Natural Community Surveys of Beaver Island

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
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ODAWA NATURAL RESOURCE DEPARTMENT

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Fox Lake Bog. Photo by Joshua G. Cohen.

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

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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 2016). 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). 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). Prior to the implementation of this project, 16 high-quality occurrences of natural communities had been documented on Beaver Island with ten of those occurrences occurring on state lands (Table 1). These natural community occurrences represent eight of the 77 natural community types described for Michigan by Cohen et al. (2014).

Prior to this project, the majority of the natural community occurrences on Beaver Island had not been surveyed in over a decade, including two sites that had not been visited since 1981 and two sites that had not been visited since 1998 (Table 1). 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 state land. 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 this island 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 on Beaver Island by (1) updating known high-quality occurrences of natural communities occurring on state land, (2) conducting surveys for new occurrences of natural communities on state land, (3) synthesizing survey results and information in MNFI's conservation database, and (4) proposing biodiversity stewardship and monitoring priorities.

Surveys were conducted during the 2016 field season. MNFI conducted surveys of ten previously known element occurrences on state land and documented five new natural community element occurrences on state land. Nine different natural community types are represented in the 15 element occurrences surveyed (Table 1 and Figue 1). 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 on Beaver Island.

Interdunal wetland, Little Sand Bay. Photo by Joshua G. Cohen.

Table 1. Natural community element occurrences (EOs) on Beaver Island. The * indicates the EOs that were surveyed in 2016. The ^ indicates the EOs that occur on state land.

Community Type	EO ID	Survey Site	EO RANK	Prior EO RANK	Year Surveyed Prior to Project	Year Last Observed
Bog*^	12097	Fox Lake Bog	AB	AB	2006	2016
Bog^	20442	Greene's Lake	AB	AB	2015	2015
Boreal Forest*^	6311	French Bay	B	C	2006	2016
Boreal Forest*	2437	Little Sand Bay	C	BC	1981	2016
Dry-Mesic Northern Forest*^	9259	Pointe La Par	B	AB	2006	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	2006	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	2006	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	2016
Rich Conifer Swamp*^	20689	Greene's Lake Swamp	BC	NA	2016	2016
Rich Conifer Swamp*^	20692	Little Sand Bay	C	NA	2016	2016

Boreal forest, French Bay. Photo by Joshua G. Cohen.

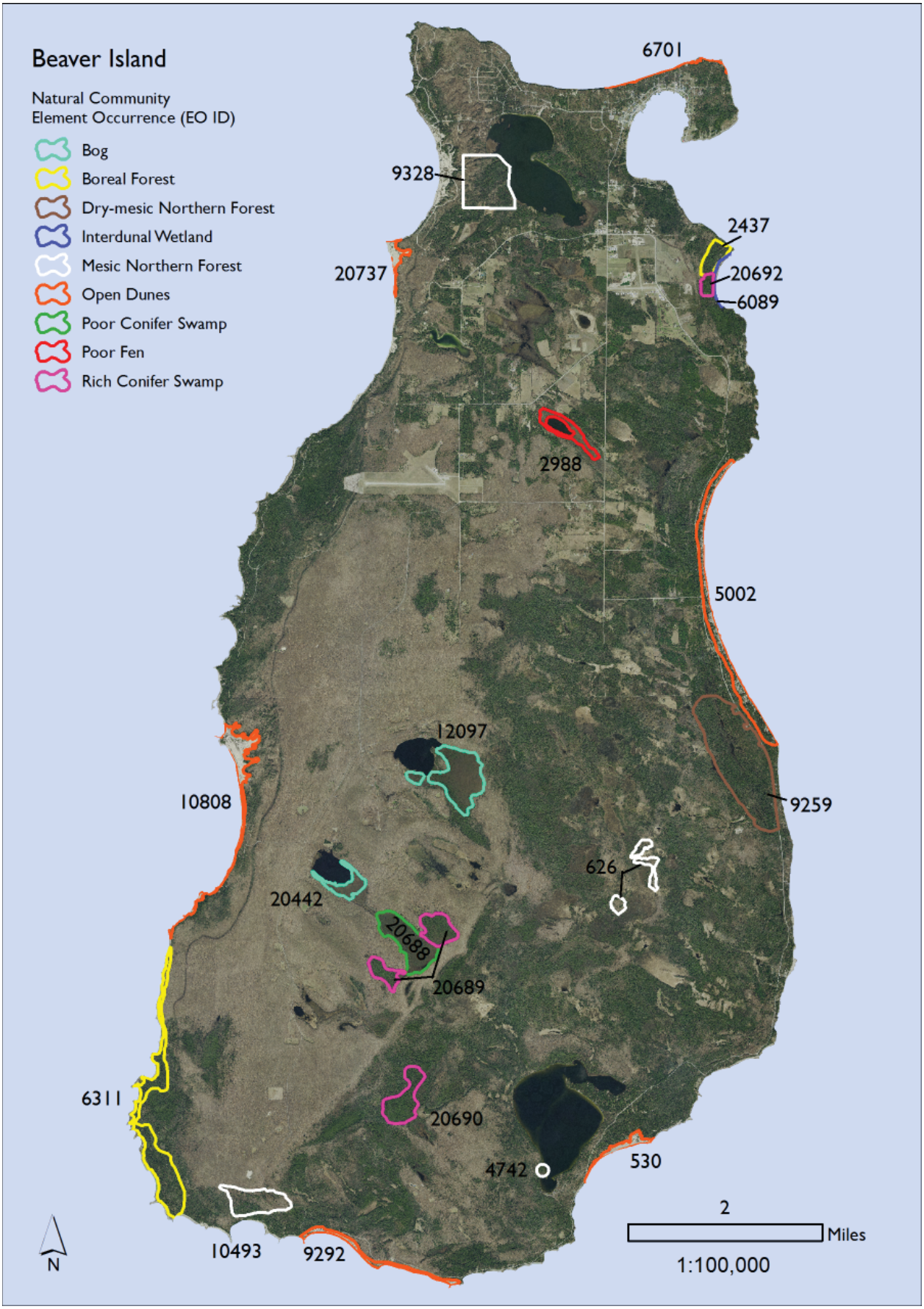


Figure 1. Natural community element occurrences (EOs) on Beaver Island.

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 on Beaver Island in 2006, 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 15 high-quality natural communities were surveyed in 2016 on Beaver Island (Table 1). 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. Ecological field surveys were conducted during the 2016 growing season from August 22 through August 26 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. 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.

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 2016). 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 (Cohen and Slaughter 2015). For each natural community element occurrence on Beaver Island, 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 on Beaver Island is presented in the **Stewardship Prioritization Results** section.

Rich conifer swamp, Greene's Lake Swamp. Photo by Joshua G. Cohen.

SURVEY RESULTS

Fifteen occurrences of high-quality natural communities were surveyed during the 2016 field season. A total of nine different natural community types were visited including: bog (1 element occurrence or EO), boreal forest (2 EOs), dry-mesic northern forest (1 EO), interdunal wetland (1 EO), mesic northern forest (2 EOs), open dunes (3 EOs), poor conifer swamp (1 EO), poor fen (1 EO), and rich conifer swamp (3 EOs). Table 1 lists the visited sites, their element occurrence ranks, and their previous element occurrence ranks if applicable. One previously documented site on state land, Greene's Lake bog (EO ID 20442) was not visited in 2016 since it had been recently surveyed by MNFI in 2015.

The following site summaries provide detailed site descriptions and discuss threats and management recommendations for each of the 14 natural community EOs visited in 2016. These site summaries are organized alphabetically by community type and then by element occurrence. 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. 2014). 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:

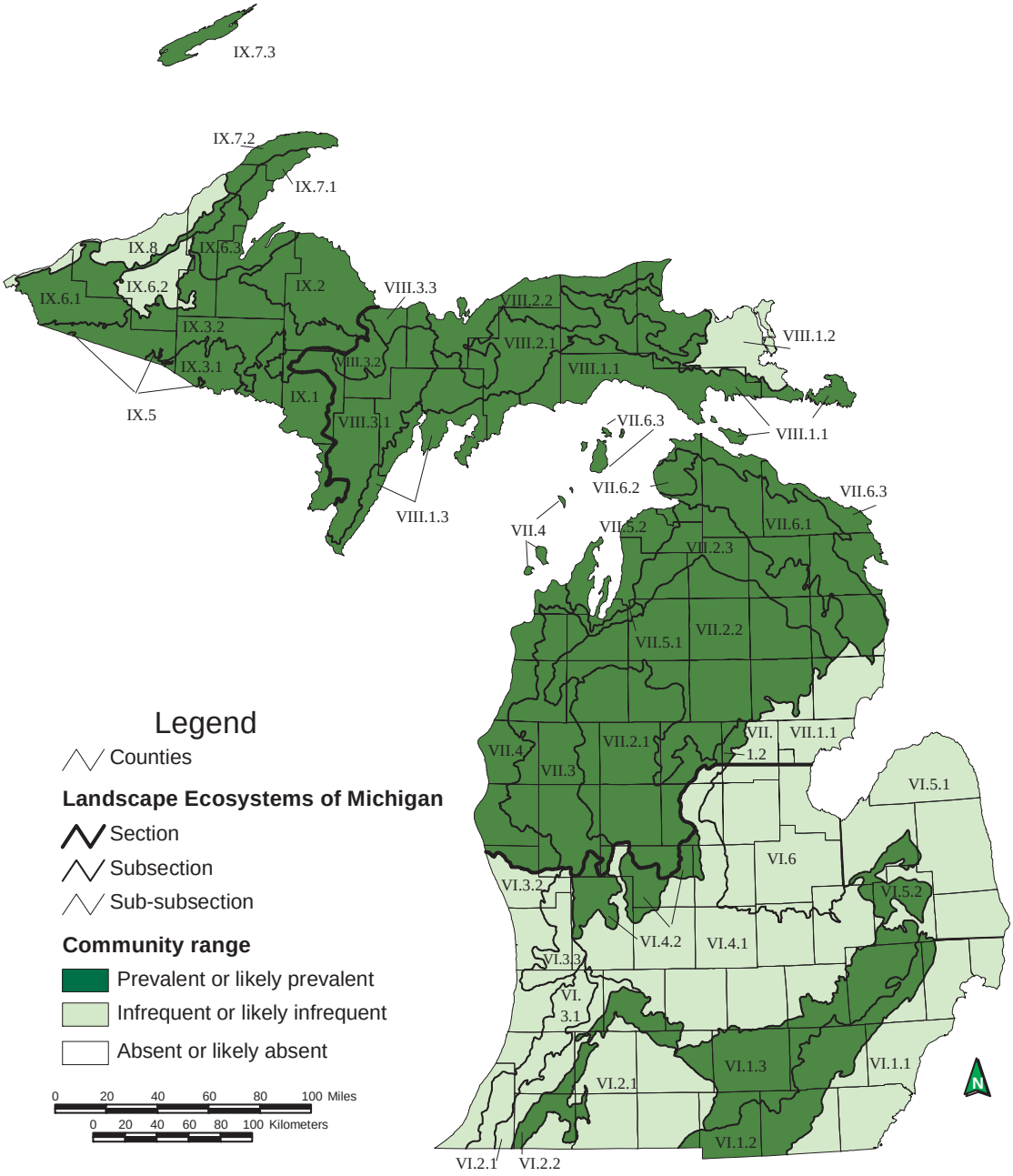
a) site name
b) natural community type
c) global and state rank (see Appendix 1 for ranking criteria)
d) current element occurrence rank
e) size
f) digital photograph(s)
g) site description
h) threat assessment
i) management recommendations

Bog, Fox Lake Bog. 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. 2014).



