

Natural Community Surveys of Michigan's Coastal Zone



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Cover photo: West Side Dunes open dunes, North Manitou Island. Photo by Joshua G. Cohen.

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EXECUTIVE SUMMARY

The integration of natural resource conservation into a sustainable development strategy requires accurate, detailed, easily accessible natural resource information. Coastal areas currently face a variety of pressures associated with shoreline development and modification, the development of near-shore wind turbines and associated infrastructure, the establishment and spread of invasive plant and animal species, and climate change. Assessing the impacts of these developments on the integrity of coastal natural resources, including native ecosystems, requires accurate, up-to-date information on the location, identity, and condition of natural lands within the coastal zone.

The goal of this project, undertaken by Michigan Natural Features Inventory (MNFI), was to begin the collection of updated and new data for coastal natural communities to provide natural resource managers and land use planners with accurate, detailed information on the current status of coastal ecosystems in order to help guide activities ranging from biodiversity management and restoration to planning and zoning efforts.

The two primary objectives of this project were to (1) update known high-quality occurrences of natural communities within the coastal zone, and (2) conduct surveys for new occurrences of natural communities within the coastal zone, focusing primarily on areas identified by the Michigan Department of Natural Resources and its partners in their Biodiversity Planning Process or Living Legacies Initiative.

Ecological field surveys, conducted during the 2012 field season, were focused in Benzie, Leelanau, Grand Traverse, and Emmet Counties with opportunistic surveys occurring in Alpena, Manistee, Mason, and Ottawa Counties. Field surveys were focused in counties determined to be within priority wind development regions. To further focus surveys within this region, MNFI scientists developed a prioritization scheme for existing natural community element occurrences and potential natural community occurrences.

A total of 65 high-quality natural communities were surveyed in eight different counties and included seventeen different natural community types. Ecologists conducted surveys of 36 previously known element occurrences and documented 29 new natural community element occurrences in Michigan's coastal zone, including two occurrences of a new natural community type, clay bluffs. 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.

The collected data were analyzed and transcribed to update or create element occurrence records in MNFI's statewide biodiversity conservation database. In addition, this report, "Natural Community Surveys of Michigan's Coastal Zone," provides a summary of the natural community types surveyed and detailed discussion of the primary threats, management and monitoring needs, and restoration opportunities for each of these 65 natural communities.

The standardized baseline information gathered for each natural community occurrence and summarized in this report 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 project was designed as a five-year survey effort. During the first year of this project, MNFI not only conducted field surveys but also developed a survey prioritization scheme for the entire project area and prioritized sites for future survey for the entire Lower Peninsula. It is our hope that the continuation of this survey effort will be funded in the near future. In addition to this continued survey effort, a much needed future step is the development of a framework for prioritizing stewardship efforts across these sites and in key areas within the coastal zone. This process should involve assessing the conservation significance of each site from both an ecoregional and statewide perspective and evaluating the severity of threats across sites. This analysis should be conducted using an ecological hierarchical framework. Understanding how each site relates to other examples of the same natural community and how rare that community is within an ecological region will help facilitate difficult decisions regarding the distribution of finite stewardship resources within coastal areas.

INTRODUCTION

The integration of natural resource conservation into a sustainable development strategy requires accurate, detailed, easily accessible natural resource information. Coastal areas currently face a variety of pressures associated with shoreline development and modification, the development of near-shore wind turbines and associated infrastructure, the establishment and spread of invasive plant and animal species, and climate change. Assessing the impacts of these developments on the integrity of coastal natural resources, including native ecosystems, requires accurate, up-to-date information on the location, identity, and condition of natural lands within the coastal zone.

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 2013). 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, 1546 high-quality occurrences of natural communities had been documented throughout Michigan, including 394 occurrences (25%) within two miles of the Great Lakes shorelines. These coastal occurrences represent 49 of the 77 natural community types described for Michigan by Kost et al. (2007). Among the 394 natural community occurrences, 127 (32%) are represented by natural communities that are considered critically imperiled or imperiled at the global scale, including coastal fen, coastal plain marsh, Great Lakes marsh, lakeplain oak openings, lakeplain wet prairie, and lakeplain wet-mesic prairie (NatureServe 2010). In addition, 91 of the remaining occurrences represent natural communities that are critically imperiled or imperiled at the state level (MNFI 2013). The Great Lakes coastal zone is critical for the conservation of these natural communities. Many of the natural community occurrences in the coastal zone have not been surveyed in over a decade, including 145 sites (37%) that have not been visited since 1990 or earlier. An additional need is inventory to identify new occurrences of natural communities in Michigan's coastal zone. The collection of updated and new data for coastal natural communities will provide natural resource managers and land use planners with accurate, detailed information on the current status of coastal ecosystems that can help guide activities ranging from biodiversity management and restoration to planning and zoning efforts.

