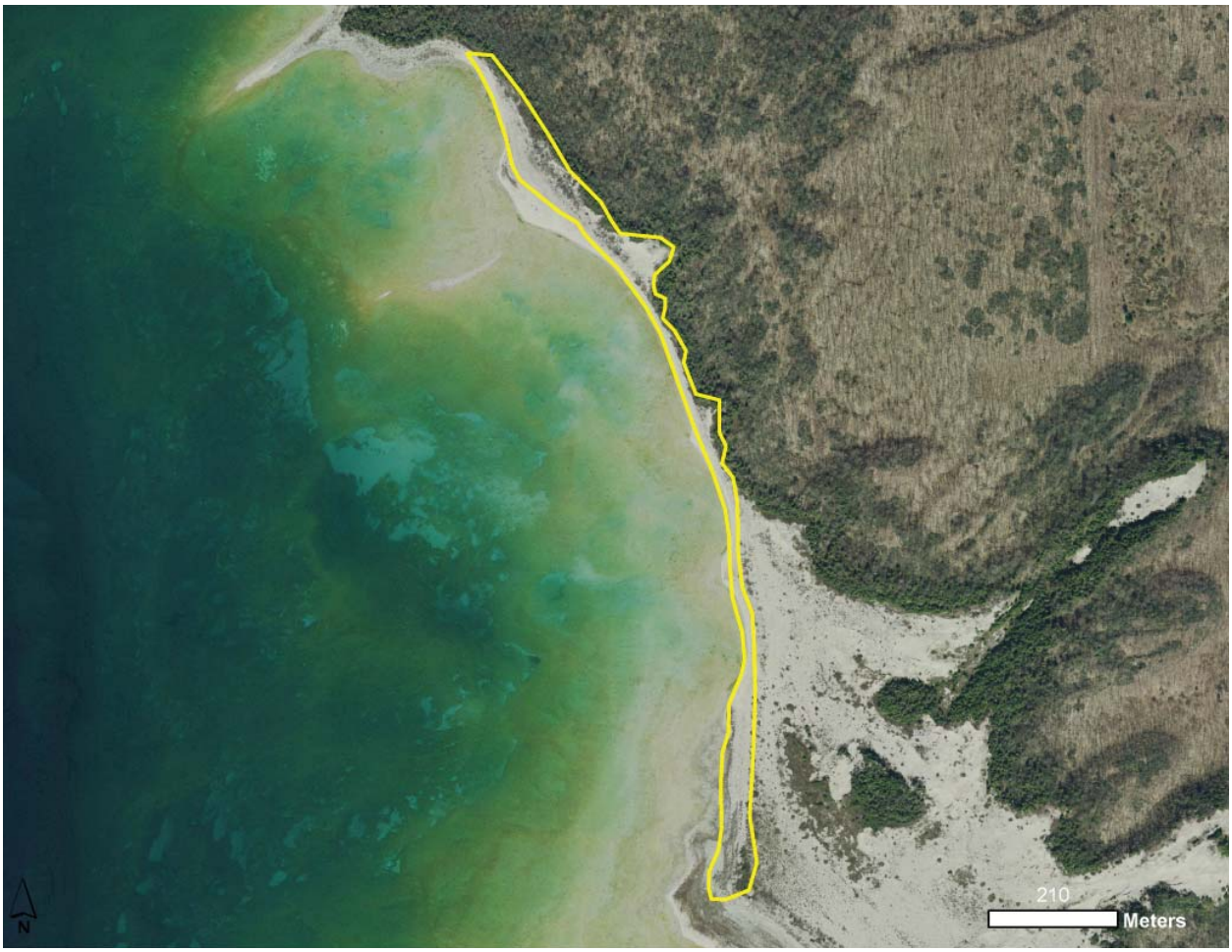
Site Description: The High Island sand and gravel beach occurs along a mile stretch of Lake Michigan shoreline along the northwestern shore of High Island. This stretch of sand and gravel beach is backed by low foredune, which is backed by Great Lakes barrens, dry-mesic northern forest, and boreal forest. Species composition and community structure are patterned by natural processes. This sand and gravel beach occurs along the Great Lakes shoreline of Lake Michigan, where wind, waves, and winter ice cause the shoreline to be too unstable to support aquatic vegetation. Because of the high levels of disturbance, this beach is typically quite open, with sand and gravel sediments and little or no vegetation. Energy from waves and ice abrasion maintain an open beach. The beach is characterized by a mixture of alkaline sands, gravel, and cobble.

This sand and gravel beach is characterized by both a low diversity of plant species and low levels of plant cover. A wide variety of plants can develop at the inland margin of sand and gravel beaches, but few establish and persist on the active beach, where there is often intense wind and wave action, resulting in almost constantly moving sand. Species noted along the margin of the sand and gravel beach and along the low foredune include marram grass (*Ammophila breviligulata*), wheat grass (*Elymus lanceolatus*), plains puccoon (*Lithospermum caroliniense*), wormwood (*Artemisia campestris*), poison ivy (*Toxicodendron radicans*), common milkweed (*Asclepias syriaca*), Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened), and red-osier dogwood (*Cornus sericea*). The non-native mossy stonecrop (*Sedum acre*) is locally common within the sand and gravel beach.

Threats: Species composition and structure are driven by natural processes. Mossy stonecrop (*Sedum acre*) is locally common within the sand and gravel beach. Additional invasives found along the shoreline include Canada bluegrass (*Poa compressa*), spotted knapweed (*Centaurea stoebe*), narrow-leaved cat-tail (*Typha angustifolia*), reed (*Phragmites australis* subsp. *australis*), and white sweet-clover (*Melilotus albus*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, eliminate clusters of non-native plants along the shoreline, and monitor for invasives.