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
Element Occurrence Identification Number: 12097 (EO Update)

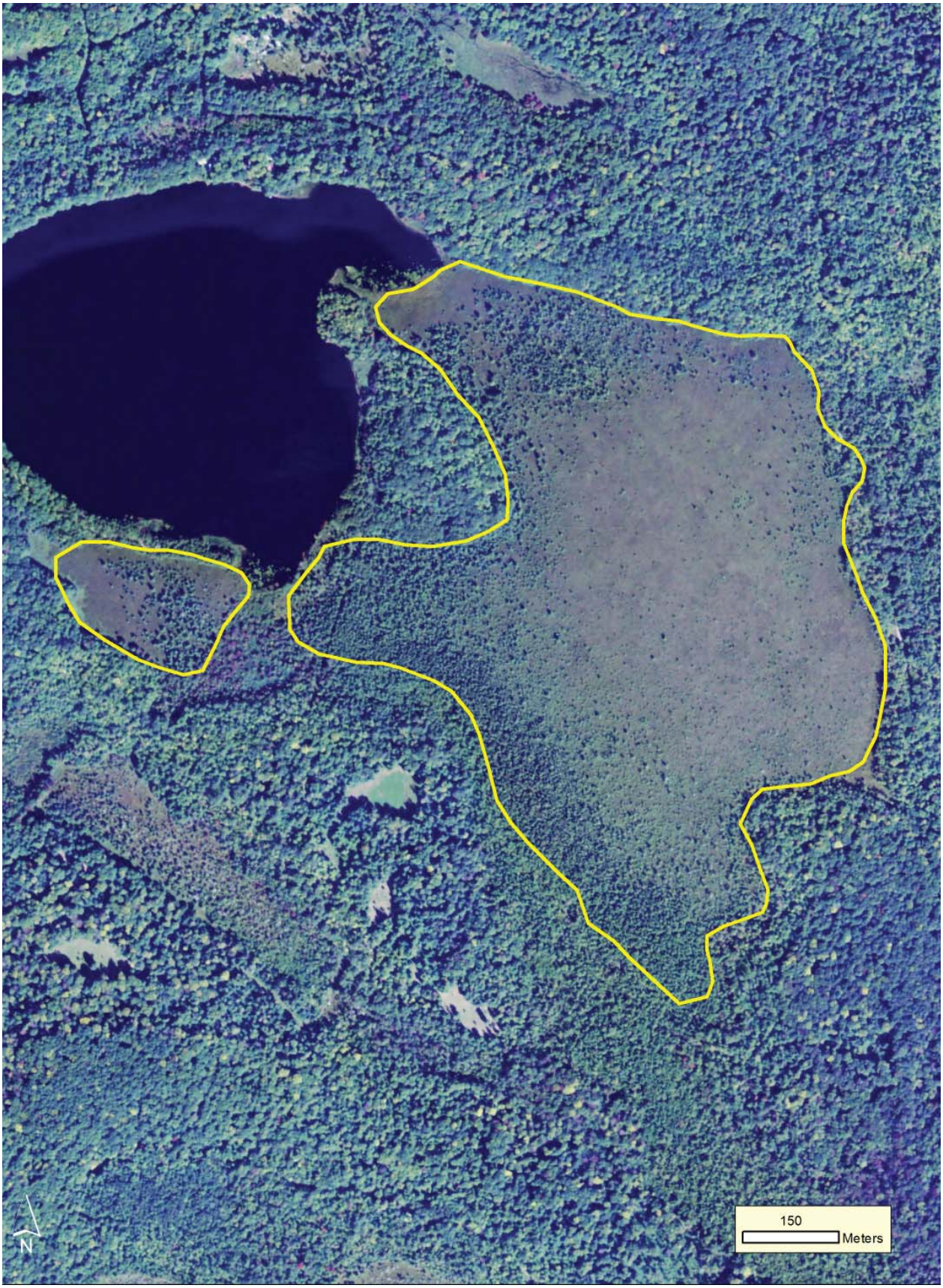
Site Description: This large ombrotrophic bog occurs on poorly drained lakeplain with deep sphagnum peats overlying sands. The sphagnum peats are strongly acidic and saturated with inundated peats occurring along the margins of Fox Lake. The lakeplain is level but diverse microtopography occurs due to 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 (*Ilex 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.

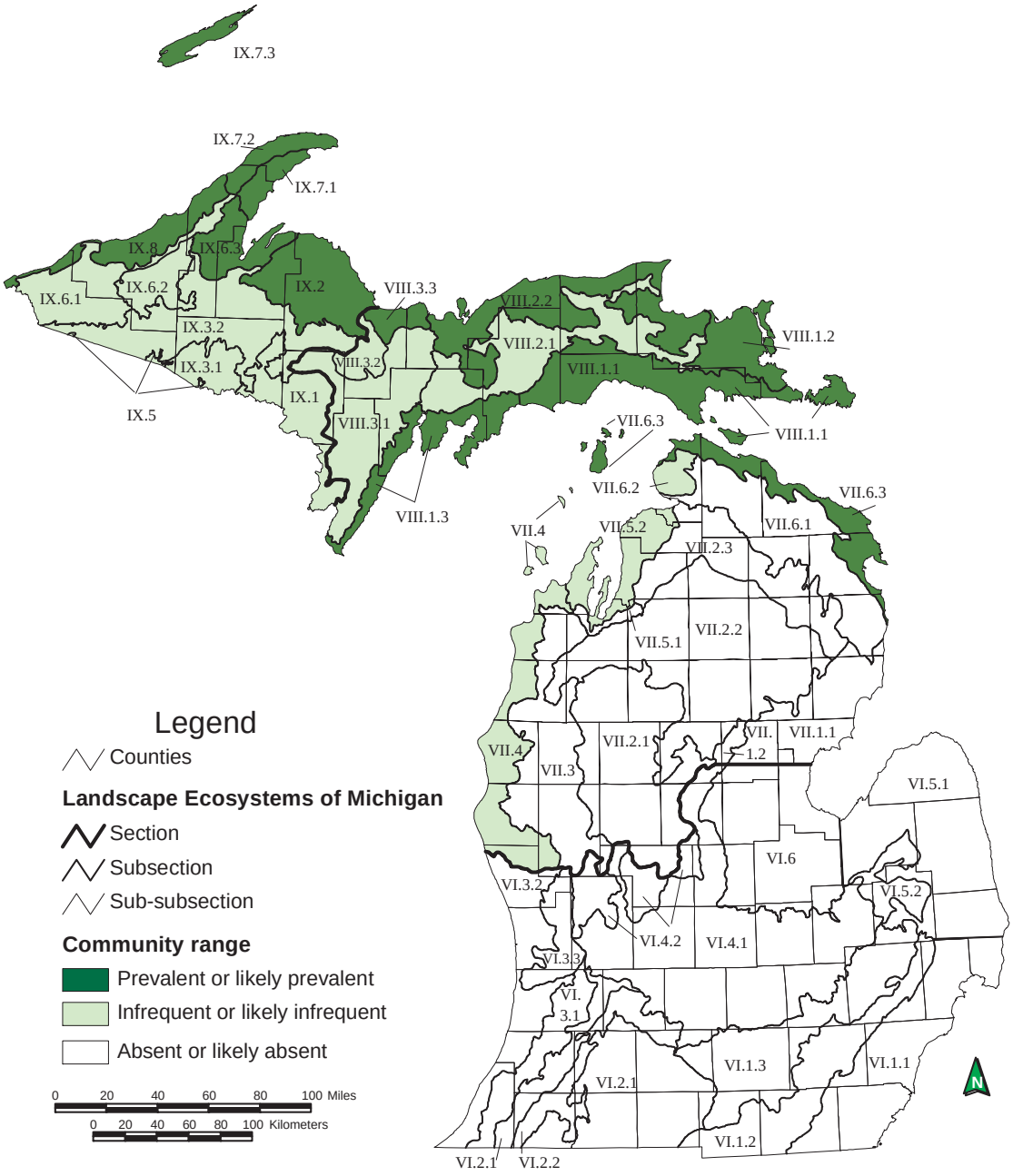
Fox Lake Bog. Photos by Joshua G. Cohen.



2014 aerial photograph of Fox 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. 2014).



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

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

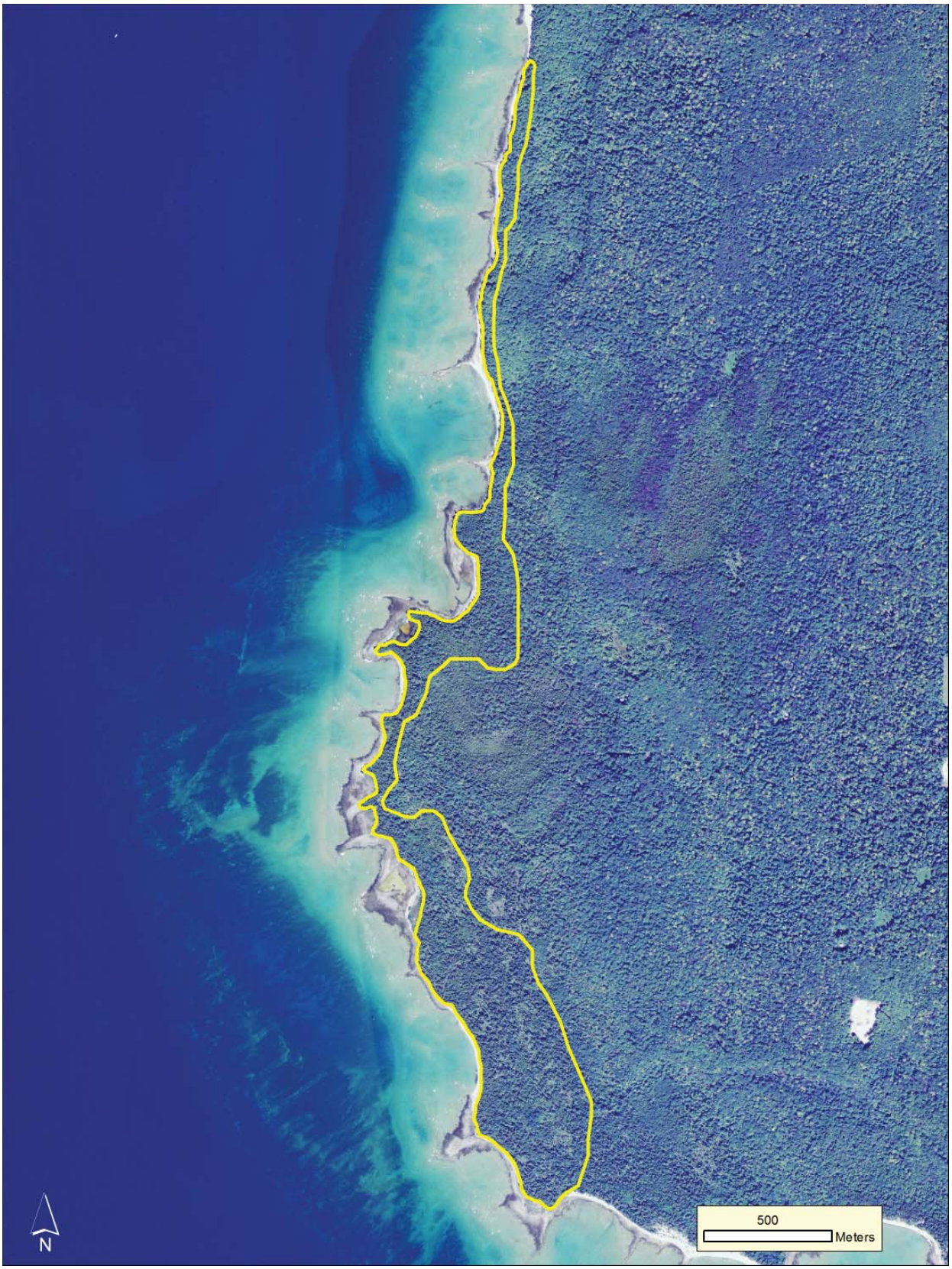
Site Description: Boreal forest occurs along the southwestern shoreline of Beaver Island. Adjacent shoreline communities include limestone cobble shore, sand and gravel beach, open dunes, and to a lesser extent Great Lakes marsh. Boreal forest is bordered along the inland side by hardwood-conifer swamp, 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 20-50 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.