Currently, the Michigan Department of Natural Resources (MDNR) and its partners are developing a network of functional representative ecosystems on MDNR-administered lands, and are establishing a strategy to cooperate with other landowners to conserve, restore, and protect the biological diversity of Michigan across ownerships. Through this biodiversity planning process or Living Legacies Initiative, the MDNR is creating a network of Biodiversity Stewardship Areas (BSAs). The goal of the Living Legacies initiative is to establish a network of representative natural communities that contribute to functioning landscape ecosystems across the state. The selection of the BSAs within this network is based on three primary elements: ecosystem representation, functionality, and condition. Many of the areas identified as potential BSAs occur within the coastal zone, and have not yet been inventoried for high-quality occurrences of natural communities. Targeted surveys for natural communities within the areas identified in the biodiversity planning process will complement updated surveys of previously identified natural communities and provide a more complete understanding of the nature and distribution of important natural features near Michigan's Great Lakes shorelines. This, in turn, will enable state and local agencies and land use planners to take into consideration previously unidentified natural features when planning biodiversity management, ecological restoration, coastal developments, and land use changes.

The purpose of this project is to assist state and local governments with land use planning and resource management by (1) updating known high-quality occurrences of natural communities within the coastal zone, and (2) conducting surveys for new occurrences of natural communities within the coastal zone, focusing

primarily on areas identified by the MDNR and its partners in their Biodiversity Planning Process. These surveys were conducted during the 2012 field season. Surveys were focused in Benzie, Leelanau, Grand Traverse, and Emmet Counties with opportunistic surveys occurring in Alpena, Manistee, Mason, and Ottawa Counties. MNFI conducted surveys of 36 previously known element occurrences and documented 29 new natural community element occurrences in Michigan's coastal zone. Seventeen different natural community types are represented in the 65 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. 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 such as the Living Legacies initiative. This report summarizes the findings of MNFI's ecological surveys.

METHODS

Field Survey Prioritization

Field surveys were focused in counties determined to be within priority wind development regions. These counties were Benzie, Leelanau, Grand Traverse, and Emmet. To further focus surveys within this region, MNFI scientists developed a prioritization scheme for existing natural community element occurrences and potential natural community occurrences and priority Biodiversity Stewardship Areas. Known element occurrences within the coastal zone were scored based on the following criteria: date since last survey (with higher scores for older records), state and global ranking (with higher scores for rarer natural communities), element occurrence ranking (with higher scores for higher quality sites), proximity to high wind potential areas, and the presence of the element occurrence within a Biodiversity Stewardship Area. The prioritization scheme for de novo natural community surveys involved scoring each Biodiversity Stewardship Area based on its size, connectivity, the number of high-quality natural communities or potential high-quality natural communities, the rarity of those natural communities, the importance of the BSA for capturing regionally important natural communities, past survey effort, and proximity to high wind potential areas. MNFI scientists used these scoring matrices to focus survey efforts. In addition, MNFI scientists opportunistically surveyed sites in Alpena, Manistee, Mason, and Ottawa Counties taking advantage of travel routes and work requirements for other projects.

Field Survey

A total of 65 high-quality natural communities were surveyed in eight different counties (Table 1) including the following: Alpena (1 site), Benzie (17 sites), Emmet (6 sites), Grand Traverse (7 sites), Leelanau (27 sites), Manistee (1 site), Mason (2 sites), and Ottawa (5 sites). The Empire Bluffs open dunes occurs in both Benzie and Leelanau Counties. 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 2012 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, HP iPAQ, and Ashtech Mobile Mapper 10 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 2013). Natural community boundaries were mapped or re-mapped. Information from these surveys and prior surveys, if available, was used to produce threat assessments and management recommendations for each natural community occurrence, which appear within the following Results section.

