Natural Community Surveys of Garden and High Islands

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For:
Little Traverse Bay Bands of Odawa Indians
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Cover Photo: Coastal Fen, Monatou Bay, Garden Island. Photo by Joshua G. Cohen.

INTRODUCTION

The Michigan Natural Features Inventory (MNFI) database of high-quality occurrences of natural communities is a critical source of information on Michigan's terrestrial ecosystems (MNFI 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, 12 high-quality occurrences of natural communities had been documented on Garden and High Islands. These natural community occurrences represent eight of the 77 natural community types described for Michigan by Cohen et al. (2014). Among these 12 natural community occurrences, four are represented by natural communities that are considered critically imperiled or imperiled at the global scale, including high-quality occurrences of coastal fen and Great Lakes marsh (NatureServe 2010).

Prior to this project, many of the natural community occurrences on these islands had not been surveyed in close to two decades, including six sites that had not been visited since 1986 or earlier. 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 their mapped boundaries. In addition, air photo interpretation of high-resolution imagery identified the potential for new occurrences of natural communities throughout both islands. A critical goal of this project was to collect updated and new data for natural communities to provide natural resource managers with accurate, detailed information on the current status of ecosystems on these islands that can help guide biodiversity management and restoration and ongoing planning efforts. Our project objectives were to assist resource agencies with land use planning and resource management by (1) updating known high-quality occurrences of natural communities on Garden and High Islands, (2) conducting surveys for new occurrences of natural communities on Garden and High Islands, (3) synthesizing survey results and information in MNFI's conservation database, and (4) proposing biodiversity stewardship and monitoring priorities on Garden and High Islands.

Surveys were conducted during the 2015 field season. MNFI conducted surveys of ten previously known element occurrences and documented seven new natural community element occurrences. Ten different natural community types are represented in the 17 element occurrences surveyed (Table 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 Garden and High Islands.

Table 1. Summary of natural community surveys.

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

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

METHODS

Field Survey Prioritization

Sites for survey were prioritized by evaluating their date since last survey (with higher priority for older records), state and global ranking (with higher priority for rarer natural communities), and element occurrence ranking (with higher priority for higher quality sites). Targets for de novo survey were identified using aerial photographic interpretation focusing on rare ecosystems, 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 17 high-quality natural communities were surveyed in 2015 on Garden and High Islands (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 2015 growing season to evaluate the condition and classification of the sites. To assess natural community size and landscape context, a combination of field surveys, aerial photographic interpretation, and Geographic Information System (GIS) analysis was employed. Typically, a minimum of a half day was dedicated to each site, depending on the size and complexity of the site.

The ecological field surveys involved:

a) compiling comprehensive plant species lists and noting dominant and representative species

b) describing site-specific structural attributes and ecological processes

c) measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants (where appropriate)

d) analyzing soils and hydrology

e) noting current and historical anthropogenic disturbances

f) evaluating potential threats

g) ground-truthing aerial photographic interpretation using GPS (Garmin units were 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 or evaluating past and current restoration activities and noting additional management needs and restoration opportunities

Following completion of the field surveys, the collected data were analyzed and transcribed to update or create element occurrence records in MNFI's statewide biodiversity conservation database (MNFI 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

Following the 2015 field season, we conducted an intersection of the natural community element occurrences and the coastal zone as defined by Department of Environmental Quality. A total of 645 natural community element occurrences are found within the coastal zone as of December 2015. We developed a scoring matrix for all of these 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. Since 2006, MNFI scientists have surveyed or resurveyed 409 natural community element occurrences in the coastal zone, constituting 63% of the total number of occurrences. These surveys included threat assessments that were used to inform the assigning of threat severity scores for individual sites and for inferring the likely threat to sites not recently surveyed by community type and region. For each natural community element occurrence, 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 Garden and High Islands is presented in the Stewardship Prioritization Results section.

High water inundating limestone cobble shore, High Island. Photo by Joshua G. Cohen.

RESULTS

Survey Results

Seventeen occurrences of high-quality natural communities were surveyed during the 2015 field season with nine sites occurring on Garden Island and eight sites occurring on High Island. A total of 10 different natural community types were visited including: boreal forest (2 element occurrences or EOs), coastal fen (3 EOs), dry-mesic northern forest (1 EO), Great Lakes barrens (1 EO), Great Lakes marsh (1 EO), limestone cobble shore (3 EOs), mesic northern forest (2 EOs), open dunes (1 EO), sand and gravel beach (2 EOs), and wooded dune and swale complex (1 EO). Table 1 lists the visited sites, their element occurrence ranks, and their previous element occurrence ranks if applicable. Two previously documented sites, Indian Harbor Great Lakes marsh (EO ID 13020) and Garden Island Harbor northern wet meadow (EO ID 11804), were not re-visited due to time constraints. Of the 12 natural community element occurrences on Garden and High Islands, these two sites were determined to be the lowest priority for resurvey since they had been surveyed prior to this project most recently (in 1999). As a result, 10 of the 12 previously documented natural community element occurrences were surveyed in 2015 and seven new natural community element occurrences were documented.

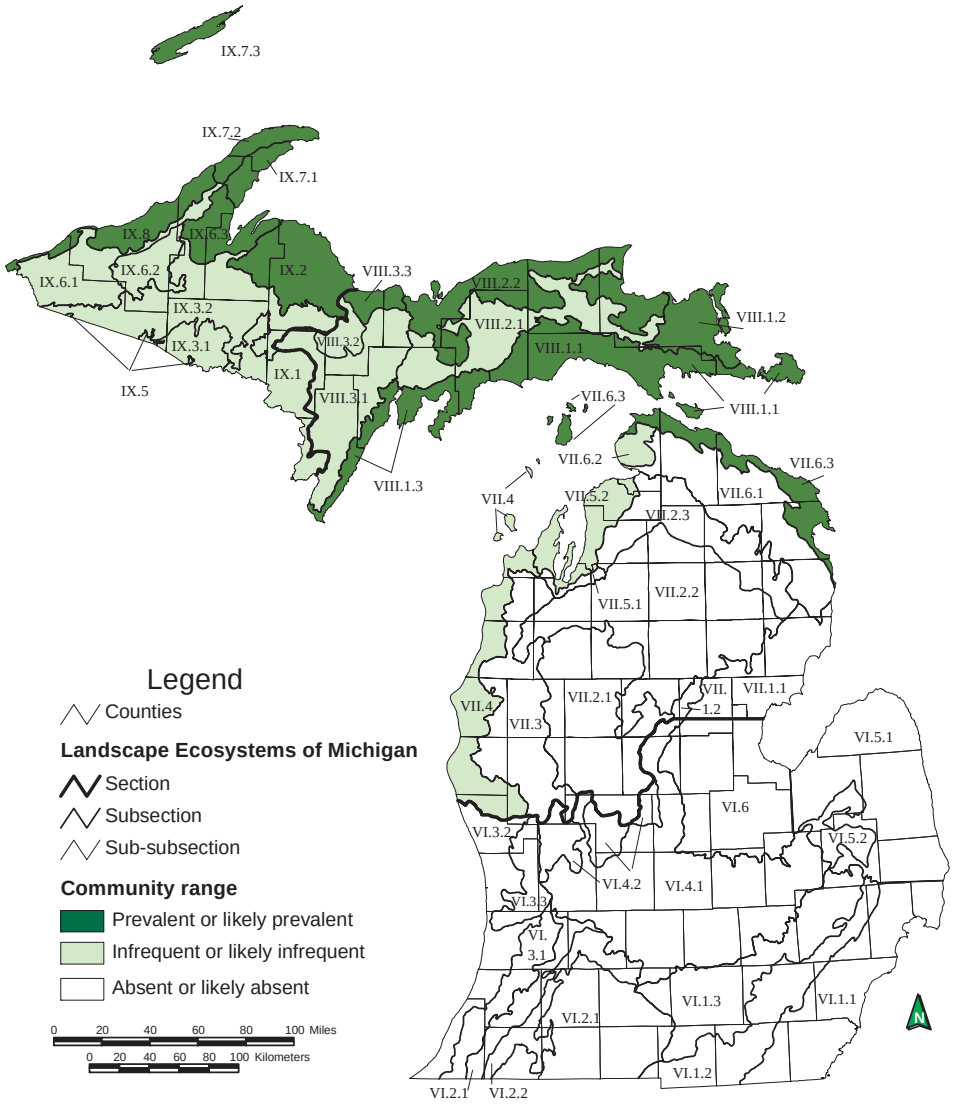
The following site summaries summarize threats and management recommendations for each of the 17 natural community EOs visited in 2015 organized alphabetically by community type and then by element occurrence. Each grouping of communities begins with an overview of the natural community type, which was 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) locational information
g) digital photograph(s)
h) site description
i) threat assessment
j) management recommendations

SITE SUMMARIES

BOREAL FOREST

Overview: Boreal forest is a conifer or conifer-hardwood forest type occurring on moist to dry sites characterized by species dominant in the Canadian boreal forest. It typically occupies upland sites along shores of the Great Lakes, on islands in the Great Lakes, and locally inland. The community occurs north of the climatic tension zone primarily on sand dunes, glacial lakeplains, and thin soil over bedrock or cobble. Soils of sand and sandy loam are typically moderately acid to neutral, but heavier soils and more acid conditions are common. Proximity to the Great Lakes results in high levels of windthrow and climatic conditions characterized by low summer temperatures and high levels of humidity, snowfall, and summer fog and mist. Additional important forms of natural disturbance include fire and insect epidemics (Kost et al. 2007, Cohen et al. 2014).



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

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

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

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

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

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

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

Aerial Photograph of Garden Island Boreal Forest.