High Island sand and gravel beach. Photos by Joshua G. Cohen.



Aerial photograph of High Island sand and gravel beach.

42. High Island Bay
Natural Community Type: Sand and Gravel Beach
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: A
Size: 28 acres
Location: High Island
Element Occurrence Identification Number: 10977 (EO update)

Site Description: The High Island Bay sand and gravel beach occurs along a two mile stretch of Lake Michigan shoreline along the northeastern shore of High Island. This sand and gravel beach is backed by low foredune, Great Lakes barrens, dry-mesic northern forest, and boreal forest. Species composition and community structure are patterned by natural processes. This sand and gravel beach occurs along the Great Lakes shoreline of Lake Michigan, where wind, waves, and winter ice cause the shoreline to be too unstable to support aquatic vegetation. Because of the high levels of disturbance, this beach is typically quite open, with sand and gravel sediments and little or no vegetation. Energy from waves and ice abrasion maintain an open beach. The beach is characterized by a mixture of sands, gravel, and cobble.

This sand and gravel beach is characterized by both a low diversity of plant species and low levels of plant cover. A wide variety of plants can develop at the inland margin of sand and gravel beaches, but few establish and persist on the active beach, where there is often intense wind and wave action, resulting in almost constantly moving sand. Species noted along the margin of the sand and gravel beach and along the low foredune include marram grass (*Ammophila breviligulata*), wheat grass (*Elymus lanceolatus*), plains puccoon (*Lithospermum caroliniense*), wormwood (*Artemisia campestris*), poison ivy (*Toxicodendron radicans*), common milkweed (*Asclepias syriaca*), Pitcher's thistle (*Cirsium pitcheri*, state and federally threatened), and red-osier dogwood (*Cornus sericea*). The non-native mossy stonecrop (*Sedum acre*) and spotted knapweed (*Centaurea stoebe*) are locally common within the sand and gravel beach.

Threats: Species composition and structure are driven by natural processes. Mossy stonecrop (*Sedum acre*) and spotted knapweed (*Centaurea stoebe*) are locally common within the sand and gravel beach. Additional invasives found along the shoreline include Canada bluegrass (*Poa compressa*), narrow-leaved cat-tail (*Typha angustifolia*), reed (*Phragmites australis* subsp. *australis*), and white sweet-clover (*Melilotus albus*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, eliminate clusters of non-native plants along the shoreline, and monitor for invasive species.

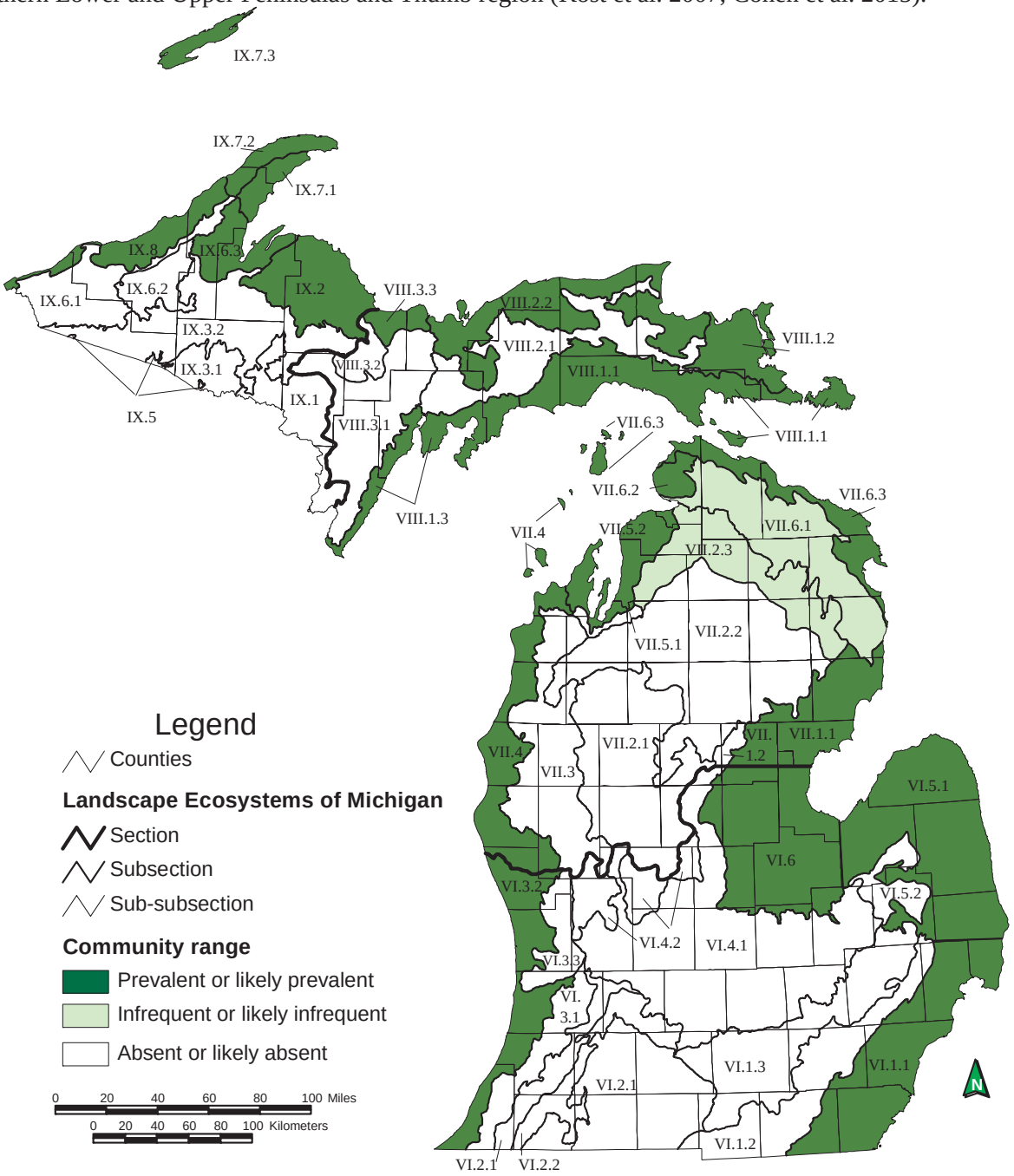
High Island Bay sand and gravel beach. Photos by Joshua G. Cohen.