RESULTS

The 65 occurrences of high-quality natural communities were surveyed during the 2012 field season. As noted above, the 65 sites surveyed were within eight different counties (see above and Table 1). A total of seventeen different natural communities were visited including: bog (3 element occurrences or EOs), boreal forest (4 EOs), clay bluffs (2 EOs), coastal fen (1 EO), dry-mesic northern forest (3 EOs), emergent marsh (1 EO), Great Lakes barrens (6 EOs), Great Lakes marsh (1 EO), hardwood-conifer swamp (1 EO), interdunal wetland (7 EOs), limestone cobble shore (2 EOs), mesic northern forest (3 EOs), northern fen (2 EOs), open dunes (19 EOs), rich conifer swamp (1 EO), sand and gravel beach (3 EOs), and wooded dune and swale complex (6 EOs). Table 1 lists the visited sites, their element occurrence ranks, and their previous element occurrence ranks if applicable.

The following site summaries contain a detailed discussion for each of these 65 natural communities organized alphabetically by community type and then by element occurrence. The beginning of each grouping of communities contains an overview of the natural community type, which was adapted from MNFI's natural community classification (Kost et al. 2007). In addition, an ecoregional distribution map is provided for each natural community type (Albert et al. 2008). For each site summary, the following information is provided:

- 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) threat assessment
- i) management recommendations

Community Type	EO ID	County	Survey Site	PRIOR EO RANK	CURRENT EO RANK	Surveyor
Bog	6555	Grand Traverse	Brinkman Bog	C	C	Joshua Cohen
Bog	6244	Mason	Green Road Bogs	B	B	Joshua Cohen
Bog	4572	Leelanau	Lost Lake Bog	BC	BC	Joshua Cohen
Boreal Forest	16925	Emmet	Headlands Boreal Forest	BC	BC	Joshua Cohen
Boreal Forest	19137	Leelanau	Leelanau Lighthouse	New EO	BC	Joshua Cohen
Boreal Forest	1867	Benzie	Point Betsie	C	BC	Bradford Slaughter
Boreal Forest	19140	Leelanau	Whaleback	New EO	C	Joshua Cohen
Clay Bluffs	19142	Leelanau	Clay Cliff	New EO	BC	Joshua Cohen
Clay Bluffs	19147	Leelanau	North Manitou Bluffs	New EO	AB	Joshua Cohen
Coastal Fen	19148	Emmet	Trail's End Bay	New EO	B	Joshua Cohen
Dry-mesic Northern Forest	19139	Leelanau	Kehl Lake	New EO	C	Joshua Cohen
Dry-mesic Northern Forest	3082	Grand Traverse	Leffingwell Point	B	C	Joshua Cohen
Dry-mesic Northern Forest	19149	Mason	Piney Ridge	New EO	BC	Joshua Cohen
Emergent Marsh	12715	Grand Traverse	Petobego Marsh	C	D	Joshua Cohen
Great Lakes Barrens	10494	Ottawa	Kitchel Dunes	BC	CD	Bradford Slaughter
Great Lakes Barrens	7312	Benzie	Platte Bay East	B	B	Bradford Slaughter
Great Lakes Barrens	19144	Benzie	Platte Bay West	New EO	AB	Joshua Cohen
Great Lakes Barrens	19150	Leelanau	North Manitou Barrens	New EO	B	Joshua Cohen
Great Lakes Barrens	273	Leelanau	Shalda Creek, Good Harbor Bay	BC	BC	Bradford Slaughter
Great Lakes Barrens	19151	Leelanau	South Manitou Barrens	New EO	B	Joshua Cohen
Great Lakes Marsh	12744	Emmet	Trail's End Bay	BC	BC	Joshua Cohen
Hardwood-Conifer Swamp	19138	Leelanau	Kehl Lake	New EO	C	Joshua Cohen
Interdunal Wetland	2008	Ottawa	Kitchel Dune Wetlands	C	C	Bradford Slaughter
Interdunal Wetland	6666	Benzie	Platte Bay East	BC	C	Bradford Slaughter
Interdunal Wetland	239	Benzie	Platte Bay West	BC	B	Joshua Cohen
Interdunal Wetland	19163	Benzie	Point Betsie	New EO	C	Bradford Slaughter
Interdunal Wetland	19164	Leelanau	Shalda Creek, Good Harbor Bay	New EO	BC	Bradford Slaughter
Interdunal Wetland	19152	Leelanau	South Manitou Island	New EO	BC	Joshua Cohen
Interdunal Wetland	19146	Leelanau	Vessel Point	New EO	BC	Joshua Cohen
Limestone Cobble Shore	19153	Emmet	Headlands Cobble Shore	New EO	B	Joshua Cohen
Limestone Cobble Shore	19135	Grand Traverse	Old Mission Lighthouse	New EO	B	Joshua Cohen
Mesic Northern Forest	10898	Grand Traverse	Leffingwell Point	B	BC	Joshua Cohen
Mesic Northern Forest	3786	Benzie	Point Betsie	C	BC	Bradford Slaughter
Mesic Northern Forest*	52	Ottawa	Rosy Mound	B	C	Bradford Slaughter