2014 aerial photograph of French Bay boreal forest.

3. 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
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.

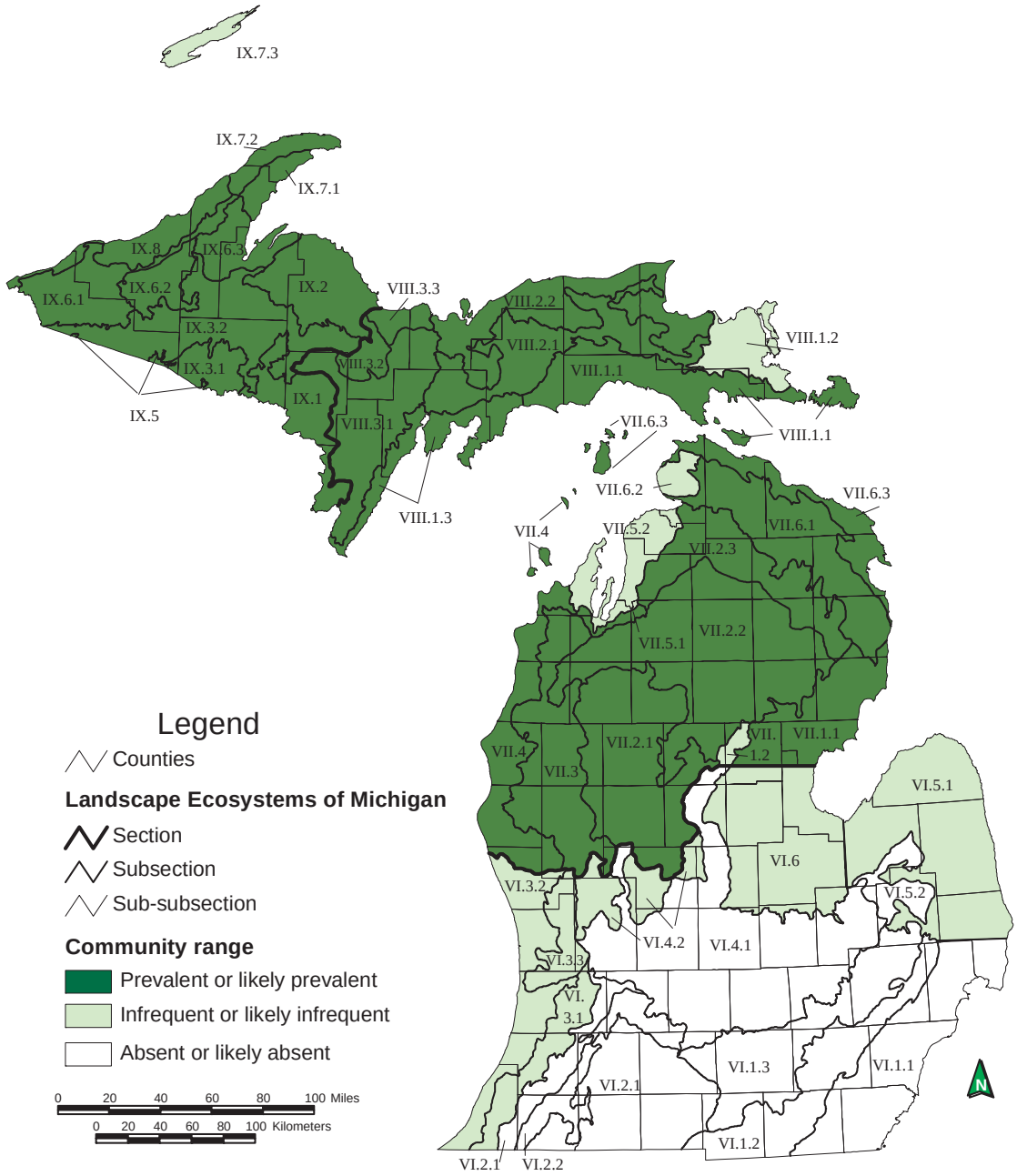
Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to retain an intact buffer of natural communities surrounding the boreal forest. Monitor for invasive species and deer browse pressure.

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

2014 aerial photograph of Little Sand Bay boreal forest.

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. 2014).



Map 3. Distribution of dry-mesic northern forest in Michigan (Albert et al. 2008).

4. 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
Element Occurrence Identification Number: 9259 (EO Update)

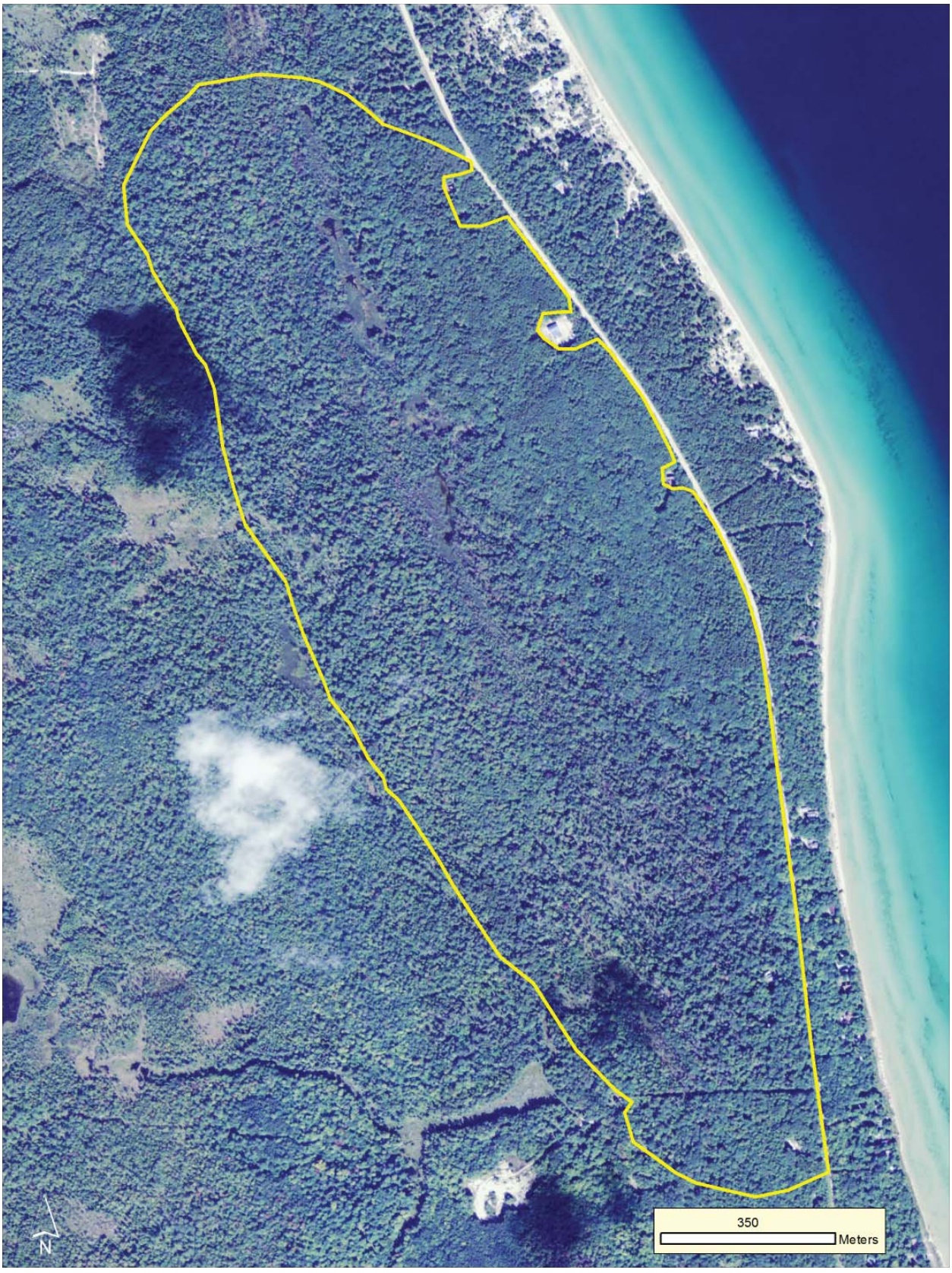
Site Description: This uneven-aged, dry-mesic northern forest occurs on dune and swale topography oriented from northwest to southeast with numerous wooded swales. The soils are fine-textured dune sands that are acidic on the dune ridges with a thick needle duff. A soil sample from the dune ridge was 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.

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 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 (*Thuja occidentalis*) 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 numerous swales, which occur 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.

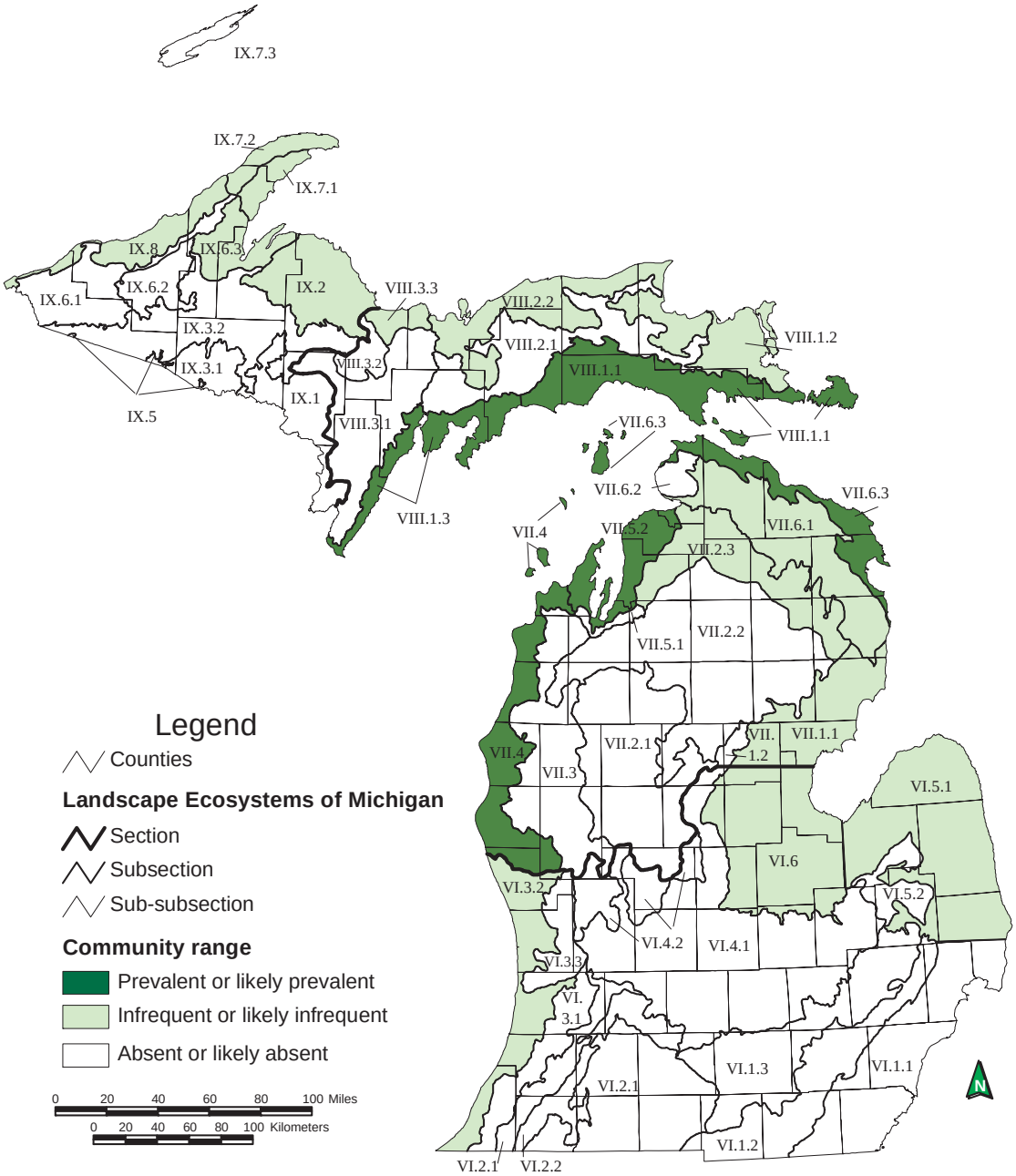
Pointe La Par dry-mesic northern forest. Photos by Joshua G. Cohen.