Aerial photograph of High Island Bay sand and gravel beach.

High Island Bay sand and gravel beach. Photo by Joshua G. Cohen.

WOODED DUNE AND SWALE COMPLEX

Overview: Wooded dune and swale complex is a large complex of parallel wetland swales and upland beach ridges (dunes) found in coastal embayments and on large sand spits along the shorelines of the Great Lakes. The upland dune ridges are typically forested, while the low swales support a variety of herbaceous or forested wetland types, with open wetlands more common near the shoreline and forested wetlands more prevalent further from the lake. Wooded dune and swale complexes occur primarily in the northern Lower and Upper Peninsulas and Thumb region (Kost et al. 2007, Cohen et al. 2015).



Map 16. Distribution of wooded dune and swale complex in Michigan (Albert et al. 2008).

43. Taganing Dune and Swale
Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 67 acres
Location: Garden Island
Element Occurrence Identification Number: 20451 (New EO)

Site Description: Hundreds to thousands of years of lacustrine processes have developed a subtle but complex patterning of northeast to southwest oriented dune ridges and swales of variable depth and width that characterize the Taganing Dune and Swale. The complex community structure includes dry-mesic northern forest, northern hardwood swamp, rich conifer swamp, northern shrub thicket, and northern wet meadow. Along the ridges the soils are characterized by a shallow A horizon (10-30 cm on one ridge) of acidic (pH 4.5) organics and sands overlying medium- to coarse-textured, alkaline (pH 7.5-7.8) sands. The sands along the ridges are more acidic closer to the surface, where the needle layer increases the acidity and less acidic with increasing depth. Shrub and meadow swales have saturated, alkaline (pH 7.5-8.0) peats (> 1 meter in one swale) overlying sands. The ridges are typically low and narrow (10-30 meters wide) and the swales are also narrow (10-20 meters wide). Many of the swales hold standing water, with measured water depths ranging from 30 to 60 cm in sedge- and shrub-dominated swales. Compared to other examples across this state, this is a very small wooded dune and swale complex. Nevertheless, the site is characterized by complex ecological patterning that results in high species and community diversity in an area with minimal anthropogenic disturbance. In addition, the site is unique in that it occurs immediately adjacent to a high-quality Great Lakes marsh (Taganing Marsh, EO ID 20450). The ridges and swales are linear and trend northeast to southwest. Coarse woody debris of early-successional species is abundant and predominantly composed of paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*). Pockets of windthrow are common on both the forested ridges and swales. Trees falling from adjacent uplands into the swales provide important substrate for plant establishment and growth. Throughout the gently rolling dune ridges, there are charred snags and cut stumps, indicating that the complex burned and was locally logged in the past. A 31.5 cm northern white-cedar (*Thuja occidentalis*) from a dry-mesic dune ridge was cored and estimated to be over 133 years old. Where the dune ridges and swales are narrowest, they intergrade with each other vegetatively.

The dry-mesic dune ridges are dominated by northern white-cedar with common associates including paper birch, trembling aspen (*Populus tremuloides*), and red pine (*Pinus resinosa*). Diameters of canopy trees range from 10 to 30 cm. Early-successional species (i.e., paper birch and balsam fir) are senescing and their small diameter coarse woody debris is prevalent along the dune ridges. Prevalent understory species include balsam fir and yew (*Taxus canadensis*). Balsam fir is locally dense in the understory. The low shrub layer is patchy to dense with mountain maple (*Acer spicatum*), yew, and Labrador-tea (*Rhododendron groenlandicum*). Characteristic ground cover species include bracken fern (*Pteridium aquilinum*), Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), twinflower (*Linnaea borealis*), gay-wings (*Polygala paucifolia*), starflower (*Trientalis borealis*), and naked miterwort (*Mitela nuda*).

The northern hardwood swamp swales are dominated by black ash (*Fraxinus nigra*) with prevalent ground cover species including starflower, bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), and Canada mayflower. Areas of rich conifer swamp are dominated by northern white-cedar with canopy associates including black ash and tamarack (*Larix laricina*). Prevalent understory species include tag alder (*Alnus incana*), mountain holly (*Ilex verticillata*), balsam fir, red-osier dogwood (*Cornus sericea*), and northern white-cedar. Common species of the low shrub layer include Labrador-tea, alder-leaved