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

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

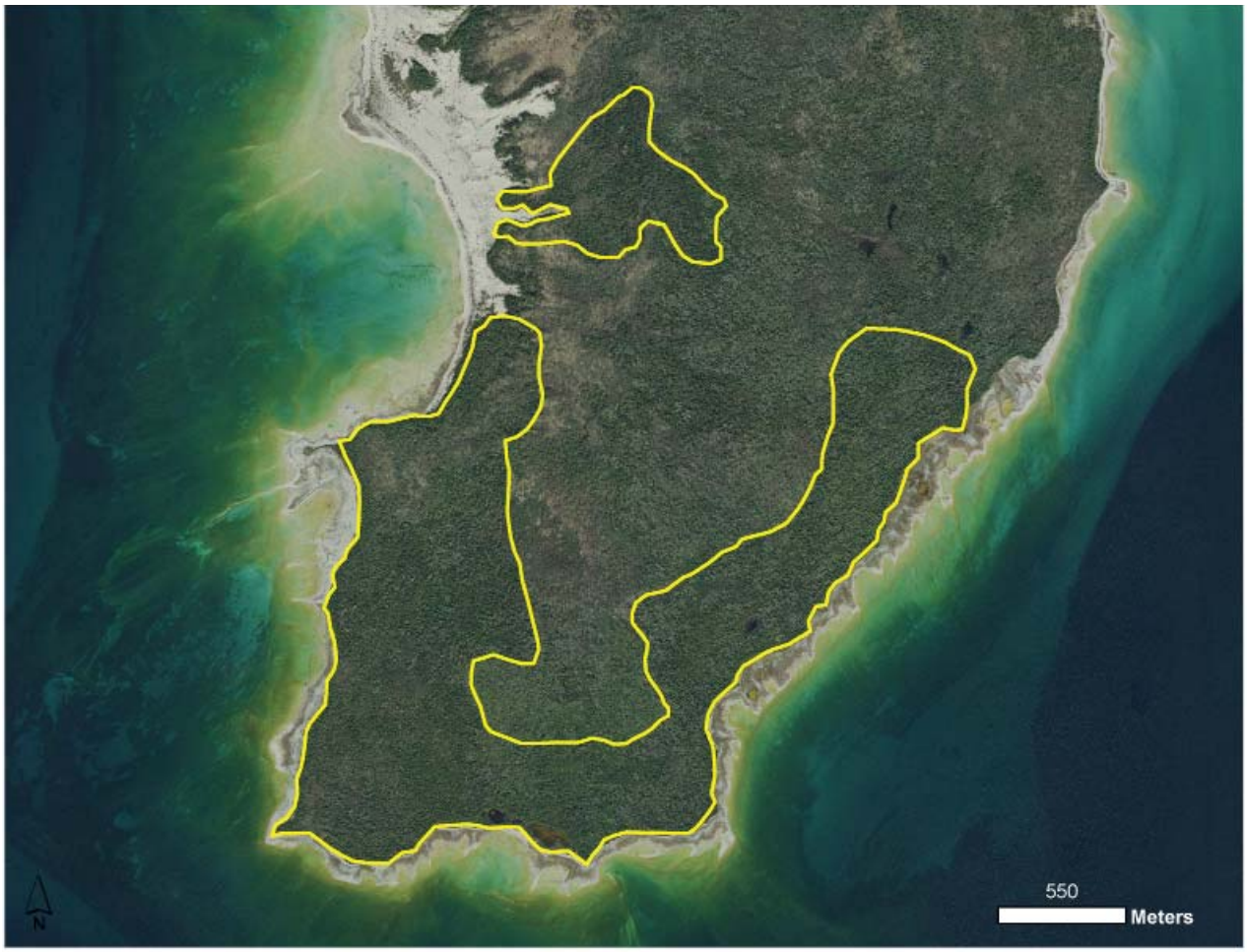
Site Description: The High Island boreal forest is composed of two polygons occurring along the southern portion and central-western portion of High Island. Surveys in 2015 expanded the existing element occurrence. The southern polygon of boreal forest occurs inland from limestone cobble shore on former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

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

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

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

The High Island boreal forest is characterized by dense understory yew (*Taxus canadensis*). Photo by Joshua G. Cohen.

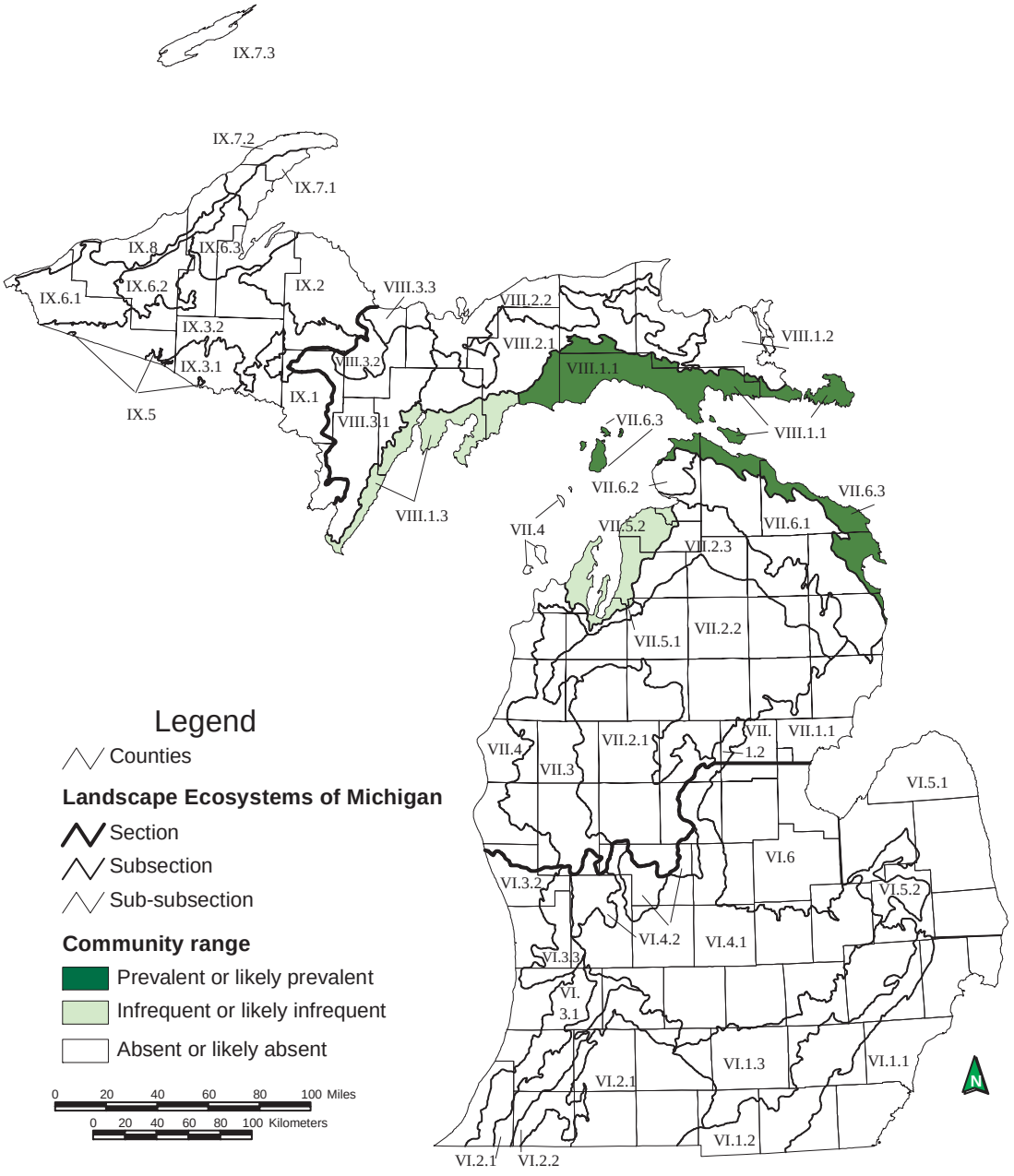


Aerial Photograph of High Island boreal forest.

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

COASTAL FEN

Overview: Coastal fen is a sedge- and rush-dominated wetland that occurs on calcareous substrates along Lake Huron and Lake Michigan north of the climatic tension zone. The community occurs where marl and organic soils accumulate in protected coves and abandoned coastal embayments and grade to moderately alkaline glacial tills and lacustrine sediments lakeward. Sediments along the lakeshore are typically fine-textured and rich in calcium and magnesium carbonates. Vegetation is comprised primarily of calcicolous species capable of growing on wet alkaline substrates (Kost et al. 2007, Cohen et al. 2014).



Map 2. Distribution of coastal fen in Michigan (Albert et al. 2008).

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

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

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

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

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

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

Aerial photograph of Jensen Harbor coastal fen.

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

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

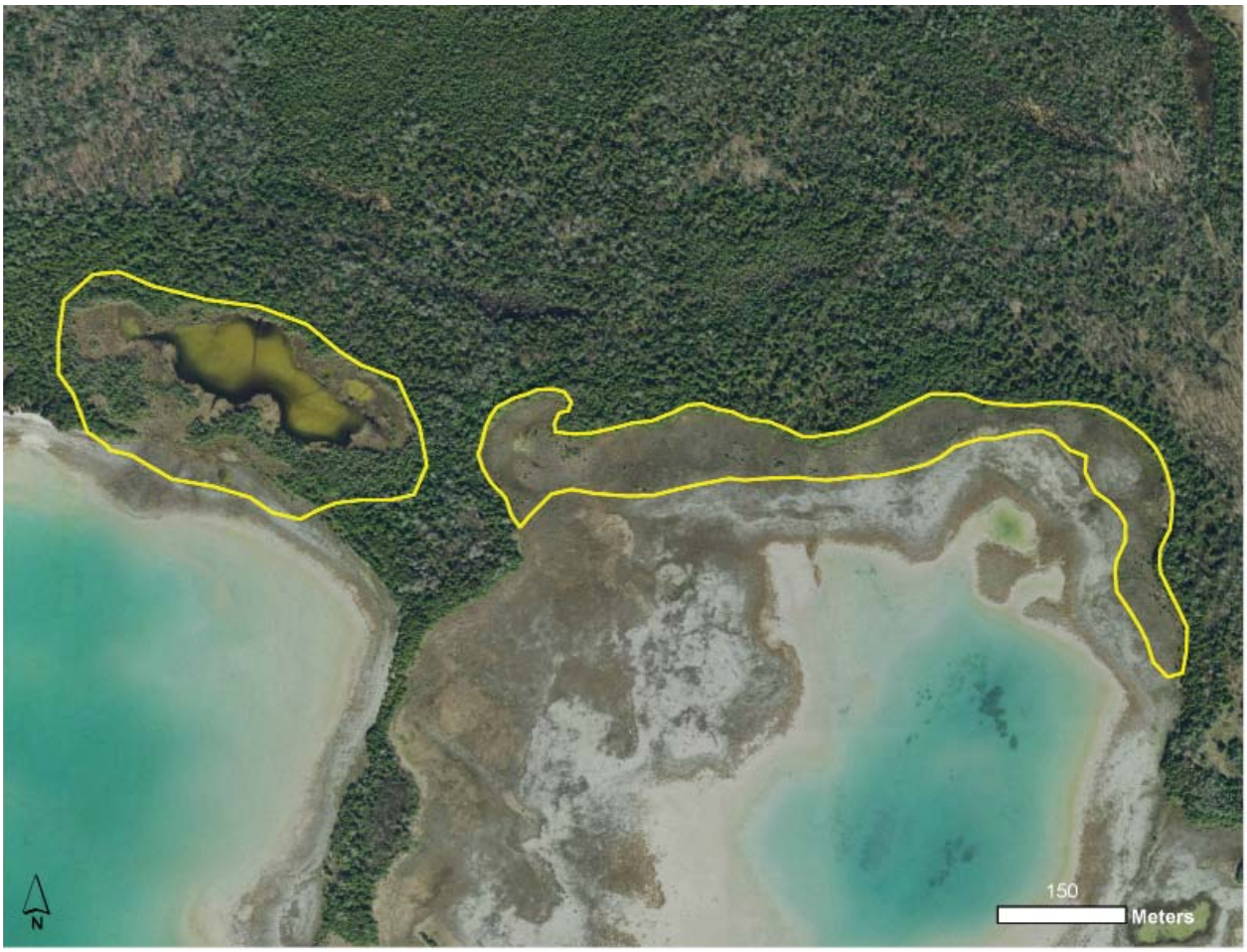
Site Description: This coastal fen occurs in Northcutt and Monatou Bays on Garden Island. In 2015, surveys focused on the shoreline in Monatou Bay just east of Northcutt Bay. Surveys resulted in the expansion of this coastal fen to include areas of fen along the Monatou Bay shoreline and this site description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

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

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

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

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



Aerial photograph of Northcutt and Monatou Bays coastal fen.