2014 aerial photograph of Pointe La Par dry-mesic northern forest.

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. 2014).



Map 4. Distribution of interdunal wetland in Michigan (Albert et al. 2008).

5. Little Sand Bay
Natural Community Type: Interdunal Wetland
Rank: G2? S2, imperiled throughout range
Element Occurrence Rank: BC
Size: 17 acres
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*).

Threats: The interdunal wetlands are 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.

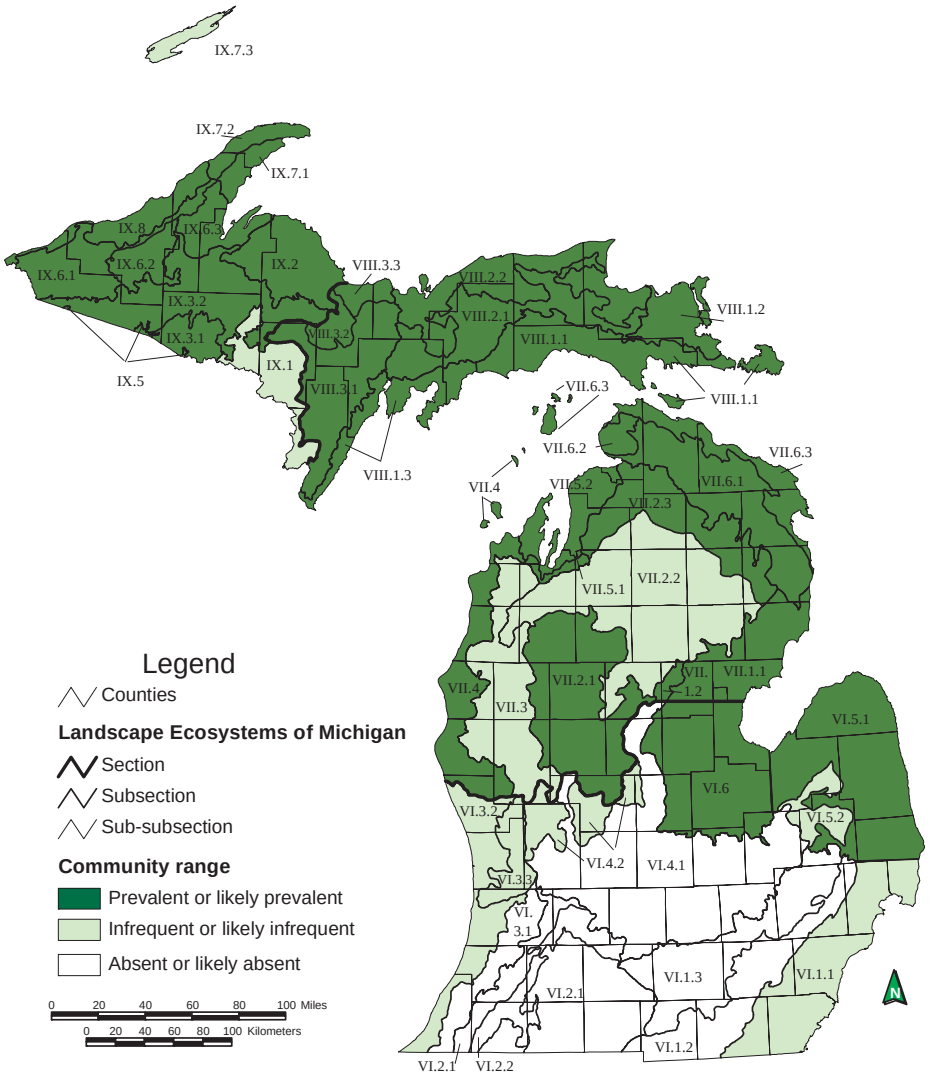
Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to monitor for invasive plants along the shoreline.

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

2014 aerial photograph of Little Sand Bay interdunal wetland.

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. 2014).



Map 5. Distribution of mesic northern forest in Michigan (Albert et al. 2008).

6. 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
Element Occurrence Identification Number: 626 (EO Update)

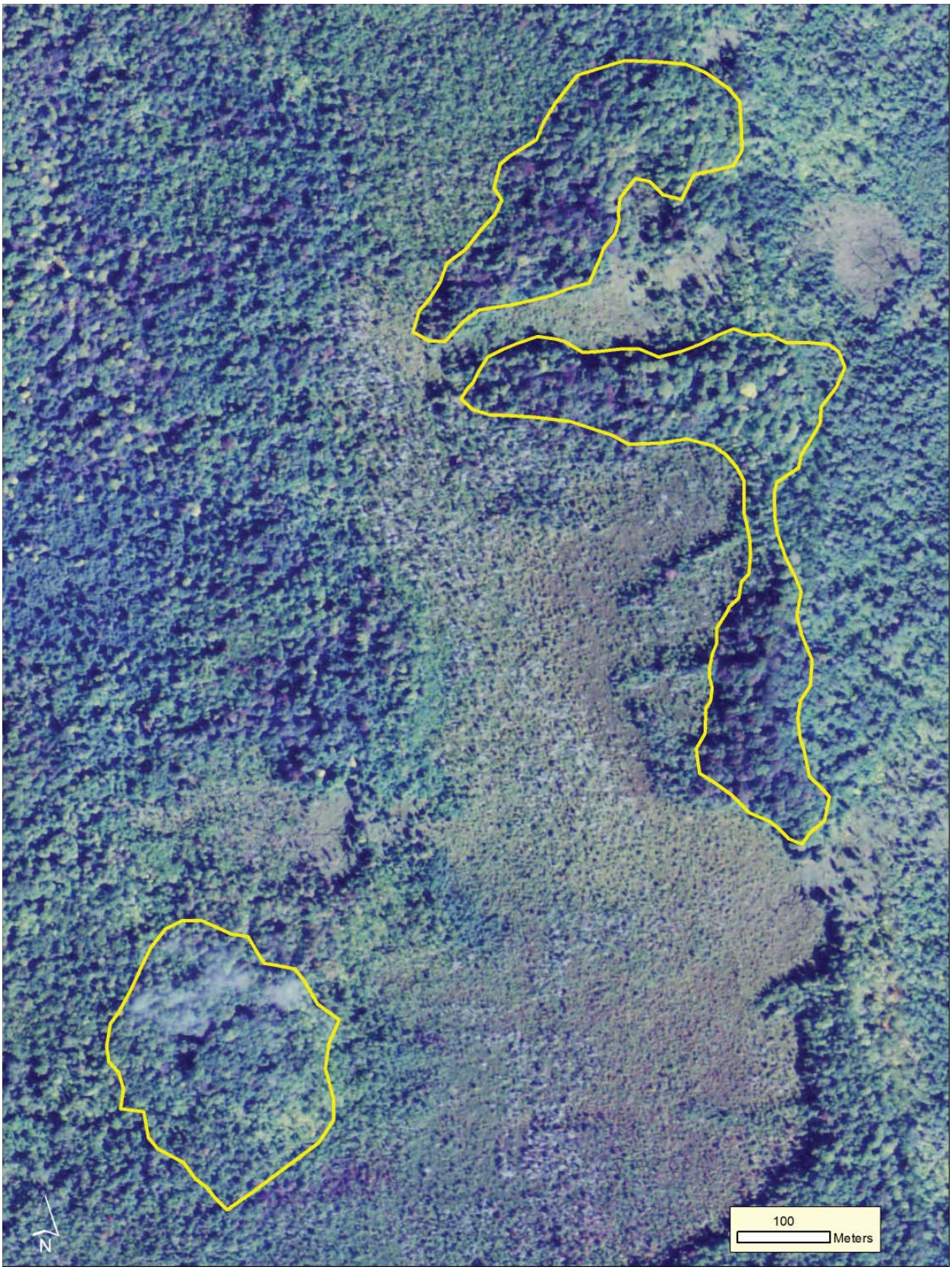
Site Description: Three small islands of uneven-aged, old-growth mesic northern forest occur on rolling ground moraine with fine- to medium-textured loamy sands that range from acidic to alkaline. The site is characterized by well-developed pit and mound topography but only moderate levels of coarse 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. American 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.



2014 aerial photograph of Martin's Bluff mesic northern forest.

7. 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
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 (5cm 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.

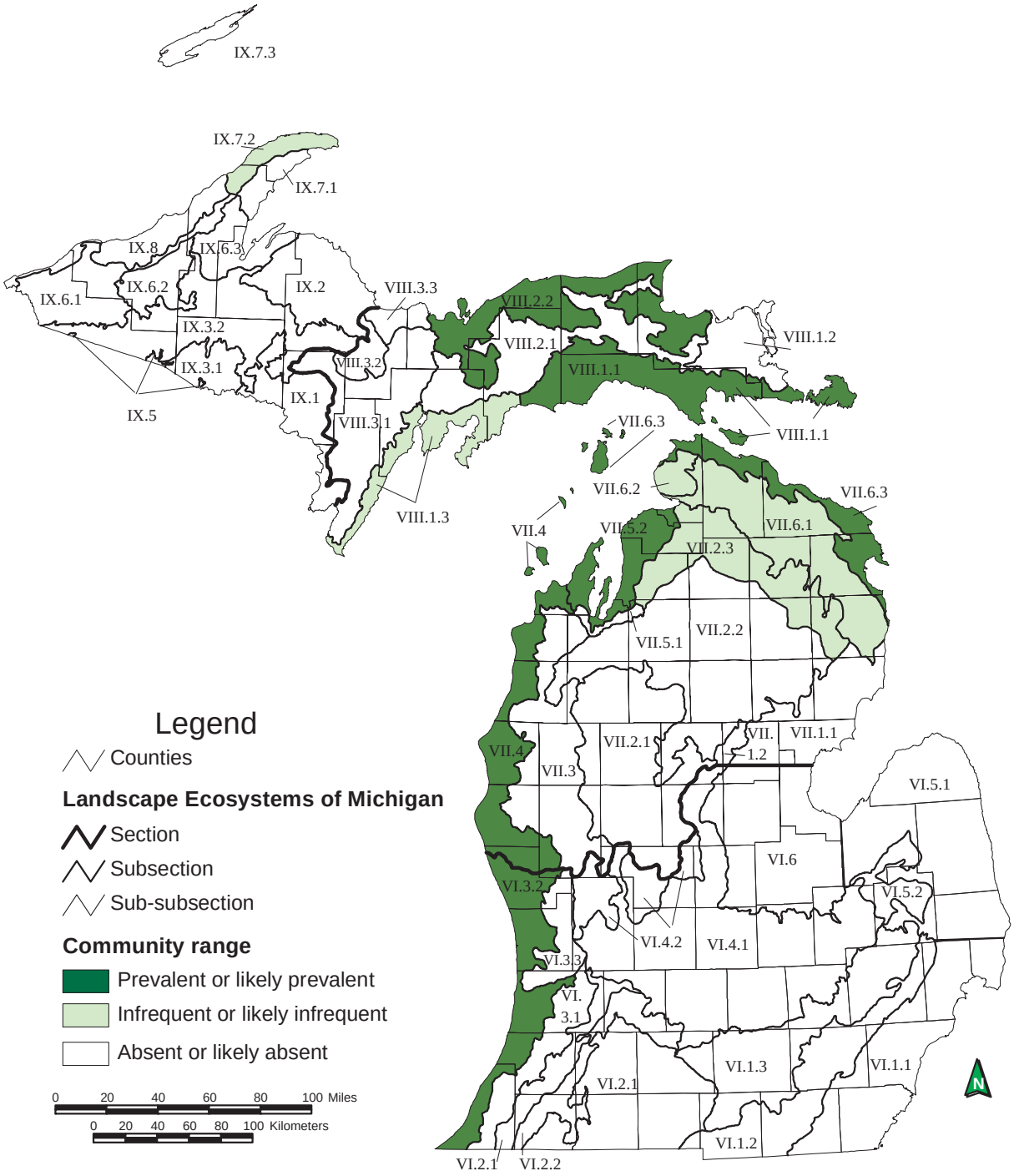
Southwest Old Growth mesic northern forest. Photo by Joshua G. Cohen.