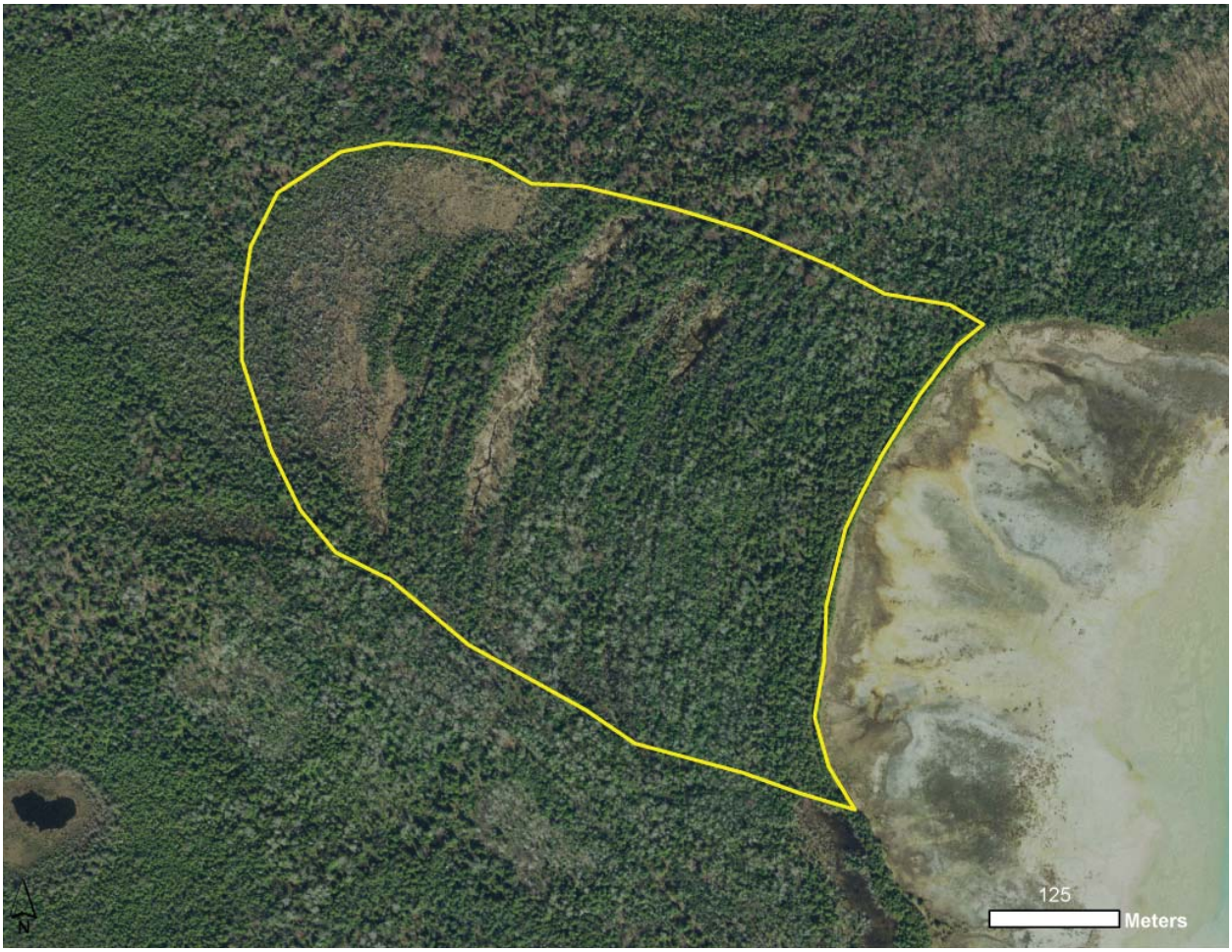
buckthorn (*Rhamnus alnifolia*), and bog rosemary (*Andromeda glaucophylla*). Characteristic ground cover species include tussock sedge (*Carex stricta*), bunchberry, marsh fern (*Thelypteris palustris*), starflower, goldthread, royal fern (*Osmunda regalis*), creeping snowberry (*Gaultheria hispidula*), sensitive fern (*Onoclea sensibilis*), and miterwort.

Shrub swales are dominated by tag alder with tall shrub associates including red-osier dogwood and mountain holly and common low shrubs including Labrador-tea, alder-leaved buckthorn, and bog rosemary. Characteristic ground cover species in the shrub swales include tussock sedge, wild blue flag (*Iris versicolor*), bunchberry, wild strawberry (*Fragaria virginiana*), marsh fern, royal fern, sensitive fern, and mad-dog skullcap (*Scutellaria lateriflora*). Standing water in the shrub swales was typically between 30 to 60 cm deep. Graminoid-dominated meadow swales are characterized by sedge dominance with tussock sedge and wiregrass sedge (*Carex lasiocarpa*) prevalent and ground cover associates including wild blue flag, marsh fern, marsh cinquefoil (*Comarum palustre*), and hardstem bulrush (*Schoenoplectus acutus*).

Taganing Dune and Swale wooded dune and swale complex. Photo by Joshua G. Cohen.

Threats: The site is characterized by complex ecological patterning that results in high species and community diversity in a small area with minimal anthropogenic disturbance. Logging has occurred in portions of the complex on the ridges. Cut and charred stumps occur scattered throughout the wooded dune and swale complex and the diameters of the cut stumps are smaller or similar to the diameter of living trees. No current threats were observed during the course of the survey.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the wooded dune and swale complex, and monitor for invasive species.



Aerial photograph of Taganing Dune and Swale wooded dune and swale complex.