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

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

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

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

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

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

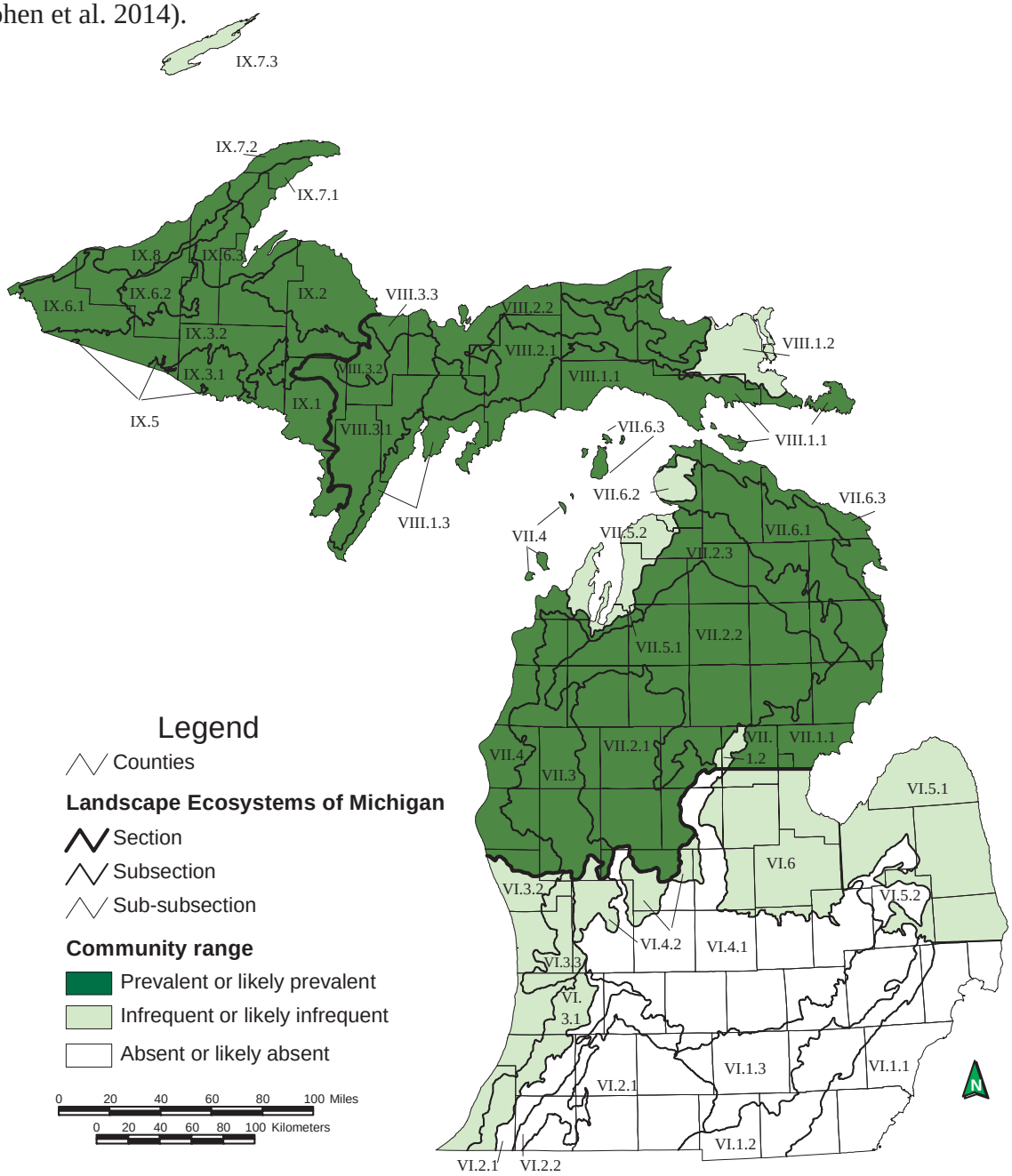
Sweat Lodge Swale coastal fen. Photo by Joshua G. Cohen.

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

Aerial photograph of Sweat Lodge Swale coastal fen.

DRY-MESIC NORTHERN FOREST

Overview: Dry-mesic northern forest is a pine or pine-hardwood forest type of generally dry-mesic sites located mostly north of the transition zone. Dry-mesic northern forest is characterized by acidic, coarse- to medium-textured sand or loamy sand and occurs principally on sandy glacial outwash, sandy glacial lakeplains, and less often on inland dune ridges, coarse-textured moraines, and thin glacial drift over bedrock. The community historically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires (Kost et al. 2007, Cohen et al. 2014).



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

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

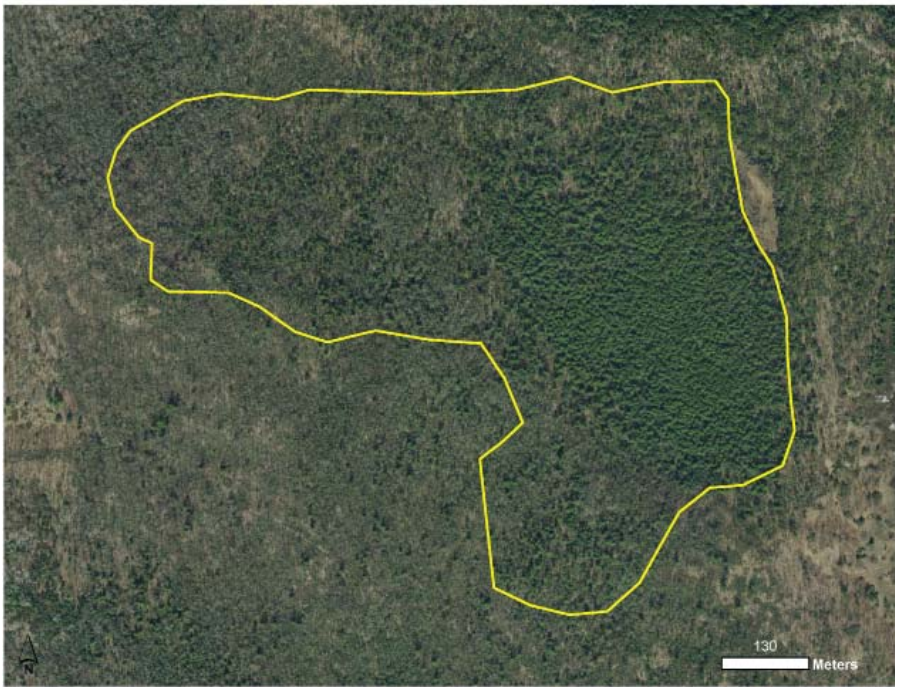
Site Description: The High Island dry-mesic northern forest occurs in the northeastern portion of High Island on undulating topography of former dune shoreline. This forest likely established over 120 years ago following a severe fire event. Charcoal was noted on old tree stumps. Estimated tree ages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

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

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

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

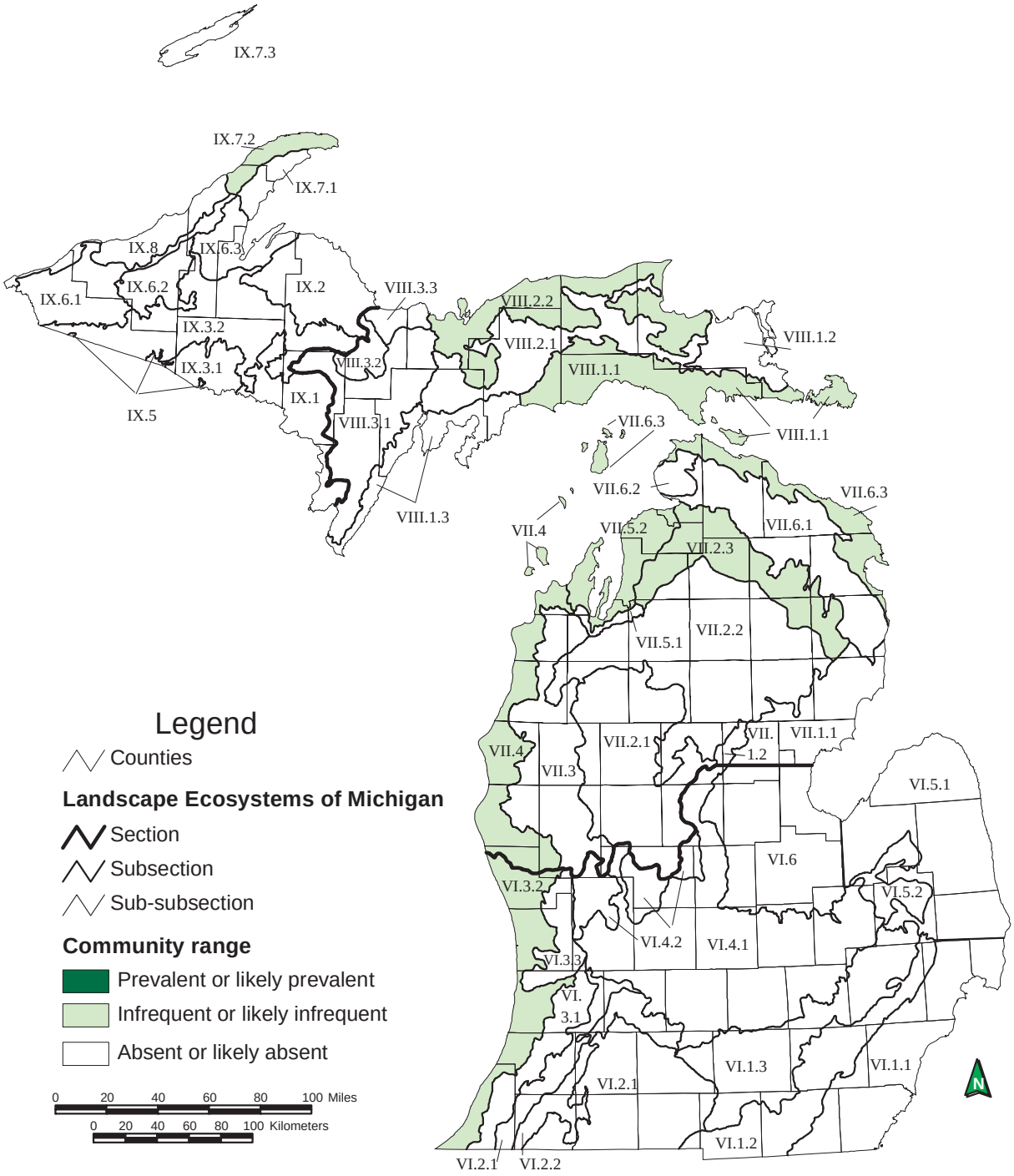
High Island dry-mesic northern forest. Photo by Joshua G. Cohen.



Aerial photograph of High Island dry-mesic northern forest.

GREAT LAKES BARRENS

Overview: Great Lakes barrens is a coniferous savanna community of scattered and clumped trees, and an often dense, low or creeping shrub layer. The community occurs along the shores of the Great Lakes where it is often associated with interdunal wetlands and open dunes (Kost et al. 2007, Cohen et al. 2014).



Map 4. Distribution of Great Lakes barrens in Michigan (Albert et al. 2008).