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

2014 aerial photograph of Southwest Old Growth mesic northern forest.

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. 2014).



Map 6. Distribution of open dunes in Michigan (Albert et al. 2008).

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

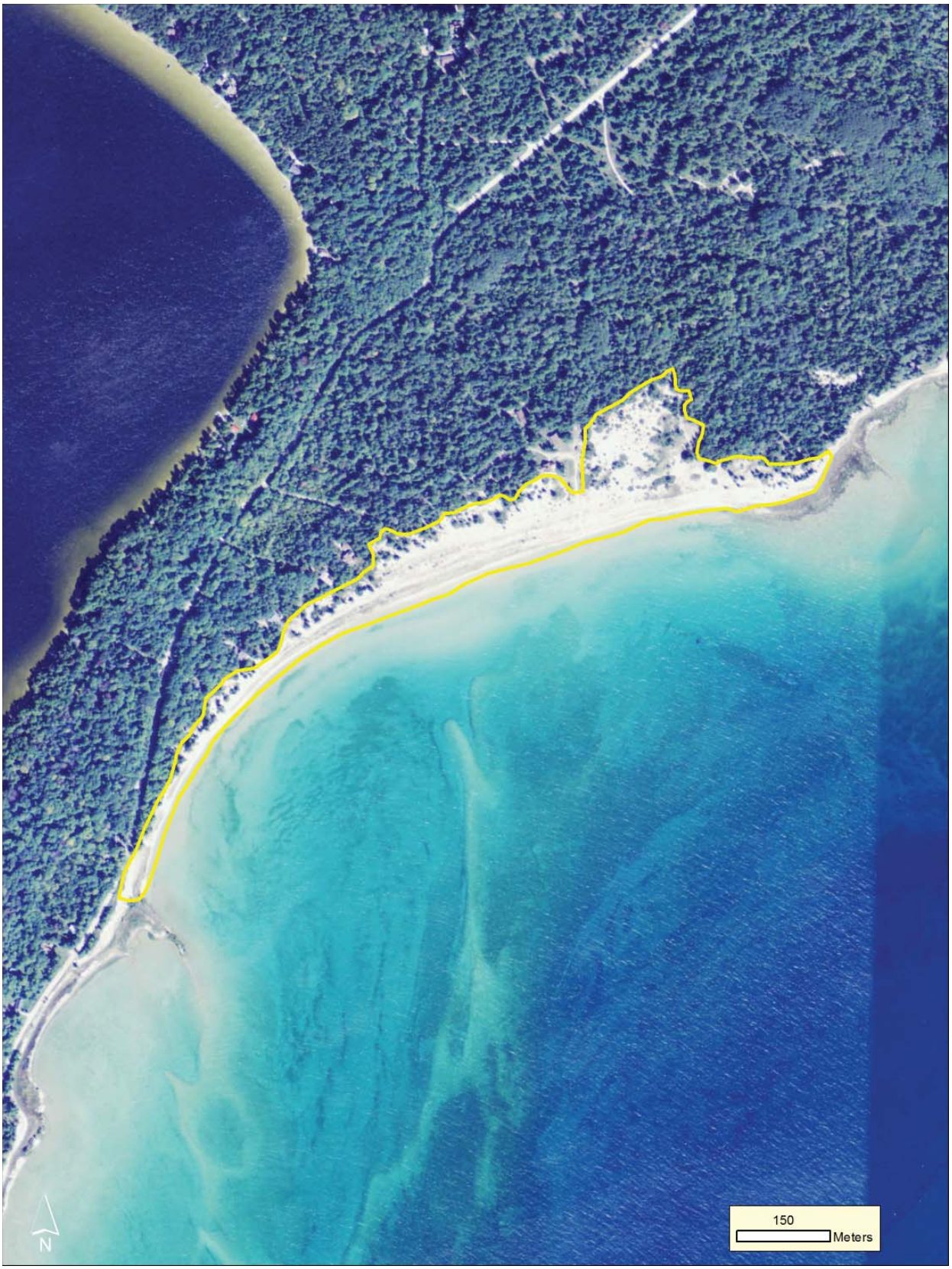
Site Description: This site is characterized by low parabolic dunes and a low foredune that occurs along the southeastern shore of Beaver Island. The soils are fine-textured, wind-blown and wave-worked, alkaline (pH 8.0) sands. The parabolic dunes and associated blowout are found in the northeastern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



2014 aerial photograph of Cable Bay open dunes.

9. McCauley Point
Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 30 acres
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 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 (*Juniperus 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).

2014 aerial photograph of MacCauley Point open dunes.

10. McFadden Point
Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 102 acres
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 maculosa*) 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.

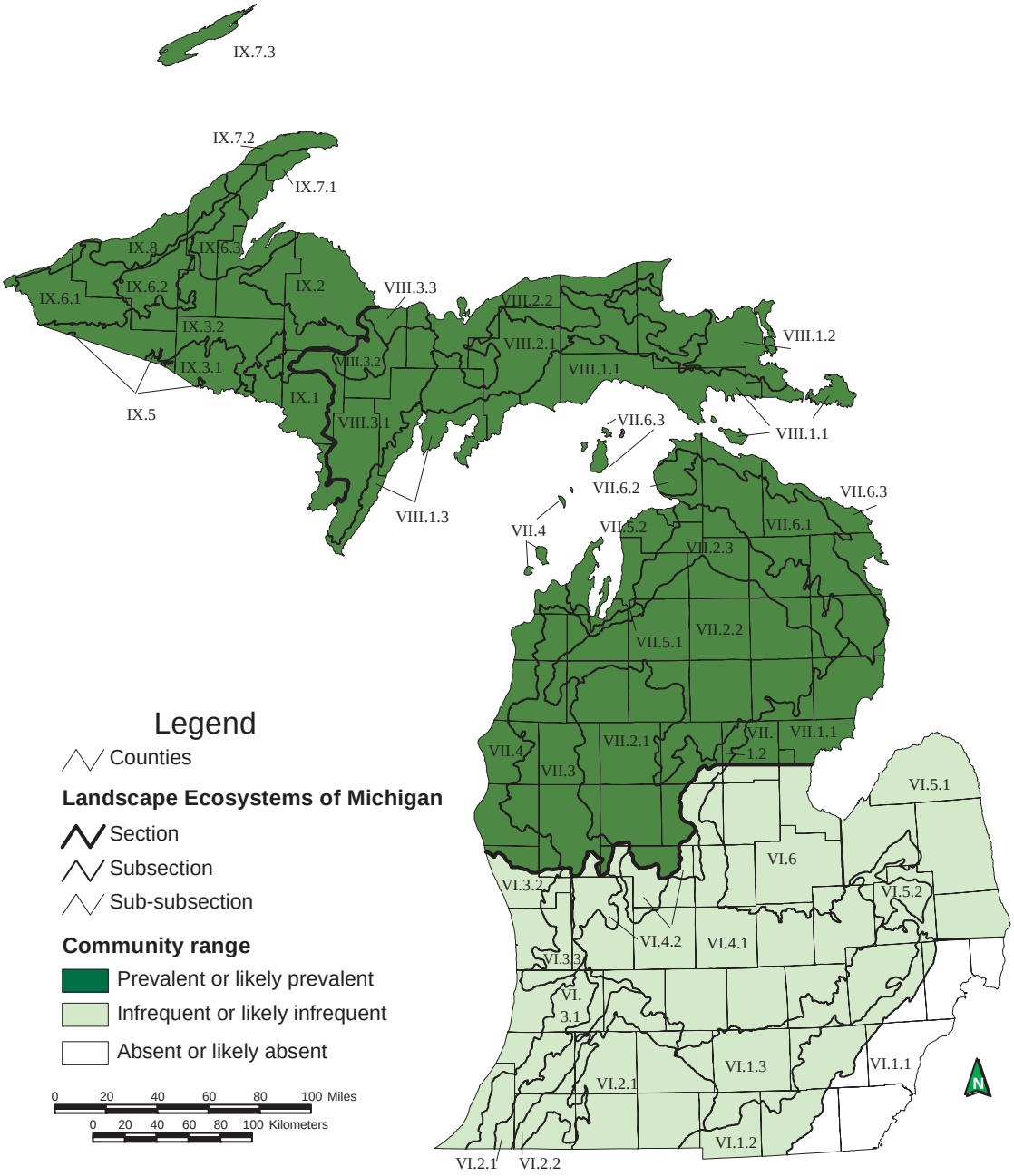
McFadden Point open dunes. Photos by Joshua G. Cohen.

McFadden Point open dunes. Photos by Bill Parsons.

2014 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. 2014).



Map 7. Distribution of poor conifer swamp in Michigan (Albert et al. 2008).