STEWARDSHIP PRIORITIZATION RESULTS

The stewardship scores for each natural community element occurrence are presented in Tables 4 and 5. Table 4 presents the stewardship scores for the natural community element occurrences found on Beaver Island and Table 5 presents the stewardship scores for the natural community element occurrences found on the outer islands of the Beaver Island Archipelago (Garden, High, and Hog Islands). Although the stewardship scores are comparable across all of the islands, these element occurrences were grouped separately because the threats for Beaver Island compared to the outer islands are significantly different. Differences between Beaver Island compared to the outer islands include: high deer densities and browse pressure on Beaver Island compared to an absence or near absence of deer on the outer islands; high levels of anthropogenic disturbance on Beaver Island associated with residential development and recreational activity compared to the outer islands that do not have permanent residences; and higher levels of invasive species on Beaver Island compared to the outer islands. For each table, the element occurrences were sorted by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

During the course of surveys on Beaver Island, invasive species were noted to be most common within the open dune ecosystems. Open dunes are also negatively impacted by erosion from foot traffic and off-road vehicle activity. Within the interior of the Beaver Island, the most notable threat to ecosystems is high deer browse pressure. Deer herbivory has negatively impacted the floristic composition and vegetative structure of forested uplands and lowlands with the mesic northern forests, boreal forests, and rich conifer swamps significantly altered. High priority stewardship sites on Beaver Island included the highest quality open dunes and mesic northern forest occurrences. Low priority sites include more common natural community types (e.g., bog and poor conifer swamp) that occur within the interior of the island and do not currently have threats that jeopardize their ecological integrity.

Table 4. Stewardship prioritization for natural community element occurrences on Beaver Island. Element occurrences are sorted by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

EO ID	Natural Community Type	Surveysite	EO Rank	Global Rank	Global Rank Score	State Rank	State Rank Score	Rarity Index	Ecological Integrity Index	Threat Severity Index	Stewardship Score
530	Open Dunes	Cable Bay	C	G3	3.00	S3	3.00	3.00	3.00	4.00	10.00
20737	Open Dunes	McCauley Point	C	G3	3.00	S3	3.00	3.00	3.00	4.00	10.00
9292	Open Dunes	Iron Ore Bay	C	G3	3.00	S3	3.00	3.00	3.00	4.00	10.00
10808	Open Dunes	McFadden Point	C	G3	3.00	S3	3.00	3.00	3.00	4.00	10.00
5002	Open Dunes	Sand Bay	C	G3	3.00	S3	3.00	3.00	3.00	4.00	10.00
626	Mesic Northern Forest	Martin's Bluff	BC	G4	2.00	S3	3.00	2.50	3.50	4.00	10.00
10493	Mesic Northern Forest	Southwest Old Growth	BC	G4	2.00	S3	3.00	2.50	3.50	4.00	10.00
6089	Interdunal Wetland	Little Sand Bay	BC	G2?	4.00	S2	4.00	4.00	3.50	2.00	9.50
6701	Open Dunes	Lookout Point	CD	G3	3.00	S3	3.00	3.00	2.50	4.00	9.50
6311	Boreal Forest	French Bay	B	GU	3.00	S3	3.00	3.00	4.00	2.00	9.00
9328	Mesic Northern Forest	Font Lake Old Growth	CD	G4	2.00	S3	3.00	2.50	2.50	4.00	9.00
4742	Mesic Northern Forest	Lake Genesereth Old Growth	CD	G4	2.00	S3	3.00	2.50	2.50	4.00	9.00
9259	Dry-mesic Northern Forest	Pointe La Par	B	G4	2.00	S3	3.00	2.50	4.00	2.00	8.50
20689	Rich Conifer Swamp	Greene's Lake Swamp	BC	G4	2.00	S3	3.00	3.00	3.50	2.00	8.50
2437	Boreal Forest	Little Sand Bay	C	GU	3.00	S3	3.00	3.00	3.00	2.00	8.00
2988	Poor Fen	Egg Lake	B	G3	3.00	S3	3.00	3.00	4.00	1.00	8.00
20690	Rich Conifer Swamp	Doty's Swamp	C	G4	2.00	S3	3.00	3.00	3.00	2.00	8.00
20692	Rich Conifer Swamp	Little Sand Bay	C	G4	2.00	S3	3.00	3.00	3.00	2.00	8.00
20688	Poor Conifer Swamp	Greene's Lake Swamp	AB	G4	2.00	S4	2.00	2.00	4.50	1.00	7.50
20442	Bog	Greene's Lake	AB	G3G5	1.50	S4	2.00	1.75	4.50	1.00	7.25
12097	Bog	Fox Lake Bog	AB	G3G5	1.50	S4	2.00	1.75	4.50	1.00	7.25

During the course of surveys on Garden, High, and Hog Islands, invasive species were noted to be most common within the shoreline ecosystems. The two highest ranking sites from the outer islands are both Great Lakes marsh occurrences that had localized infestations of invasive species. When a stewardship prioritization analysis was run for Northern Michigan, a similar result was found with Great Lakes marsh ranking highly; Great Lakes marsh was consistently the most abundant natural community in the sites categorized as high stewardship priority (Cohen and Slaughter 2015). This is partially due to the global rarity of this ecosystem that is endemic to the Great Lakes region (Great Lakes marsh has a global rarity ranking of G2, or globally imperiled). In addition, this system is particularly susceptible to infestation by invasive species. The invasives that become established within Great Lakes marsh can quickly expand and dominate, with homogenous beds of reed (*Phragmites australis* subsp. *australis*) and invasive cat-tails (*Typha angustifolia* and *T.* x. *glauca*) dramatically altering floristic composition and structure of affected sites. Additional high priority sites for the outer islands included coastal fen and northern fen. Coastal fens on Garden Island are threatened by off-road-vehicle activity and invasive species threaten coastal fen on Hog Island and the northern fen on Garden Island. Medium priority sites on the outer islands include the following shoreline ecosystems: limestone cobble shore, open dunes, Great Lakes barrens, coastal fen, and sand and gravel beach. Low priority sites were primarily more common natural community types that occur within the interior of the islands and most of these types are forested systems.