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

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

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

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

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

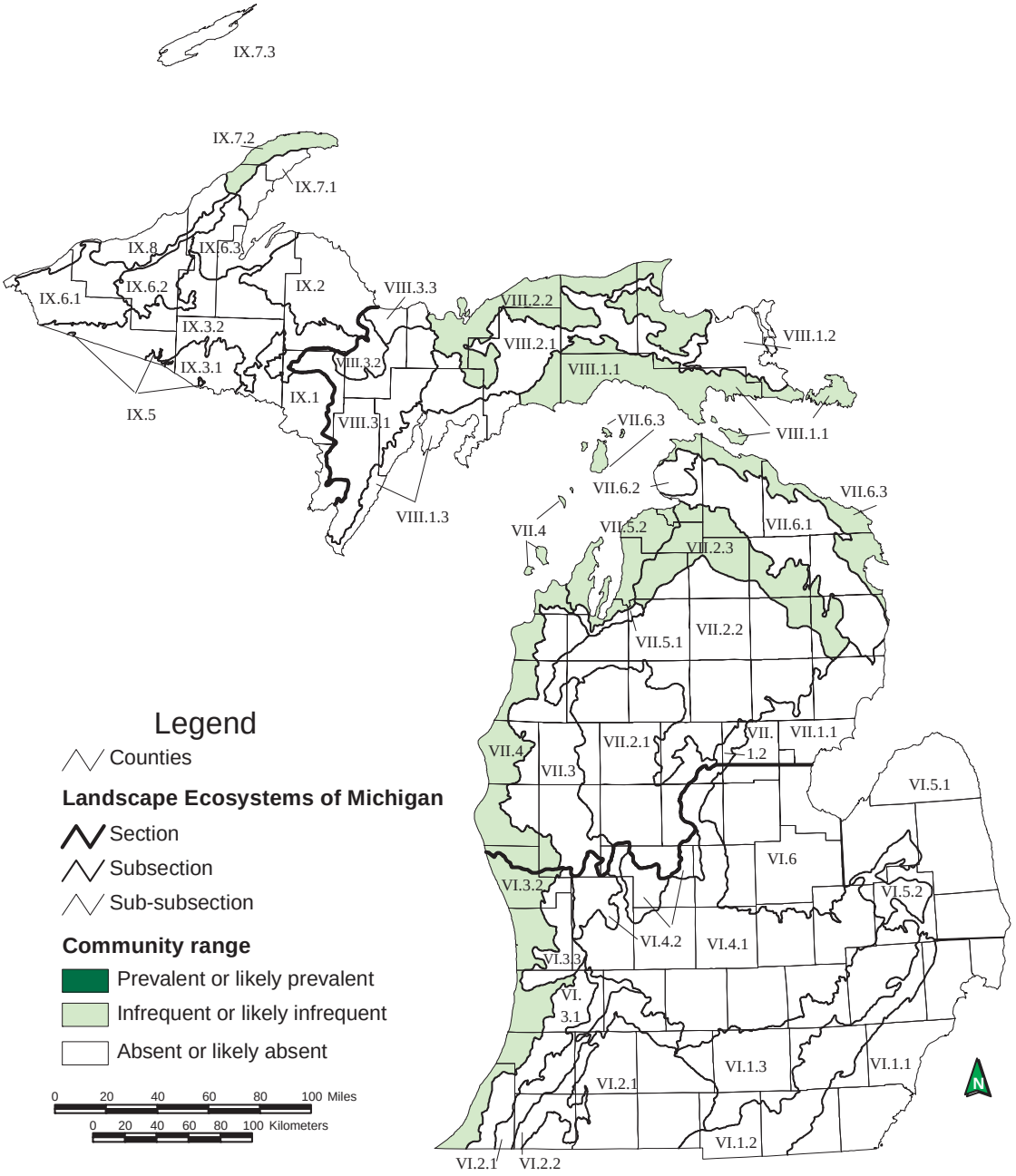
Nezewabegon Barrens Great Lakes barrens. Photo by Joshua G. Cohen.

Aerial photograph of Nezewabegon Barrens Great Lakes barrens.


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

GREAT LAKES MARSH

Overview: Great Lakes marsh is an herbaceous wetland community occurring statewide along the shoreline of the Great Lakes and their major connecting rivers. Vegetational patterns are strongly influenced by water level fluctuations and type of coastal feature, but generally include the following: a deep marsh with submerged plants; an emergent marsh of mostly narrow-leaved species; and a sedge-dominated wet meadow that is inundated by storms. Great Lakes marsh provides important habitat for migrating and breeding waterfowl, shore-birds, spawning fish, and medium-sized mammals (Kost et al. 2007, Cohen et al. 2014).



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

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

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

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

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

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

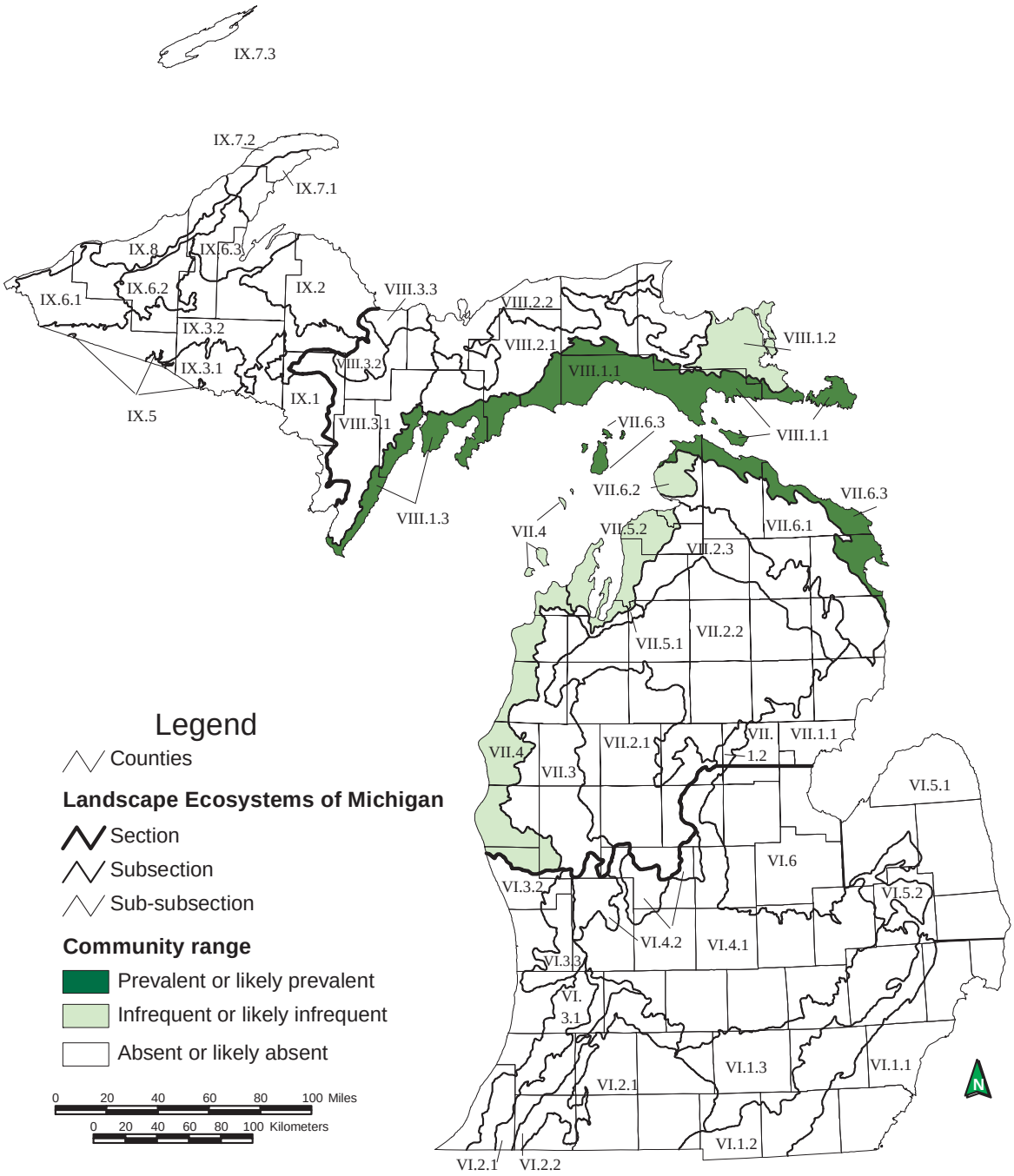
Taganing Marsh Great Lakes marsh. Photos by Joshua G. Cohen.

Aerial photograph of Taganing Marsh Great Lakes marsh.

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

LIMESTONE COBBLE SHORE

Overview: Limestone cobble shore occurs along gently sloping shorelines of Lake Michigan and Lake Huron. The community is studded with cobbles and boulders and is frequently inundated by storms and periods of high water. Limestone cobble shore is typically sparsely vegetated, because cobbles cover most of the surface and storm waves prevent the development of a diverse, persistent plant community. Soils are neutral to slightly alkaline mucks and sands that accumulate between cobbles and boulders (Kost et al. 2007, Cohen et al. 2014).



Map 6. Distribution of limestone cobble shore in Michigan (Albert et al. 2008).

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

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

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

(*Shepherdia canadensis*), ninebark (*Physocarpus opulifolius*), and balsam fir (*Abies balsamea*). Scattered saplings occur along the margins of the limestone cobble shore and include northern white-cedar, balsam fir, balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), tamarack (*Larix laricina*), and trembling aspen.

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

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

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

Aerial photograph of High Island limestone cobble shore.