10. 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
Element Occurrence Identification Number: 20688 (New EO)

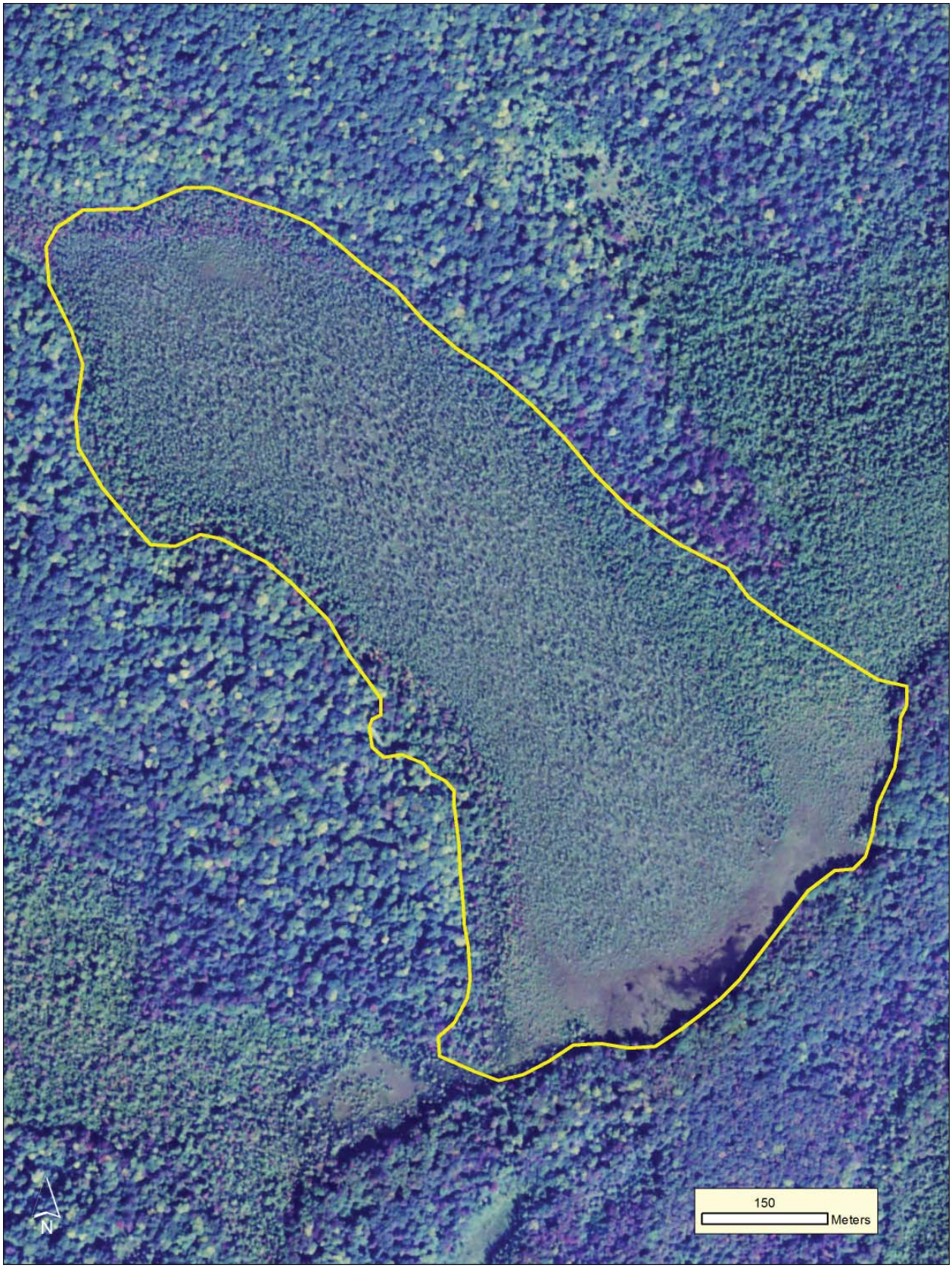
Site Description: This poor conifer swamp is part of large peatland complex associated with Greene's Lake. Poor conifer swamp, rich conifer swamp, and bog occupy a former lake basin associated with Greene's Lake. This peatland formed through lake filling or terrestrialization. The bog occurs just south 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 and to retain an intact buffer of natural communities surrounding the poor conifer swamp. Monitor for invasive species.

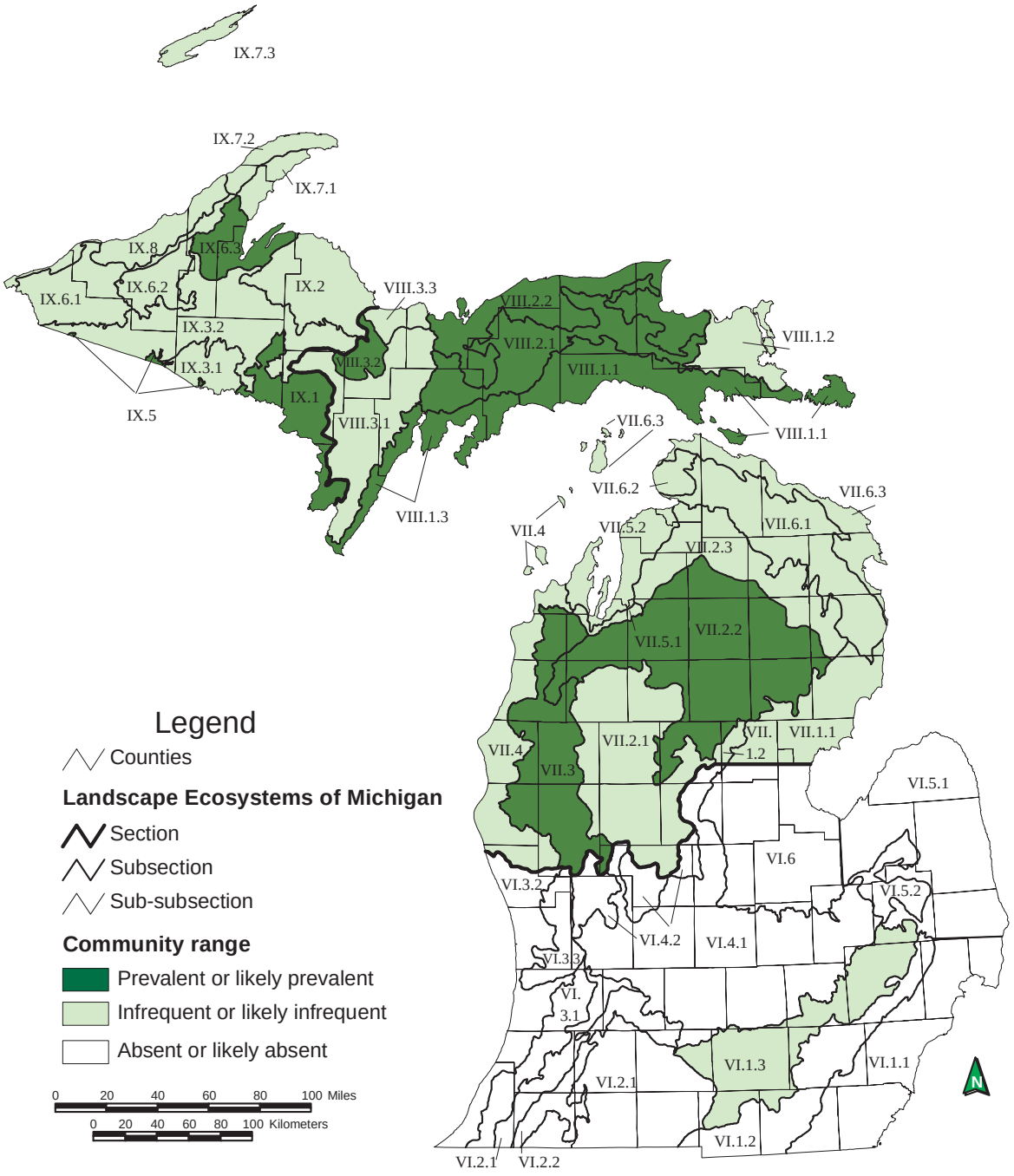
Greene’s Lake Swamp poor conifer swamp. Photos by Bill Parsons (above) and Joshua G. Cohen (below).



2014 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. 2014).



Map 8. Distribution of poor fen in Michigan (Albert et al. 2008).

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

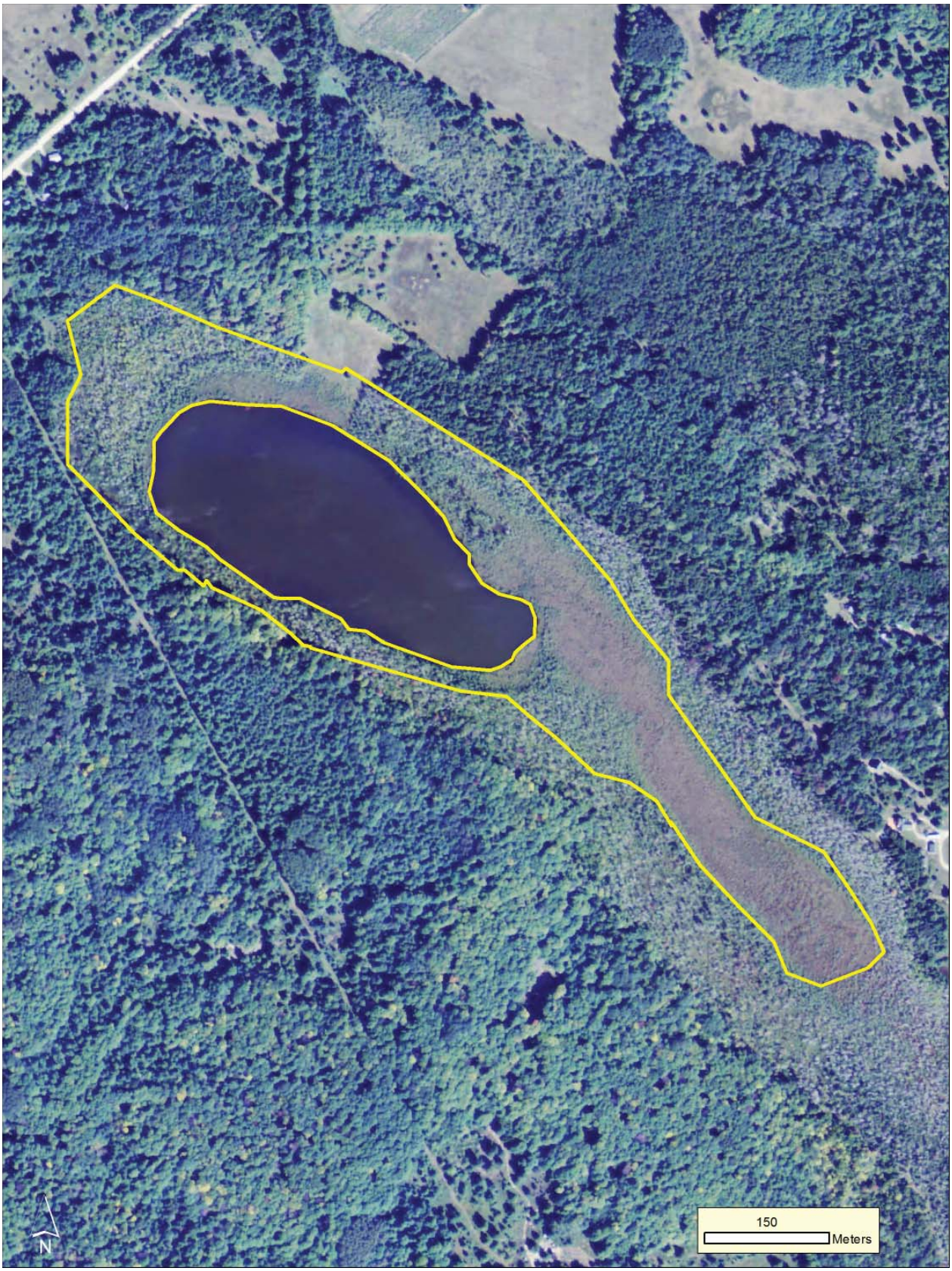
Site Description: This open peatland system occurs on a poorly drained flat lakeplain with saturated and inundated sphagnum and sedge peats that range from weakly minerotrophic to ombrotrophic. Groundwater influence creates weakly minerotrophic conditions along the peatland margin. A peat sample from the minerotrophic peatland margin was > 1 meter 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 being 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 high floristic diversity (over 60 species were noted during the 2006 survey) and complex ecological zonation.

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.