This prioritization framework was developed to help direct stewardship efforts towards those sites with the greatest stewardship need. During the 2015 and 2017 surveys of the outer islands, many of the surveyed sites were not currently impacted by threats or threats were limited in scope and severity. Many of the sites on these islands currently do not have pressing stewardship needs. However, for this unique circumstance, this framework can also be used to help resource managers determine where to focus future monitoring efforts.

Table 5. Stewardship prioritization for natural community element occurrences on outer islands of Beaver Island Archipelago (Garden, High, and Hog Islands). Element occurrences are sorted by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

EO ID	Natural Community Type	Surveysite	Island	EO Rank	Global Rank	Global Rank Score	State Rank	State Rank Score	Rarity Index	Ecological Integrity Index	Threat Severity Index	Stewardship Score
13020	Great Lakes Marsh	Indian Harbor	Garden Island	AB	G2	4.00	S3	3.00	3.50	4.50	4.00	12.00
2179	Great Lake Marsh	Hog Island	Hog Island	AB	G2	4.00	S3	3.00	3.50	4.50	4.00	12.00
3734	Coastal Fen	Hog Island	Hog Island	A	G1G2	4.50	S2	4.00	4.25	5.00	2.00	11.25
21328	Coastal Fen	Indian Harbor	Garden Island	B	G1G2	4.50	S2	4.00	4.25	4.00	3.00	11.25
7888	Coastal Fen	Jensen Harbor	Garden Island	A	G1G2	4.50	S2	4.00	4.25	5.00	2.00	11.25
10574	Coastal Fen	Northcutt and Monatou Bays	Garden Island	AB	G1G2	4.50	S2	4.00	4.25	4.50	2.00	10.75
20450	Great Lakes Marsh	Taganing Marsh	Garden Island	A	G2	4.00	S3	3.00	3.50	5.00	2.00	10.50
11804	Northern Fen	Garden Island Harbor	Garden Island	AB	G3G5	3.00	S3	3.00	3.00	4.50	3.00	10.50
20449	Limestone Cobble Shore	Taganing Shore	Garden Island	B	G2G3	3.50	S3	3.00	3.25	4.00	3.00	10.25
20448	Limestone Cobble Shore	Monatou Bay	Garden Island	A	G2G3	3.50	S3	3.00	3.25	5.00	2.00	10.25
10698	Open Dunes	High Island	High Island	A	G3	3.00	S3	3.00	3.00	5.00	2.00	10.00
10977	Sand and Gravel Beach	High Island Bay	High Island	A	G3?	3.00	S3	3.00	3.00	5.00	2.00	10.00
13026	Sand and Gravel Beach	High Island	High Island	A	G3?	3.00	S3	3.00	3.00	5.00	2.00	10.00
20454	Great Lakes Barrens	Nezewabegon Barrens	High Island	AB	G3	3.00	S2	4.00	3.50	4.50	2.00	10.00
6527	Limestone Cobble Shore	High Island	High Island	AB	G2G3	3.50	S3	3.00	3.25	4.50	2.00	9.75
20447	Limestone Cobble Shore	Hog Island	Hog Island	AB	G2G3	3.50	S3	3.00	3.25	4.50	2.00	9.75
9513	Coastal Fen	Sweat Lodge Swale	Garden Island	B	G1G2	4.50	S2	4.00	4.25	4.00	1.00	9.25
7487	Boreal Forest	Garden Island Boreal Forest	Garden Island	A	GU	3.00	S3	3.00	3.00	5.00	1.00	9.00
4856	Boreal Forest	High Island	High Island	AB	GU	3.00	S3	3.00	3.00	4.50	1.00	8.50
20446	Northern Fen	Hog Island	Hog Island	AB	G3	3.00	S3	3.00	3.00	4.50	1.00	8.50
9639	Rich Conifer Swamp	Hog Island	Hog Island	AB	G4	2.00	S3	3.00	3.00	4.50	1.00	8.50
10623	Hardwood-Conifer Swamp	Hog Island North	Hog Island	A	G4	2.00	S3	3.00	2.50	5.00	1.00	8.50
3913	Wooded Dune and Swale Complex	Hog Island - East Shoreline	Hog Island	AB	G3	3.00	S3	3.00	3.00	4.50	1.00	8.50
20452	Mesic Northern Forest	Nezewabegon Forest	High Island	AB	G4	2.00	S3	3.00	2.50	4.50	1.00	8.00
7843	Mesic Northern Forest	Hog Island	Hog Island	B	G4	2.00	S3	3.00	2.50	4.00	1.00	7.50
20453	Dry-mesic Northern Forest	High Island	High Island	B	G4	2.00	S3	3.00	2.50	4.00	1.00	7.50
20451	Wooded Dune and Swale Complex	Taganing Dune and Swale	Garden Island	C	G3	3.00	S3	3.00	3.00	3.00	1.00	7.00
10496	Mesic Northern Forest	Red Oak Garden	Garden Island	C	G4	2.00	S3	3.00	2.50	3.00	1.00	6.50