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

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

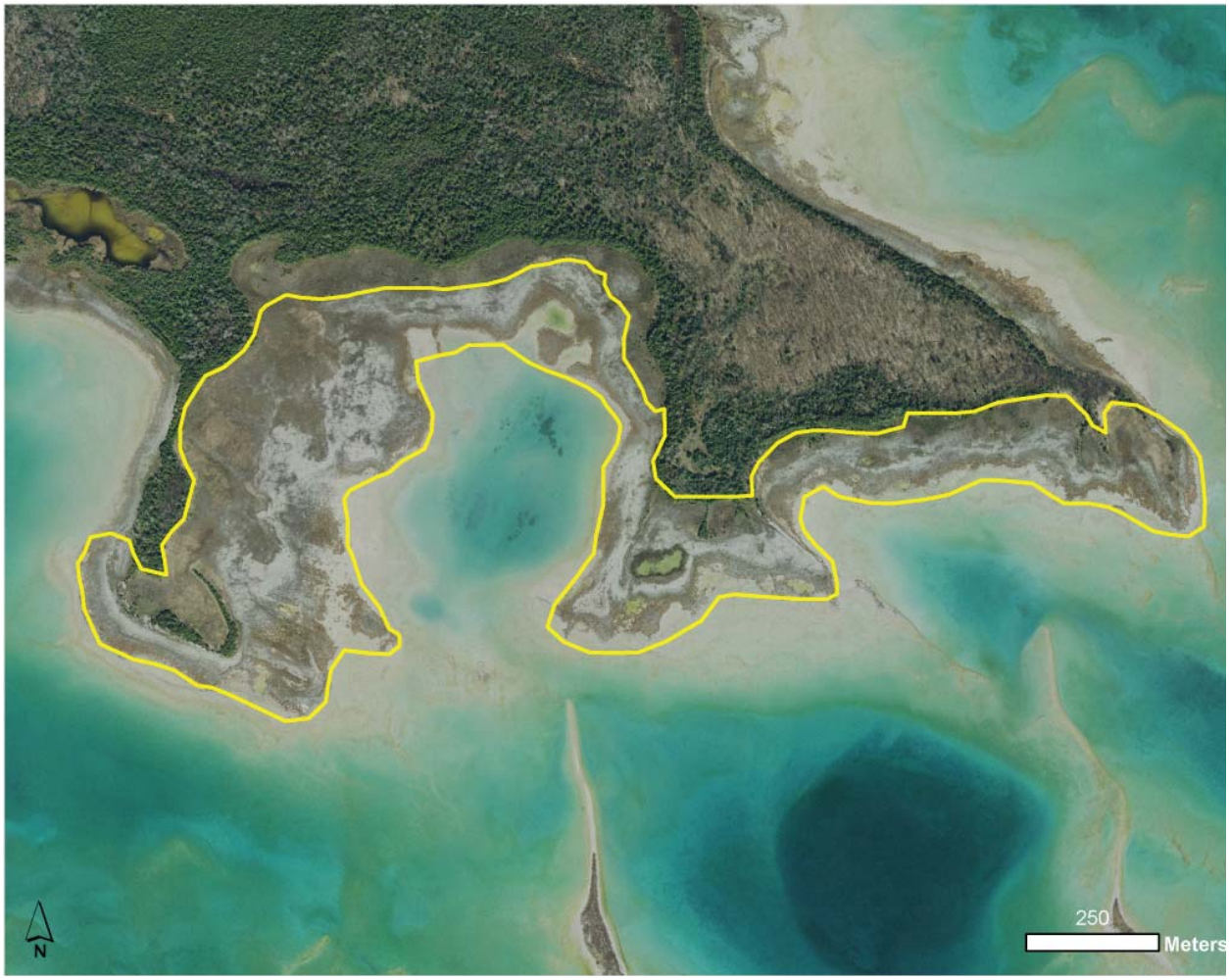
Site Description: The Monatou Bay limestone cobble shore occurs along Monatou Bay on Garden Island. Monatou Bay is the only A-ranked limestone cobble shore in the state. This limestone cobble shore grades to coastal fen inland and Great Lakes marsh lakeward. The margin between these communities shifts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

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

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

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

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



Aerial photograph of Monatou Bay limestone cobble shore.

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

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

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

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

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

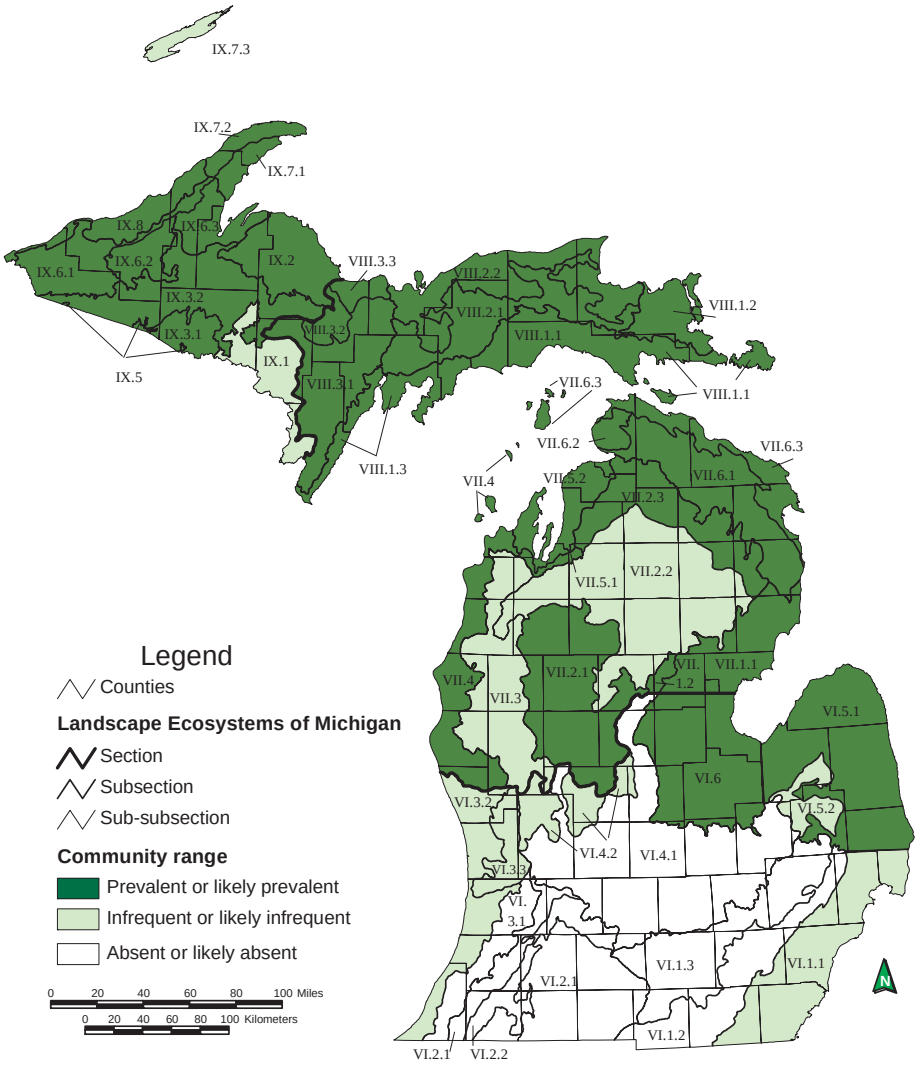
Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the limestone cobble shore and nearby areas of shoreline. Control efforts should be followed by monitoring for these invasive species.

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

Aerial photograph of Taganing Shore limestone cobble shore.

MESIC NORTHERN FOREST

Overview: Mesic northern forest is a forest type of moist to dry-mesic sites lying mostly north of the climatic tension zone, characterized by the dominance of northern hardwoods, particularly sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*). Conifers such as hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) are frequently important canopy associates. This community type breaks into two broad classes: northern hardwood forest and hemlock-hardwood forest. It is primarily found on coarse-textured ground and end moraines, and soils are typically loamy sand to sandy loam. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of the shade-tolerant canopy species. Catastrophic windthrow occurs infrequently with several generations of trees passing between large-scale, severe disturbance events. Historically, mesic northern forest occurred as a matrix system, dominating vast areas of mesic uplands in the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries (Kost et al. 2007, Cohen et al. 2014).



Map 7. Distribution of mesic northern forest in Michigan (Albert et al. 2008).

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

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

The overstory ranges from 75% to 100% and the canopy is dominated by sugar maple (*Acer saccharum*) with canopy associates including yellow birch (*Betula alleghaniensis*), hemlock, red oak, and northern white-cedar (*Thuja occidentalis*), which is concentrated closer to the shore. Canopy trees typically range in DBH from 60 to 100 cm. Scattered subcanopy trees include sugar maple, northern white-cedar, and American mountain-ash (*Sorbus americana*). The understory ranges from 10% to 20% and characteristic species include sugar maple, round-leaved dogwood (*Cornus rugosa*), mountain maple (*Acer spicatum*), red elderberry (*Sambucus racemosa*), beaked hazelnut (*Corylus cornuta*), American mountain-ash, choke cherry (*Prunus virginiana*), and yew (*Taxus canadensis*). The low shrub layer ranges from sparse (15-30%) to dense (80-90%) with yew locally dominant. Additional species in the low shrub layer include mountain maple, sugar maple, and beaked hazelnut. The ground cover is most developed where yew is less prevalent. Characteristic ground cover species include Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), woodferns (*Dryopteris* spp.), sedges (*Carex* spp.), blue-bead lily (*Clintonia borealis*), yellow violet (*Viola pubescens*), blue cohosh (*Caulophyllum thalictroides*), common trillium (*Trillium grandiflorum*), false spikenard (*Maianthemum racemosum*), downy Solomon seal (*Polygonatum pubescens*), partridge berry

(*Mitchella repens*), wild leek (*Allium tricoccum*), jack-in-the-pulipt (*Arisaema triphyllum*), large-flowered bellwort (*Uvularia grandiflora*), bedstraw (*Galium triflorum*), oak fern (*Gymnocarpium dryopteris*), purple meadow-rue (*Thalictrum dasycarpum*), cow-parsnip (*Heracleum maximum*), bloodroot (*Sanguinaria canadensis*), round-lobed hepatica (*Hepatica americana*), rose twisted-stalk (*Streptopus lanceolatus*), and white baneberry (*Actaea pachypoda*). Diverse mosses are prevalent on the boles of the old-growth trees.

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

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

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

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

Aerial photograph of Nezewabegon mesic northern forest.

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

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

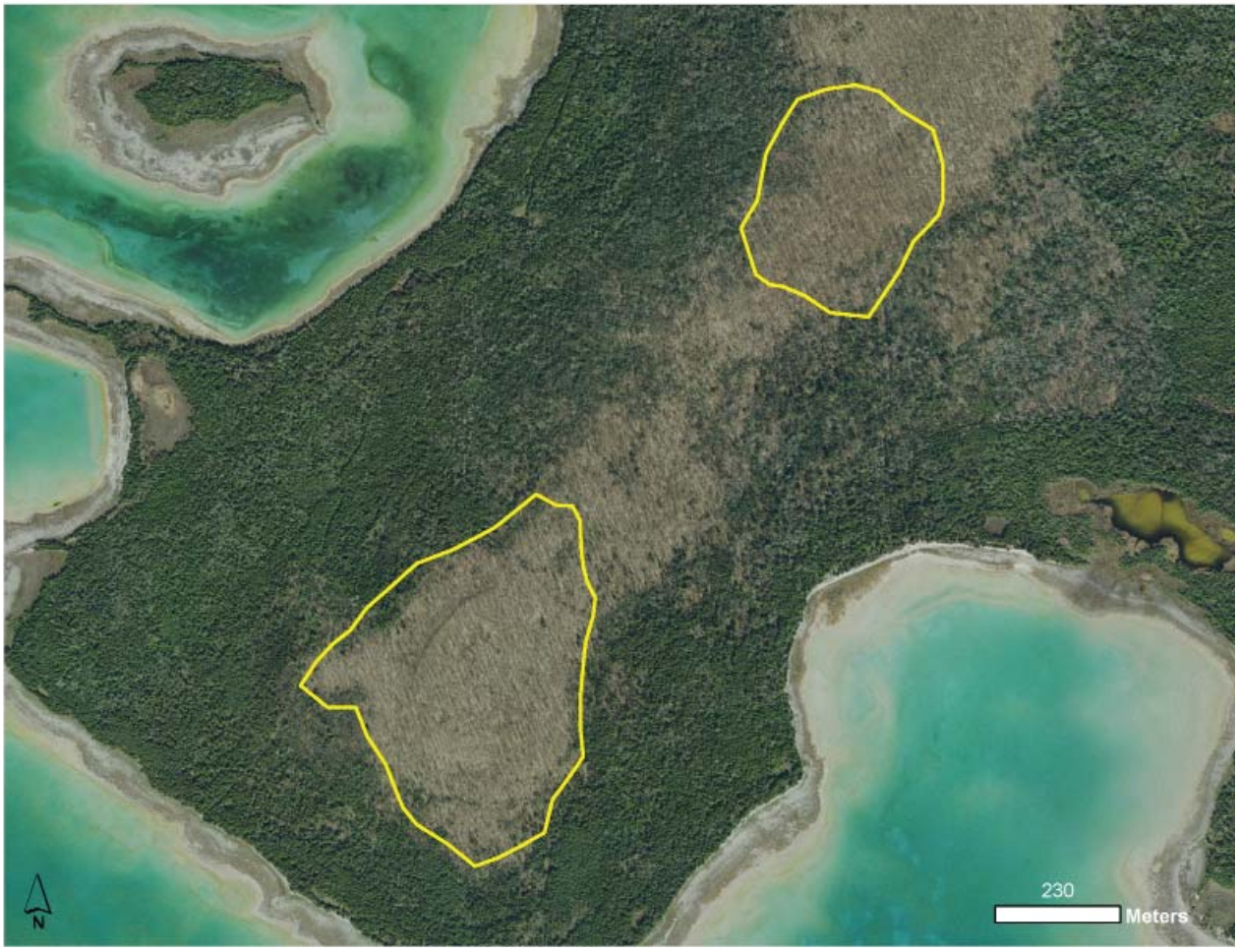
Site Description: The Red Oak Garden mesic northern forest consists of two polygons of uneven-aged forest occurring on rolling topography in the southern portion of Garden Island. Surveys in 2015 significantly expanded the element occurrence. The mesic northern forest is characterized by pit and mound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