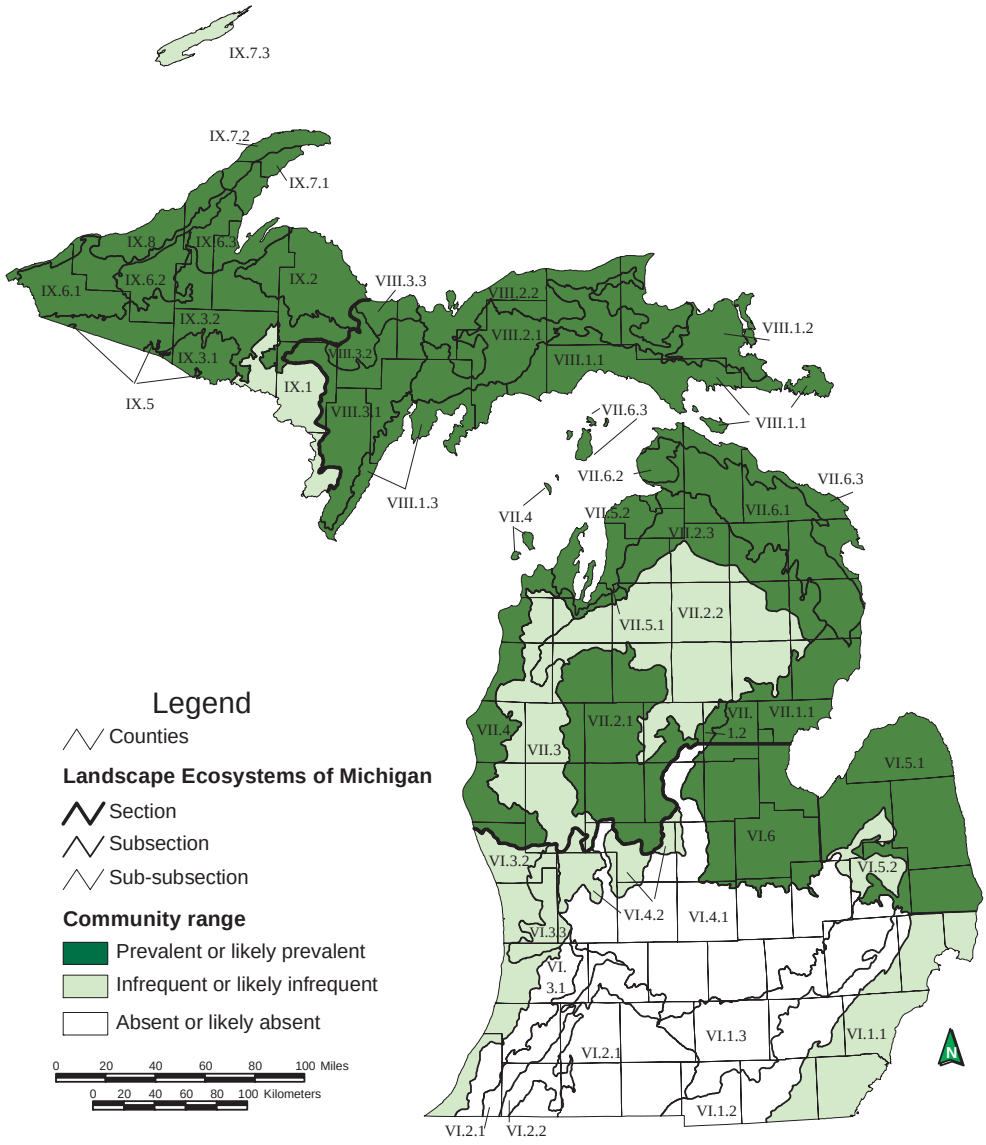
Egg Lake poor fen. Photos by Joshua G. Cohen.



2014 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. 2014).



Map 9. Distribution of rich conifer swamp in Michigan (Albert et al. 2008).

12. Doty's Swamp
Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 82 acres
Element Occurrence Identification Number: 20690 (New EO)

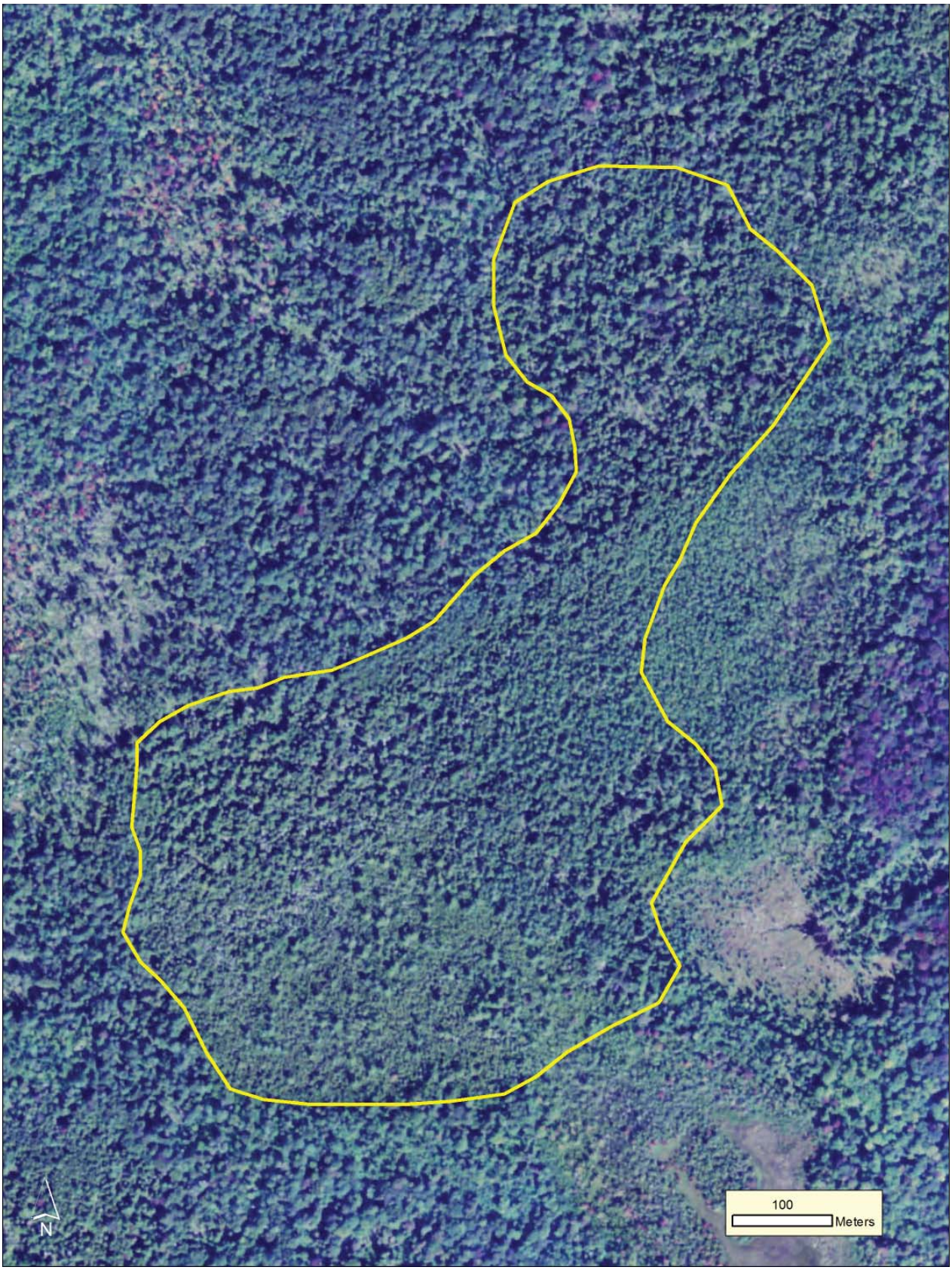
Site Description: Rich conifer swamp is part of large swamp complex northwest of Lake Geneserath. This young swamp likely established following a wildfire. Charcoal was observed within the soil profile. A 30.1 cm northern white-cedar (*Thuja occidentalis*) was cored and estimated to be 108 years old. The soils of the rich conifer swamp are shallow (10-30 cm), slightly acidic (pH 6.5) hemic to sapric peats over wet, medium-textured sands that are slighty acidic to circumneutral (pH 6.8-7.0). Sphagnum hummock and hollow microtopography is developing locally. Windthrow is prevalent throughout the swamp with numerous areas of heavy blowdown.

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*), 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 (*Fraxinus nigra*). 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*), 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 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. 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 and to retain an intact buffer of natural communities surrounding the swamp. Reducing local deer densities in the surrounding landscape would help reduce deer browse pressure. Monitor for invasive species and deer browse.

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



2014 aerial photograph of Doty's Swamp rich conifer swamp.

13. 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: 93 acres
Element Occurrence Identification Number: 20689 (New EO)

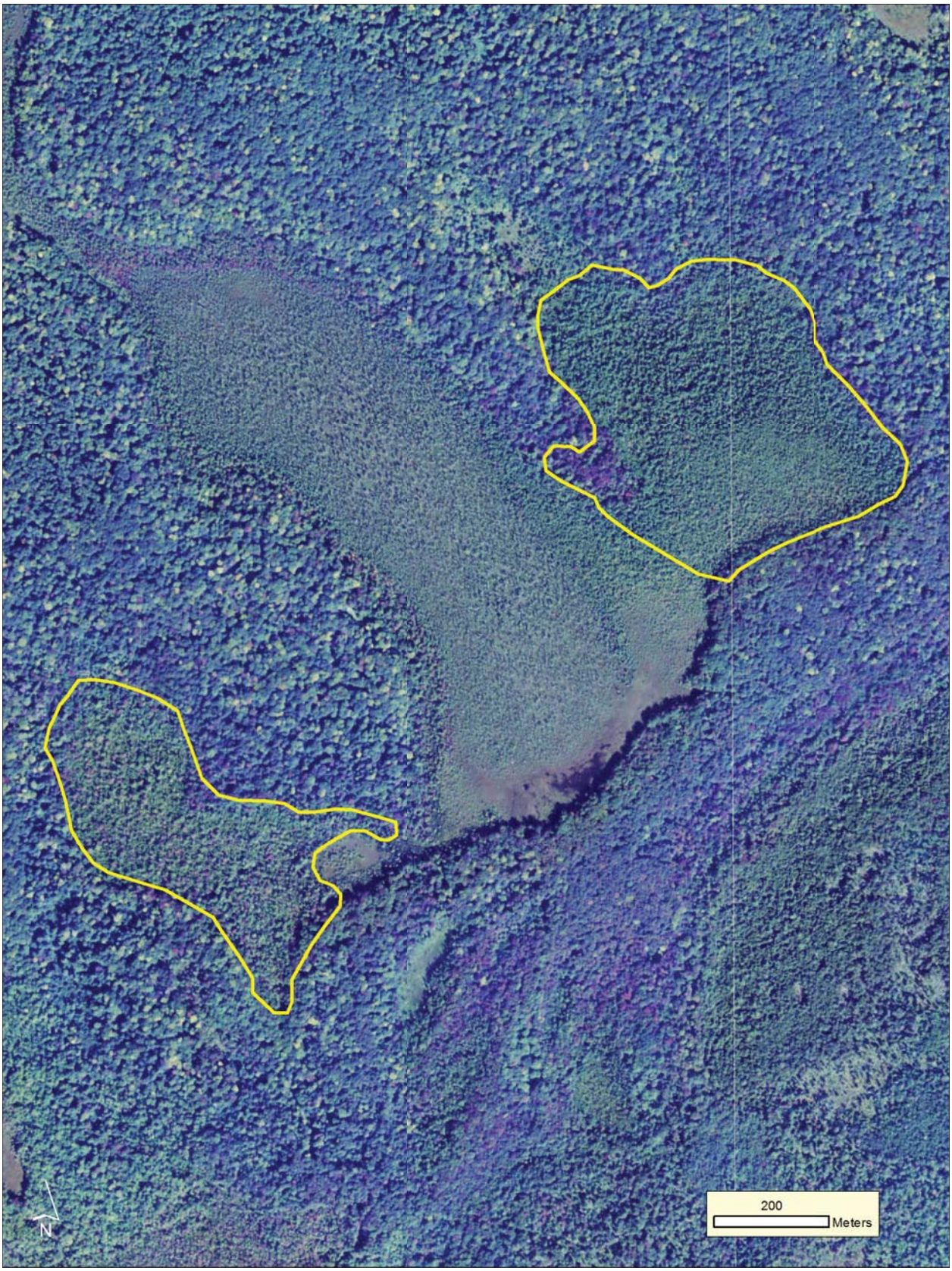
Site Description: This rich conifer swamp is part of large peatland complex associated with Greene's Lake. Rich conifer swamp, poor conifer swamp, and bog occupy the former lake basin associated with Greene's Lake. This peatland formed through lake filling or terrestrialization. The nearby bog occurs just south of Greene's Lake and transitions to poor conifer swamp in the central lobe of basin. The two lobes flanking this central lobe are minerotrophic and dominated by this 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 and a 16.5 cm northern white-cedar was cored and estimated to be 159 years old. 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 characterized as deep (> 1 meter), slightly acidic to circumneutral (pH 6.8-7.0) peat.