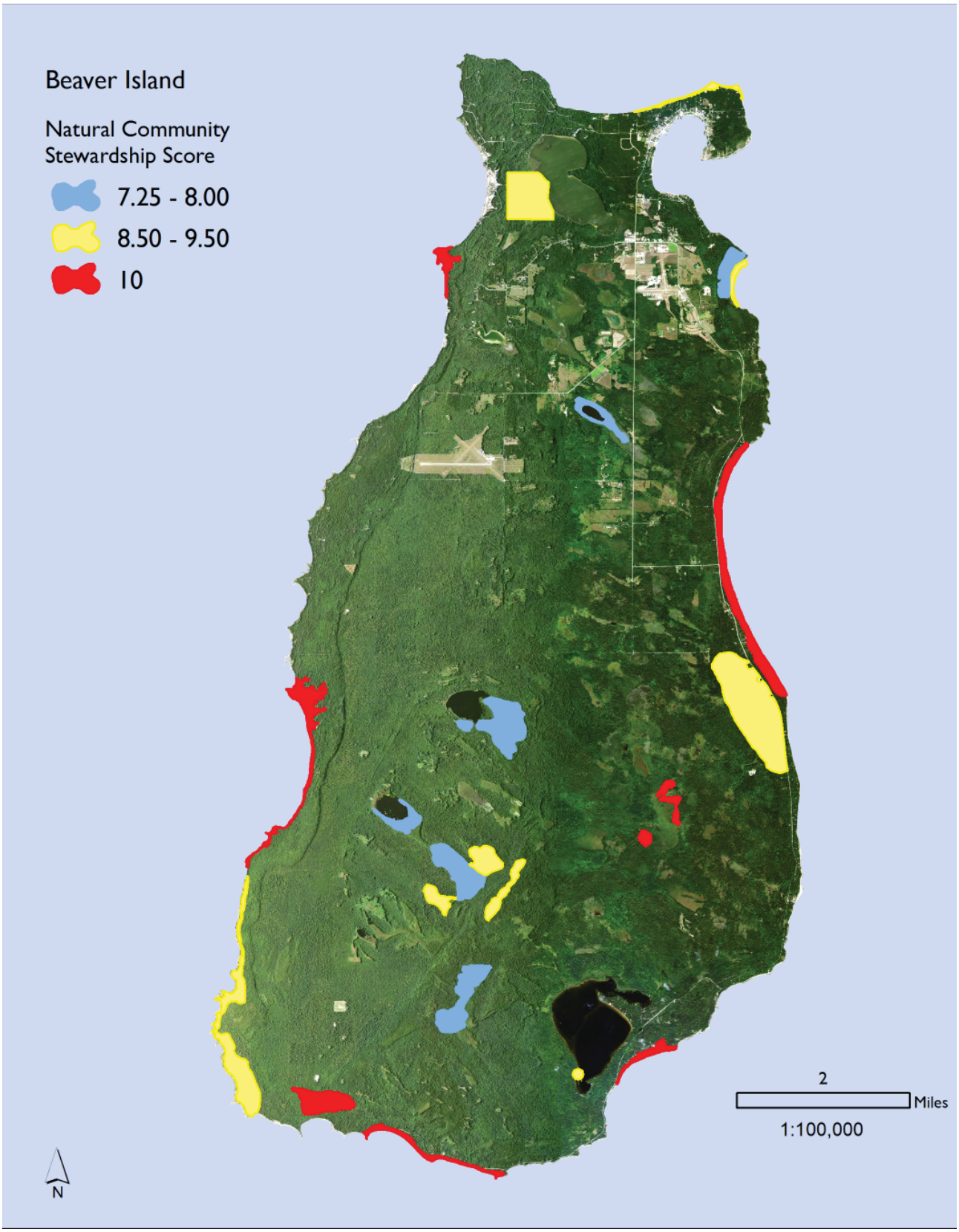


Figure 3. Stewardship prioritization for natural community element occurrences on Beaver Island. Element occurrences are displayed by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