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

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

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

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

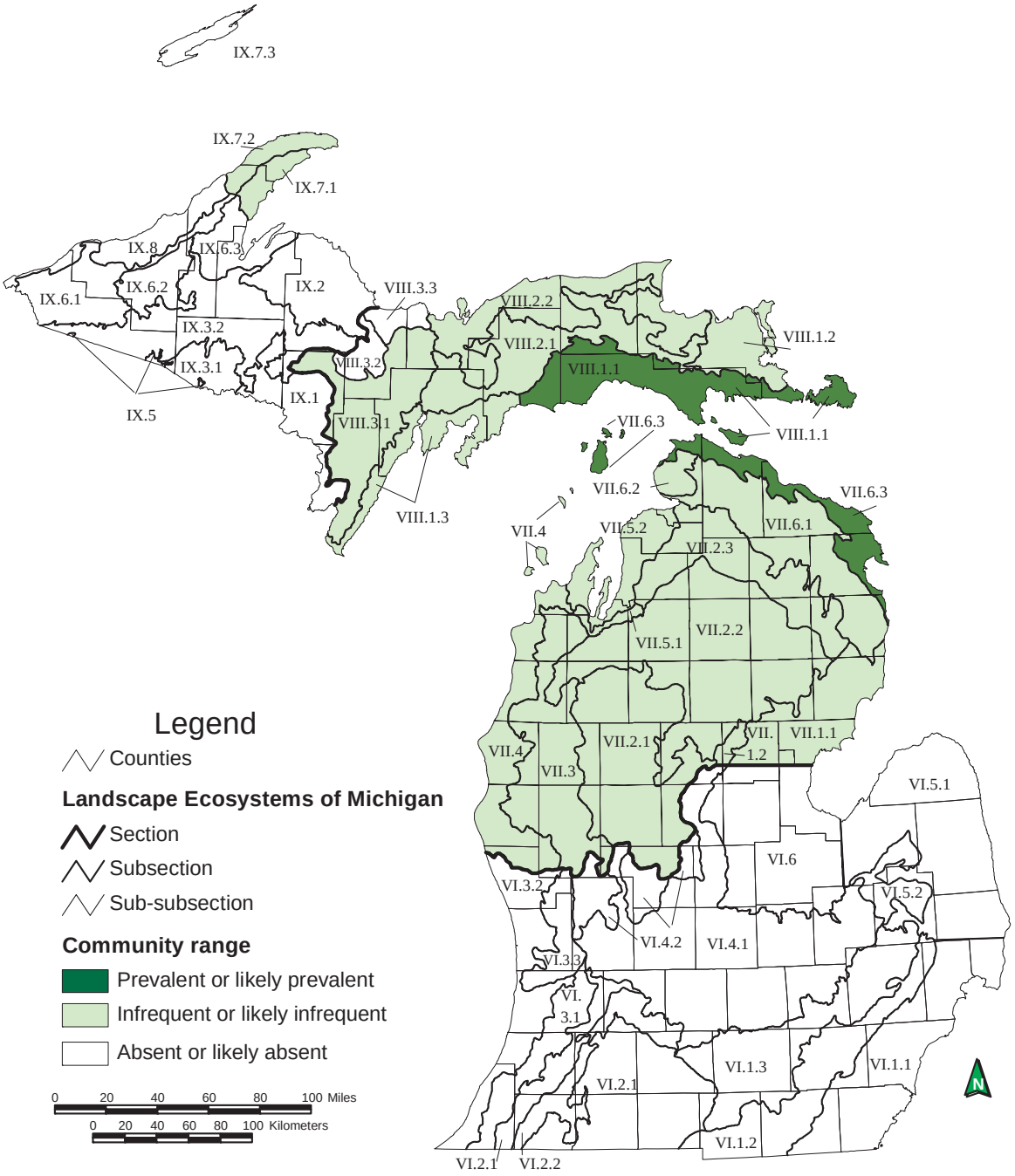


Aerial photograph of Red Oak Garden mesic northern forest.

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

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

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

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

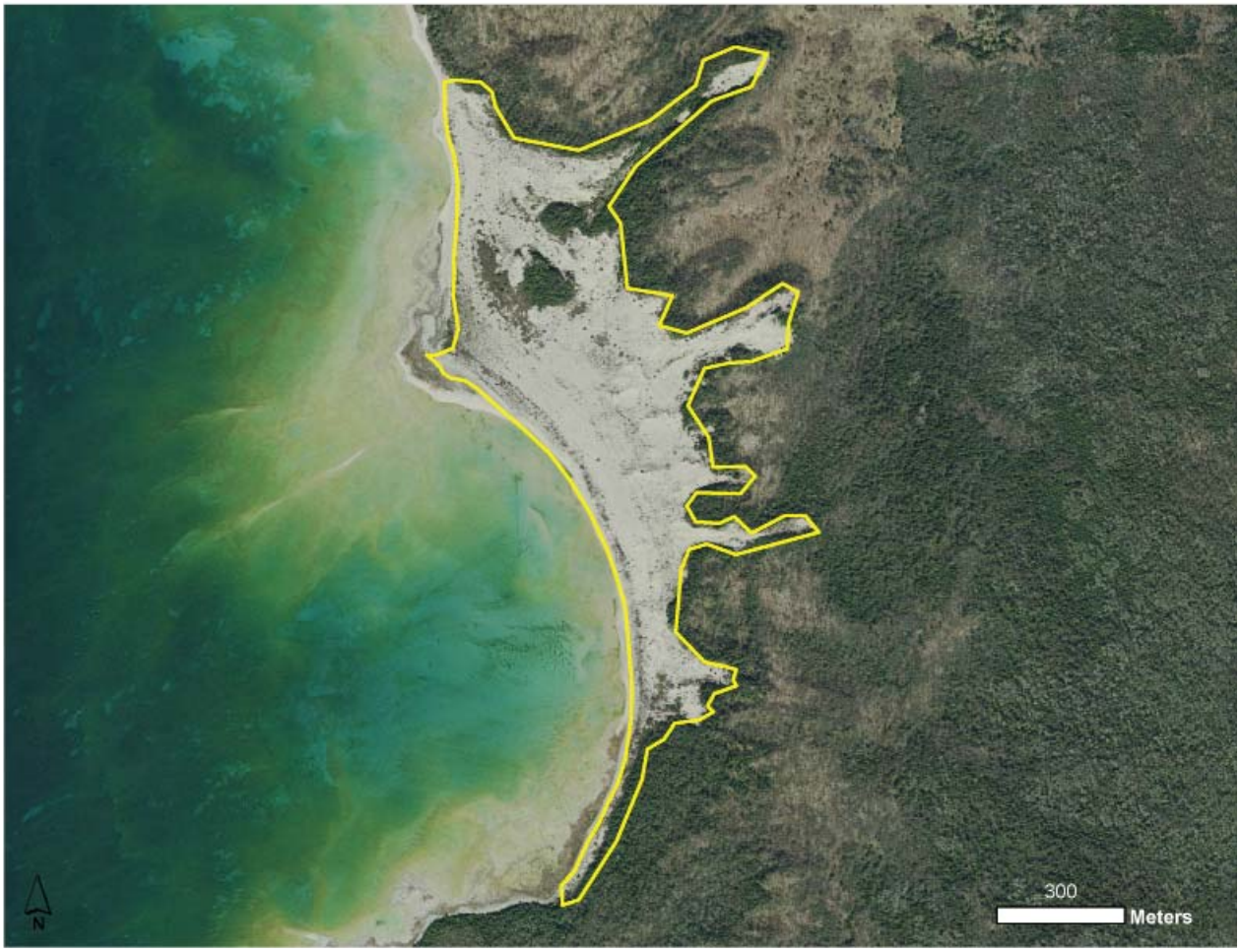
The low foredune is dominated by marram grass (*Ammophila breviligulata*) with ground cover associates including wormwood (*Artemisia campestris*), pitcher's thistle, wheat grass (*Elymus lanceolatus*), beach pea (*Lathyrus japonicus*), Gillman's goldenrod (*Solidago simplex*), and common evening-primrose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

juniper (*Juniperus horizontalis*), bearberry, and sand cherry. Characteristic ground cover species include white camas, starry false Solomon-seal, sand reed grass, and poison ivy (*Toxicodendron radicans*).