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*), and black spruce (*Picea mariana*). Canopy trees typically range in DBH from 10 to 30 cm with canopy closure ranging from 50 to 85%. Characteristic understory species include scattered (10-30%) sapling balsam fir (*Abies balsamea*) and black ash with winterberry (*Ilex verticillata*) occurring locally. Common species in the low shrub layer include alder-leaved buckthorn (*Rhamnus alnifolia*) and Labrador tea (*Rhododendron groenlandicum*) with balsam fir and black ash. Characteristic ground cover species include sedges (*Carex trisperma, C. disperma*, and *C. stricta*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), dwarf raspberry (*Rubus pubescens*), bunchberry (*Cornus canadensis*), 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*), Jack-in-the-pulpit (*Arisaema triphyllum*), gay-wings (*Polygala paucifolia*), and bulblet fern (*Cystopteris bulbifera*). 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 and to retain an intact buffer of natural communities surrounding the swamp. Reducing local deer densities throughout the landscape would help reduce deer browse pressure. Monitor for invasive species and deer browse.

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



2014 aerial photograph of Greene's Lake Swamp rich conifer swamp.

14. 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
Element Occurrence Identification Number: 20692 (New EO)

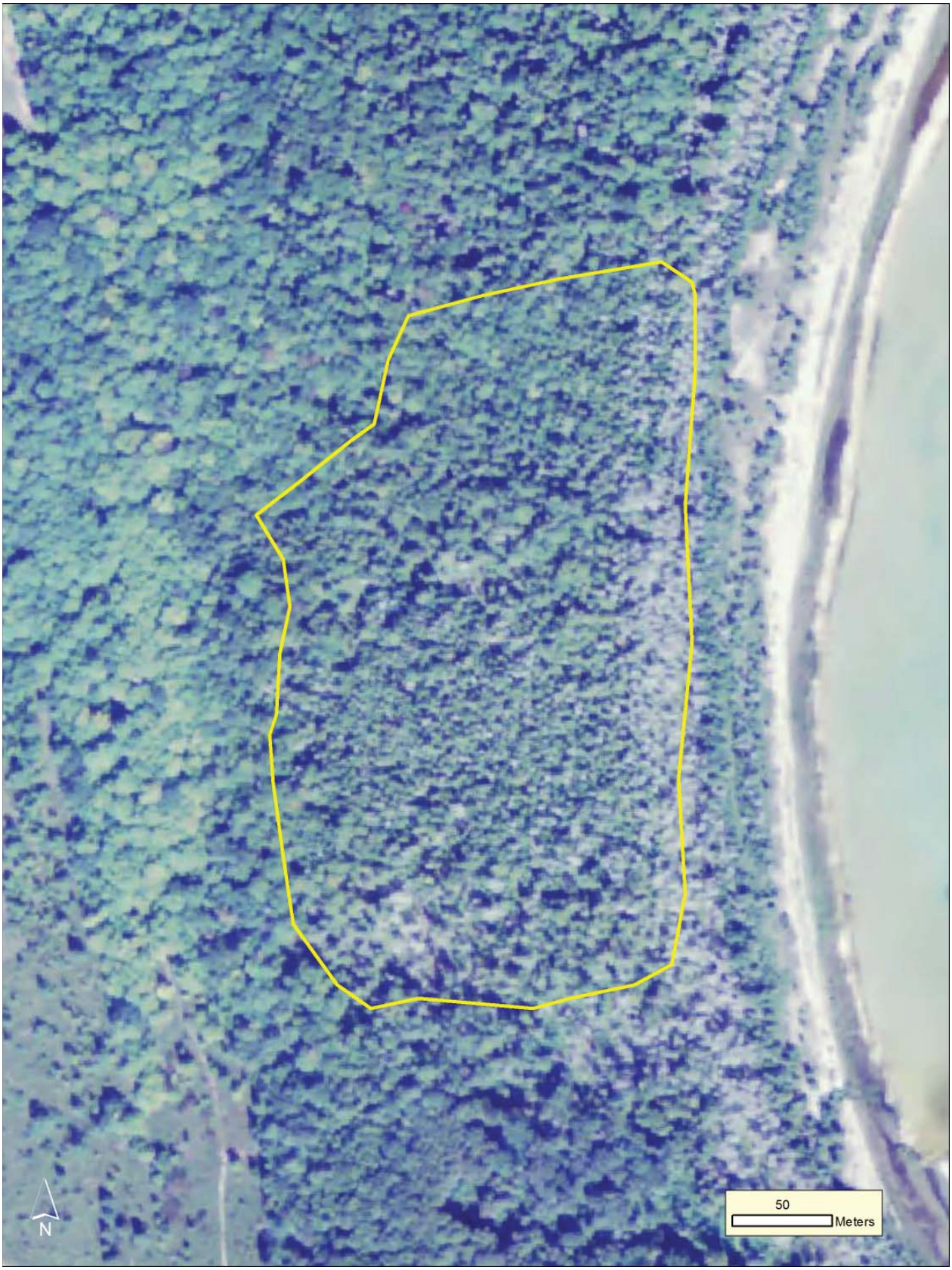
Site Description: This rich conifer swamp occurs along with boreal forest along the northeastern shoreline of Beaver Island adjacent to Little Sand Bay. The rich conifer swamp occurs inland from a sandy bay that supports interdunal wetland and a low foredune with open dunes vegetation. To the north of 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 mapping this rich conifer swamp and the adjacent boreal forest precisely 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 and to retain an intact buffer of natural communities surrounding the swamp. Reducing local deer densities throughout the landscape would help reduce deer browse pressure. Monitor for invasive species and deer browse.

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



2014 aerial photograph of Little Sand Bay rich conifer swamp.

STEWARDSHIP PRIORITIZATION RESULTS

The stewardship scores for each natural community element occurrence are presented in Table 2 and Figure 2. We sorted the element occurrences by their stewardship prioritization scores and assigned them a high (red), medium (yellow), or low (blue) stewardship priority. During the course of the 2016 surveys, 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 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 2. 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 Growht	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

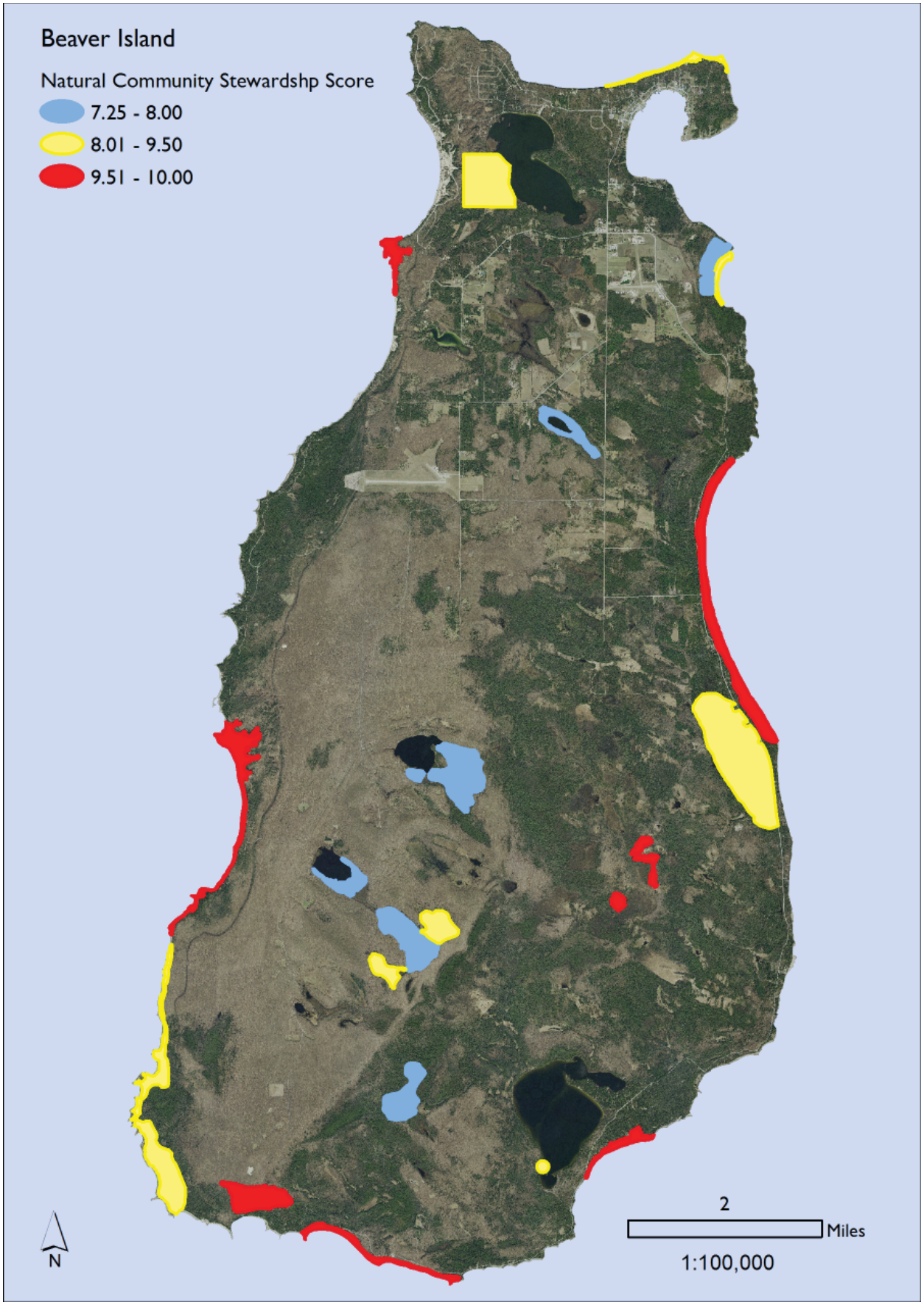


Figure 2. Stewardship prioritization for natural community element occurrences on Beaver Island. Element occurrences are displayed by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

Control of invasive species in open dune ecosystems and 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.

DISCUSSION

This report provides site-based assessments of 15 natural community element occurrences within Beaver Island that occur on state land. 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 the island 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 on the island. 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 the entire Beaver Island Archipelago. 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.

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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.