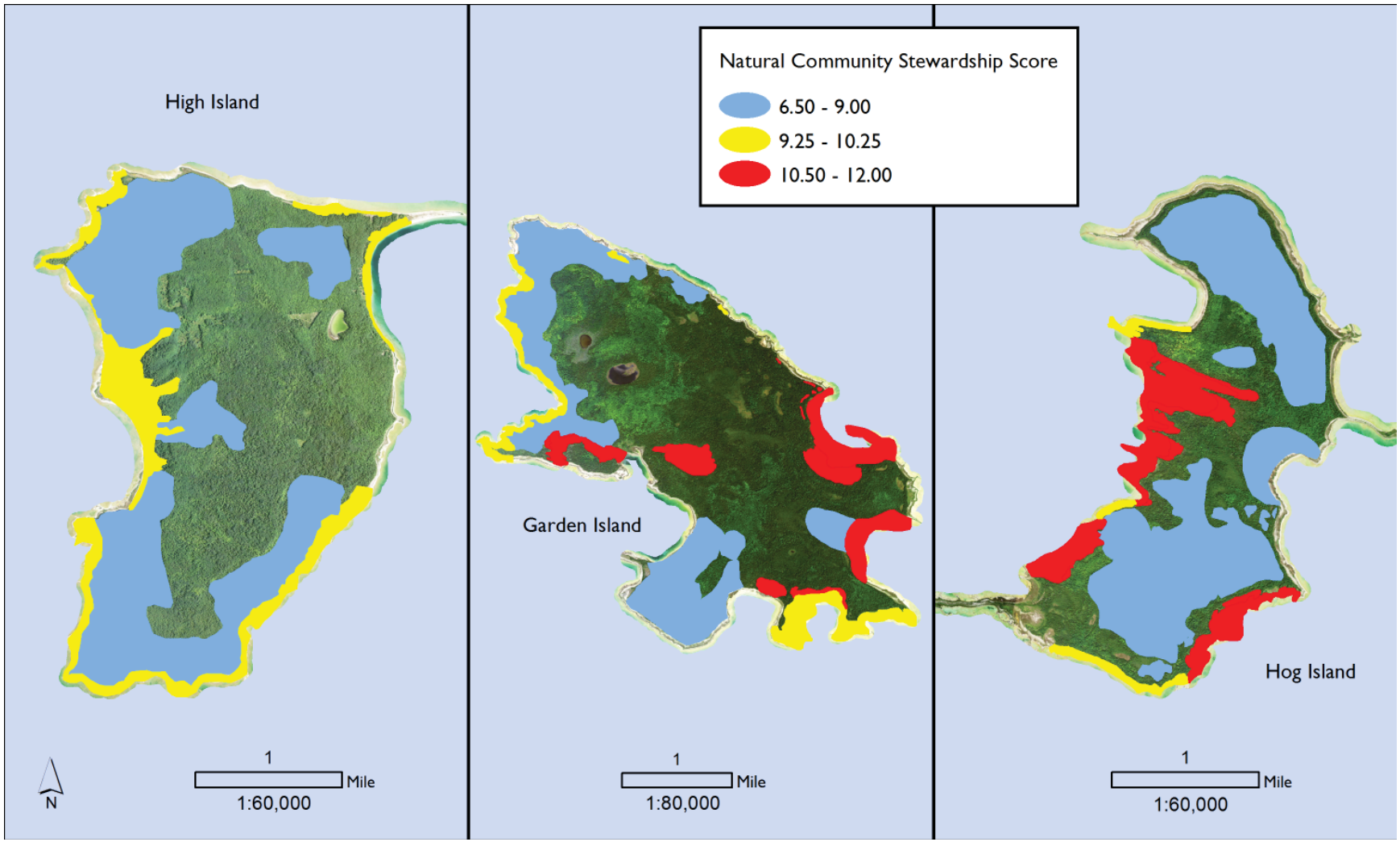


Figure 4. Stewardship prioritization for natural community element occurrences on Garden, High, and Hog Islands. Element occurrences are displayed by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

Control of invasive species in open dune ecosystems and control of deer browse pressure in forested ecosystems are the highest stewardship priorities on Beaver Island. McFadden Point open dunes pictured above and Southwest Old Growth mesic northern forest pictured below. Photos by Joshua G. Cohen.

Control and monitoring of invasive species in coastal ecosystems are the highest stewardship priorities for the outer islands of the Beaver Island Archipelago. Hog Island coastal fen grading to Great Lakes marsh pictured above and Indian Harbor Great Lakes marsh from Garden Island pictured below. Photos by Bill Parsons.

DISCUSSION

This report provides site-based assessments of 43 natural community element occurrences surveyed from 2015 through 2017 within the Beaver Island Archipelago. Threats, management needs, and restoration opportunities specific to each individual site have been discussed. The baseline information presented in the current 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 across these islands will help facilitate difficult decisions regarding the distribution of finite stewardship resources for site-based management.

The framework for stewardship and monitoring prioritization presented in this report offers a method for targeting biodiversity management and monitoring within the islands. 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 of the islands in Lake Michigan. In addition, the stewardship priority scores could be sorted by natural community type. Furthermore, other indices could be incorporated into the stewardship prioritization matrix. Additional indices to consider incorporating include indices that measure or score the potential for management success of a site, the presence of rare species, and the functionality of the landscape surrounding the site. Implementation of stewardship efforts within prioritized areas will need to be followed by monitoring to gauge the success of biodiversity management efforts and refine future stewardship prioritization efforts.

Southwest Old Growth mesic northern forest. Photo by Joshua G. Cohen.

McCauley Point open dunes. Photo by Bill Parsons.

REFERENCES

Albert, D.A., J.G. Cohen, M.A. Kost, B.S. Slaughter, and H.D. Enander. 2008. Distribution Maps of Michigan's Natural Communities. Michigan Natural Features Inventory, Report No. 2008-01, Lansing, MI. 314 pp.

Cohen, J.G., M.A. Kost, B.S. Slaughter, and D.A. Albert. 2015. A Field Guide to the Natural Communities of Michigan. Michigan State University Press, East Lansing, MI. 362 pp.

Cohen J.G., and B.S. Slaughter. 2015. Natural Community Surveys and Stewardship Prioritization of Michigan's Coastal Zone. Michigan Natural Features Inventory Report Number 2015-27, Lansing, MI. 244 pp.

Faber-Langendoen, D., J. Rocchio, P. Comer, G. Kudray, L. Vance, E. Byers, M. Schafale, C. Nordman, E. Muldavin, G. Kittel, L. Sneddon, M. Pyne, and S. Menard. 2008. Overview of Natural Heritage Methodology for Ecological Element Occurrence Ranking based on Ecological Integrity Assessment Methods [Draft for Network Review]. NatureServe, Arlington, VA.

Kost, M.A., D.A. Albert, J.G. Cohen, B.S. Slaughter, R.K. Schillo, C.R. Weber, and K.A. Chapman. 2007. Natural Communities of Michigan: Classification and Description. Michigan Natural Features Inventory Report Number 2007-21, Lansing, MI. 314 pp.

Michigan Natural Features Inventory (MNFI). 1988. Draft criteria for determining natural quality and condition grades, element occurrence size-classes and significance levels for palustrine and terrestrial natural communities in Michigan. Michigan Natural Features Inventory, Lansing, MI. 39 pp.

Michigan Natural Features Inventory (MNFI). 2017. Biotics database. Michigan Natural Features Inventory, Lansing, MI.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application Version 7.1. NatureServe, Arlington, Virginia Available http://www.natureserve.org/explorer (Accessed: May 3, 2011).

Egg Lake poor fen. Photo by Bill Parsons.

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.

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.

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.