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

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

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

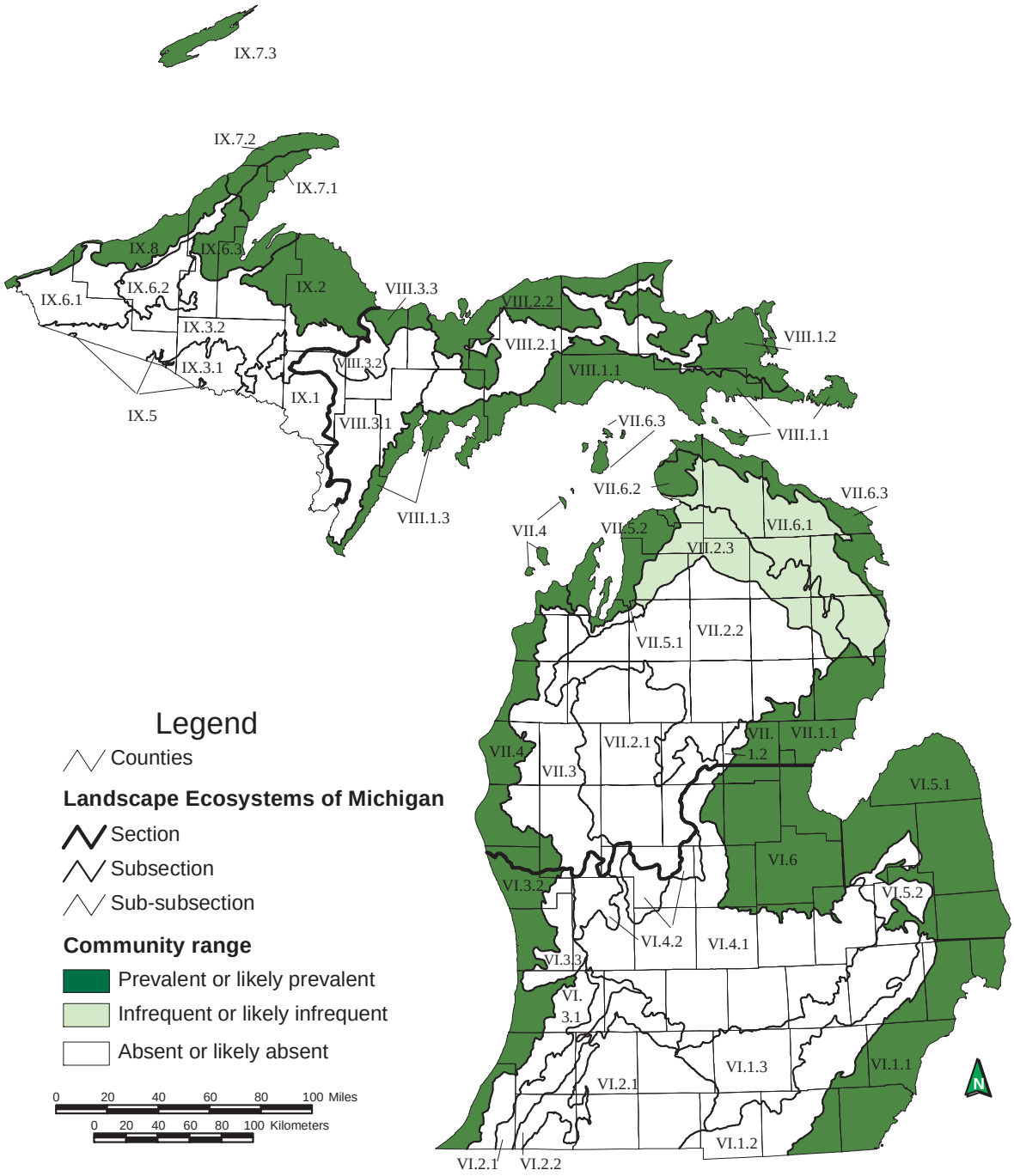


Aerial photograph of High Island open dunes.

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

SAND AND GRAVEL BEACH

Overview: Sand and gravel beaches occur along the shorelines of the Great Lakes and on some of Michigan's larger freshwater lakes, where wind, waves, and winter ice cause the shoreline to be too unstable to support aquatic vegetation. Because of the high levels of disturbance, these beaches are typically quite open, with sand and gravel sediments and little or no vegetation (Kost et al. 2007, Cohen et al. 2014).



Map 9. Distribution of sand and gravel beach in Michigan (Albert et al. 2008).

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

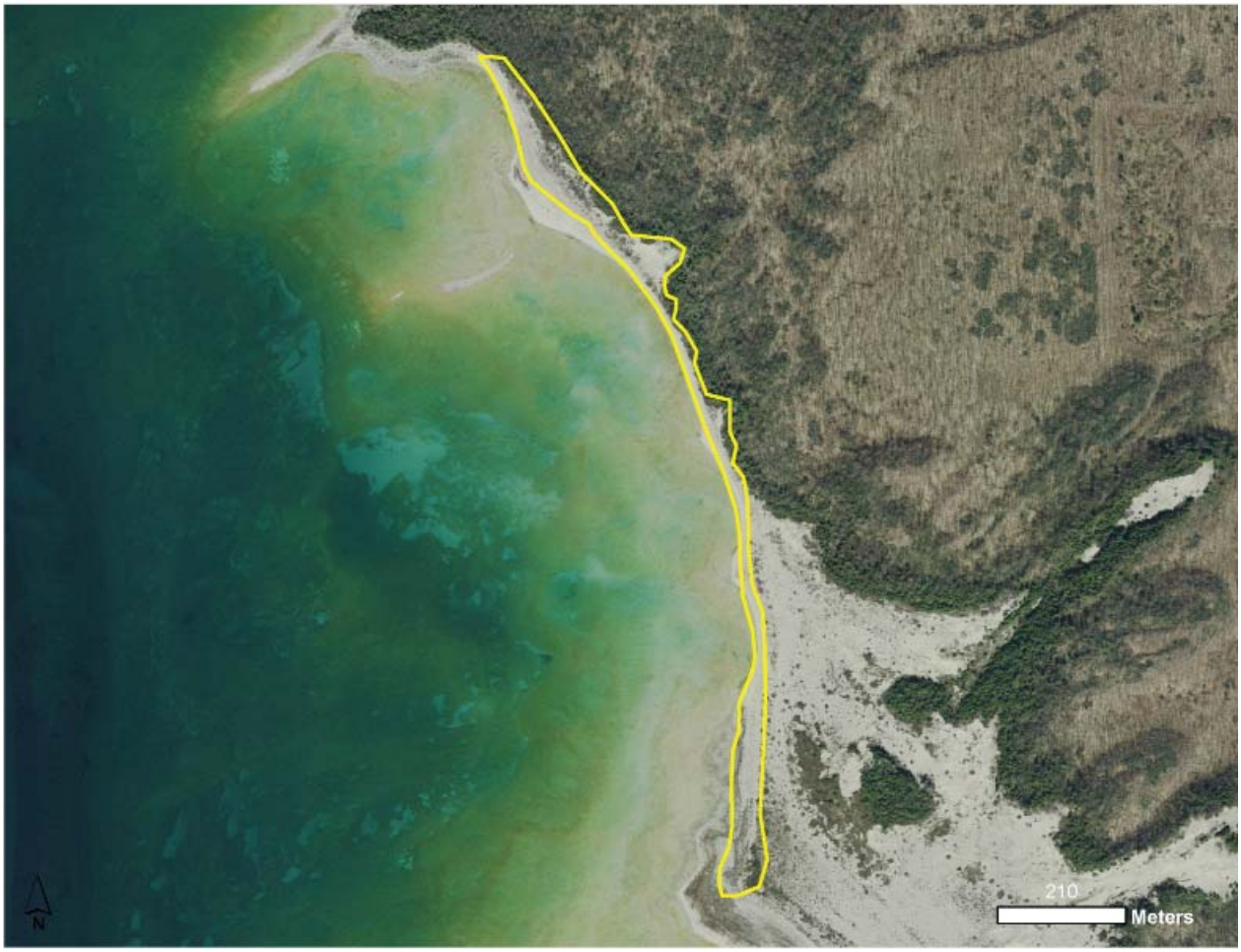
Site Description: The High Island sand and gravel beach occurs along a mile stretch of Lake Michigan shoreline along the northwestern shore of High Island. This stretch of sand and gravel beach is backed by low foredune, which is backed by Great Lakes barrens, dry-mesic northern forest, and boreal forest.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

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

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

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

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



Aerial photograph of High Island sand and gravel beach.

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

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

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

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

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

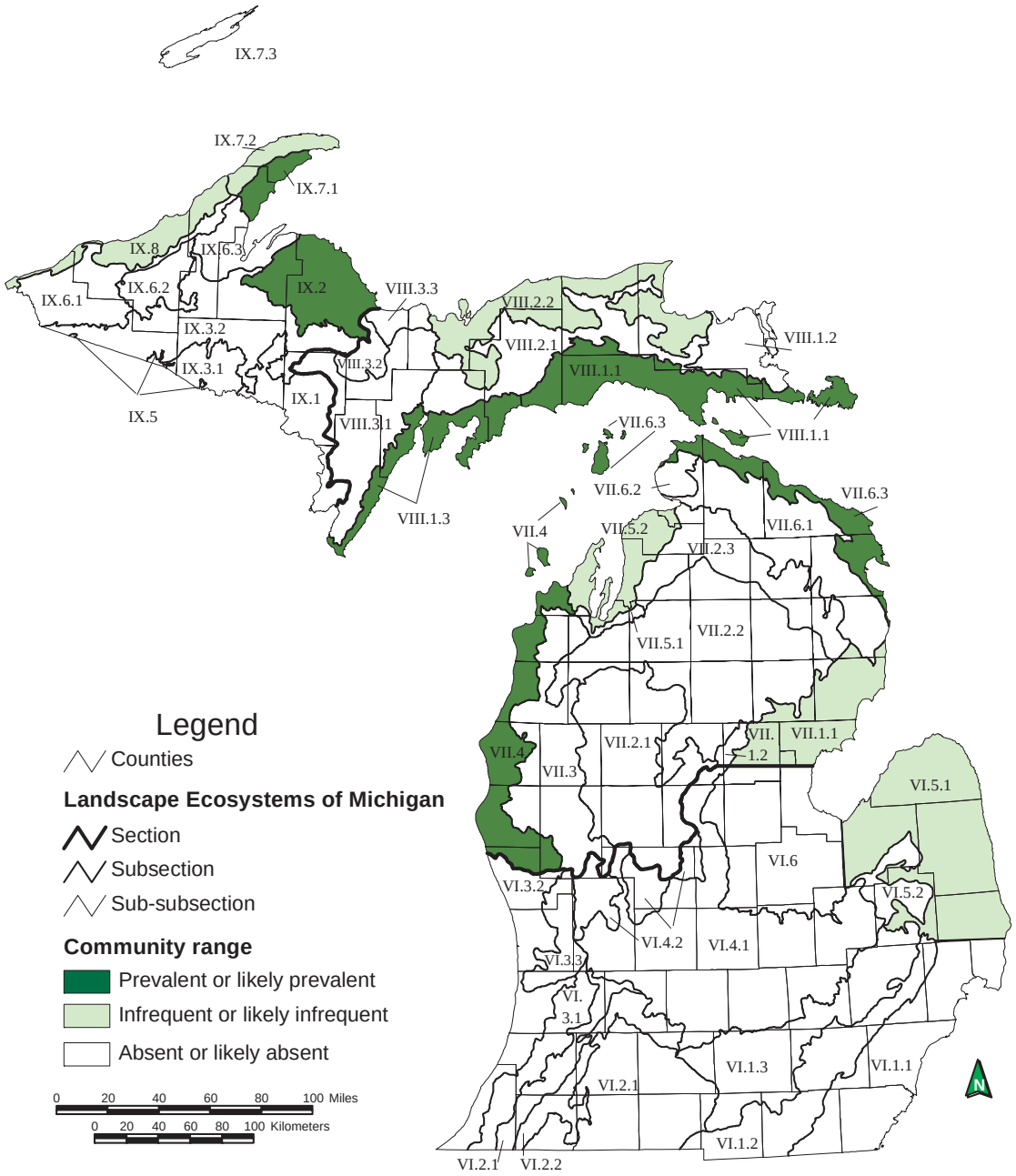
High Island Bay sand and gravel beach. Photos by Joshua G. Cohen.

Aerial photograph of High Island Bay sand and gravel beach.

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

WOODED DUNE AND SWALE COMPLEX

Overview: Wooded dune and swale complex is a large complex of parallel wetland swales and upland beach ridges (dunes) found in coastal embayments and on large sand spits along the shorelines of the Great Lakes. The upland dune ridges are typically forested, while the low swales support a variety of herbaceous or forested wetland types, with open wetlands more common near the shoreline and forested wetlands more prevalent further from the lake. Wooded dune and swale complexes occur primarily in the northern Lower and Upper Peninsulas and Thumb region (Kost et al. 2007, Cohen et al. 2014).



Map 10. Distribution of wooded dune and swale complex in Michigan (Albert et al. 2008).

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

Site Description: Hundreds to thousands of years of lacustrine processes have developed a subtle but complex patterning of northeast to southwest oriented dune ridges and swales of variable depth and width that characterize the Taganing Dune and Swale. The complex community structure includes dry-mesic northern forest, northern hardwood swamp, rich conifer swamp, northern shrub thicket, and northern wet meadow. Along the ridges the soils are characterized by a shallow A horizon (10-30 cm on one ridge) of acidic (pH 4.5) organics and sands overlying medium- to coarse-textured, alkaline (pH 7.5-7.8) sands. The sands along the ridges are more acidic closer to the surface, where the needle layer increases the acidity and less acidic with increasing depth. Shrub and meadow swales have saturated, alkaline (pH 7.5-8.0) peats (> 1 meter in one swale) overlying sands. The ridges are typically low and narrow (10-30 meters wide) and the swales are also narrow (10-20 meters wide). Many of the swales hold standing water, with measured water depths ranging from 30 to 60 cm in sedge- and shrub-dominated swales. Compared to other examples across this state, this is a very small wooded dune and swale complex. Nevertheless, the site is characterized by complex ecological patterning that results in high species and community diversity in an area with minimal anthropogenic disturbance. In addition, the site is unique in that it occurs immediately adjacent to a high-quality Great Lakes marsh (Taganing Marsh, EO ID 20450).

The ridges and swales are linear and trend northeast to southwest. Coarse woody debris of early-successional species [paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*)] is abundant. Pockets of windthrow are common on both the forested ridges and swales. Trees falling from adjacent uplands into the swales provide important substrate for plant establishment and growth. Throughout the gently rolling dune ridges, there are charred snags and cut stumps, indicating that the complex burned and was locally logged in the past. A 31.5 cm northern white-cedar (*Thuja occidentalis*) from a dry-mesic dune ridge was cored and estimated to be over 133 years old. Where the dune ridges and swales are narrowest, they intergrade with each other vegetatively. The wooded dune and swale complex occurs adjacent to high-quality Great Lakes marsh.

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

canadense), wild sarsaparilla (*Aralia nudicaulis*), twinflower (*Linnaea borealis*), gay-wings (*Polygala paucifolia*), starflower (*Trientalis borealis*), and naked miterwort (*Mitela nuda*).

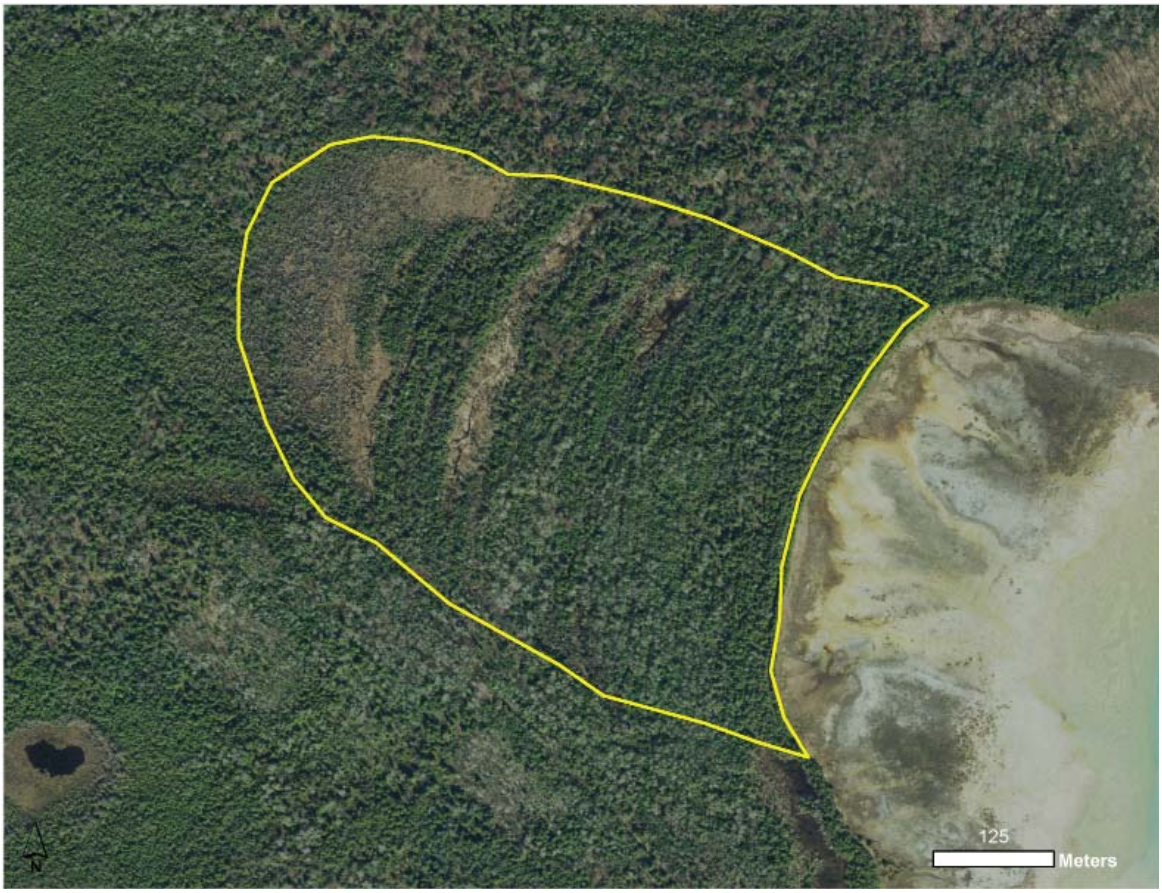
The northern hardwood swamp swales are dominated by black ash (*Fraxinus nigra*) with prevalent ground cover species including starflower, bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), and Canada mayflower. Areas of rich conifer swamp are dominated by northern white-cedar with canopy associates including black ash and tamarack (*Larix laricina*). Prevalent understory species include tag alder (*Alnus incana*), mountain holly (*Ilex verticillata*), balsam fir, red-osier dogwood (*Cornus sericea*), and northern white-cedar. Common species of the low shrub layer include Labrador-tea, alder-leaved buckthorn (*Rhamnus alnifolia*), and bog rosemary (*Andromeda glaucophylla*). Characteristic ground cover species include tussock sedge (*Carex stricta*), bunchberry, marsh fern (*Thelypteris palustris*), starflower, goldthread, royal fern (*Osmunda regalis*), creeping snowberry (*Gaultheria hispidula*), sensitive fern (*Onoclea sensibilis*), and miterwort.

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

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

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

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



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

RESULTS

Stewardship Prioritization Results and Observations

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

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

Due to the remote location of Garden and High Islands, current threats are primarily limited to localized patches of non-native plants occurring along the shoreline. The primary stewardship priorities are to control pockets of non-native plants and continue monitoring coastal ecosystems for invasives. Photo by Joshua G. Cohen.

Table 2. Stewardship prioritization for natural community element occurrences on Garden and High Islands. Element occurrences are sorted by their stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority.

EO ID	Natural Community Type	Surveysite	Island	EO Rank	Global Rank	Global Rank Score	State Rank	State Rank Score	Rarity Index	Ecological Integrity Index	Threat Severity Index	Stewardship Score
13020	Great Lakes Marsh	Indian Harbor	Garden Island	AB	G2	4.00	S3	3.00	3.50	4.50	6.00	14.00
20450	Great Lakes Marsh	Taganing Marsh	Garden Island	A	G2	4.00	S3	3.00	3.50	5.00	5.00	13.50
7888	Coastal Fen	Jensen Harbor	Garden Island	A	G1G2	4.50	S2	4.00	4.25	5.00	1.00	10.25
20449	Limestone Cobble Shore	Taganing Shore	Garden Island	B	G2G3	3.50	S3	3.00	3.25	4.00	3.00	10.25
20448	Limestone Cobble Shore	Monatou Bay	Garden Island	A	G2G3	3.50	S3	3.00	3.25	5.00	2.00	10.25
10698	Open Dunes	High Island	High Island	A	G3	3.00	S3	3.00	3.00	5.00	2.00	10.00
10977	Sand and Gravel Beach	High Island Bay	High Island	A	G3?	3.00	S3	3.00	3.00	5.00	2.00	10.00
13026	Sand and Gravel Beach	High Island	High Island	A	G3?	3.00	S3	3.00	3.00	5.00	2.00	10.00
20454	Great Lakes Barrens	Nezewabegon Barrens	High Island	AB	G3	3.00	S2	4.00	3.50	4.50	2.00	10.00
10574	Coastal Fen	Northcutt Bay	Garden Island	AB	G1G2	4.50	S2	4.00	4.25	4.50	1.00	9.75
6527	Limestone Cobble Shore	High Island	High Island	AB	G2G3	3.50	S3	3.00	3.25	4.50	2.00	9.75
9513	Coastal Fen	Sweat Lodge Swale	Garden Island	B	G1G2	4.50	S2	4.00	4.25	4.00	1.00	9.25
7487	Boreal Forest	Garden Island Boreal Forest	Garden Island	A	GU	3.00	S3	3.00	3.00	5.00	1.00	9.00
4856	Boreal Forest	High Island	High Island	AB	GU	3.00	S3	3.00	3.00	4.50	1.00	8.50
20452	Mesic Northern Forest	Nezewabegon Forest	High Island	AB	G4	2.00	S3	3.00	2.50	4.50	1.00	8.00
11804	Northern Wet Meadow	Garden Island Harbor	Garden Island	A	G4G5	1.50	S4	2.00	1.75	5.00	1.00	7.75
20453	Dry-mesic Northern Forest	High Island	High Island	B	G4	2.00	S3	3.00	2.50	4.00	1.00	7.50
20451	Wooded Dune and Swale Complex	Taganing Dune and Swale	Garden Island	C	G3	3.00	S3	3.00	3.00	3.00	1.00	7.00
10496	Mesic Northern Forest	Red Oak Garden	Garden Island	C	G4	2.00	S3	3.00	2.50	3.00	1.00	6.50

Taganing Marsh, Great Lakes marsh, Garden Island. Preventing the establishment and spread of invasive plants in the Great Lakes marshes of Garden Island is a high stewardship priority for the Beaver Island Archipelago. Photo by Joshua G. Cohen.

DISCUSSION

This report provides site-based assessments of 17 natural community element occurrences within Garden and High Islands. Threats, management needs, and restoration opportunities specific to each individual site have been discussed. The baseline information presented in the current report provides resource managers with an ecological foundation for prescribing site-level biodiversity stewardship, monitoring these management activities, and implementing landscape-level biodiversity planning to prioritize management efforts. The framework for prioritizing stewardship and monitoring efforts across sites across these islands will help facilitate difficult decisions regarding the distribution of finite stewardship resources for site-based management.

The framework for stewardship and monitoring prioritization presented in this report offers a method for targeting biodiversity management and monitoring within these islands. This method could be refined to suit the specific and local needs of resource agencies. This stewardship prioritization could also be refined within broader ecological or political regions such as ecological subsection, county, or 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.

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

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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.