Table 1. Summary of Natural Community Surveys (* indicates element occurrence natural community type was re-classified).

Community Type	EO ID	County	Survey Site	PRIOR EO RANK	CURRENT EO RANK	Surveyor
Northern Fen	16763	Alpena	North Point Road Fen	B	B	Joshua Cohen
Northern Fen	19145	Benzie	Round Lake Fen	New EO	B	Joshua Cohen
Open Dunes	19136	Grand Traverse	Bluff's Road	New EO	CD	Joshua Cohen
Open Dunes	10670	Benzie	Elberta Dunes	C	CD	Joshua Cohen
Open Dunes	4199	Benzie and Leelanau	Empire Bluffs	BC	B	Joshua Cohen
Open Dunes	2678	Benzie	Frankfort Beach	C	CD	Joshua Cohen
Open Dunes	19160	Leelanau	Gull Point Dunes	New EO	B	Joshua Cohen
Open Dunes	8436	Ottawa	Kitchel Dunes	C	CD	Bradford Slaughter
Open Dunes	6368	Emmet	McCort Hill	C	C	Joshua Cohen
Open Dunes	19161	Leelanau	North Shore Dunes	New EO	B	Joshua Cohen
Open Dunes	12637	Benzie	Platte Bay East	B	B	Bradford Slaughter
Open Dunes	8311	Benzie	Platte Bay West	AB	B	Joshua Cohen
Open Dunes	10790	Benzie	Point Betsie	BC	BC	Bradford Slaughter
Open Dunes	12961	Leelanau	Pyramid Point	BC	BC	Joshua Cohen
Open Dunes	2247	Ottawa	Rosy Mound	C	C	Bradford Slaughter
Open Dunes	11583	Leelanau	Shalda Creek, Good Harbor Bay	BC	BC	Bradford Slaughter
Open Dunes	19156	Leelanau	Section 17 Dunes	New EO	BC	Joshua Cohen
Open Dunes	7756	Mamistee	South Arcadia Dunes	C	C	Joshua Cohen
Open Dunes	19157	Leelanau	South Shore Dunes	New EO	AB	Joshua Cohen
Open Dunes	19154	Leelanau	West Side Dunes	New EO	AB	Joshua Cohen
Open Dunes	19141	Leelanau	Whaleback	New EO	C	Joshua Cohen
Rich Conifer Swamp	19143	Benzie	Otter Lake Swamp	New EO	C	Joshua Cohen
Sand and Gravel Beach	19159	Leelanau	South Manitou Beach	New EO	AB	Joshua Cohen
Sand and Gravel Beach	19158	Leelanau	Vessel Point	New EO	AB	Joshua Cohen
Sand and Gravel Beach	19155	Leelanau	West Side Beach	New EO	AB	Joshua Cohen
Wooded Dune and Swale Complex	6428	Leelanau	Crystal River	C	BC	Bradford Slaughter
Wooded Dune and Swale Complex	4223	Grand Traverse	Bower's Harbor Swamp	C	C	Joshua Cohen
Wooded Dune and Swale Complex	13045	Benzie	Platte Bay East	A	B	Bradford Slaughter
Wooded Dune and Swale Complex	1409	Benzie	Platte Bay West	A	B	Joshua Cohen
Wooded Dune and Swale Complex	2334	Leelanau	Shalda Creek, Good Harbor Bay	BC	B	Bradford Slaughter
Wooded Dune and Swale Complex	12324	Emmet	Trail's End Bay	C	C	Joshua Cohen

Table 1. Summary of Natural Community Surveys.

SITE SUMMARIES

BOG

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

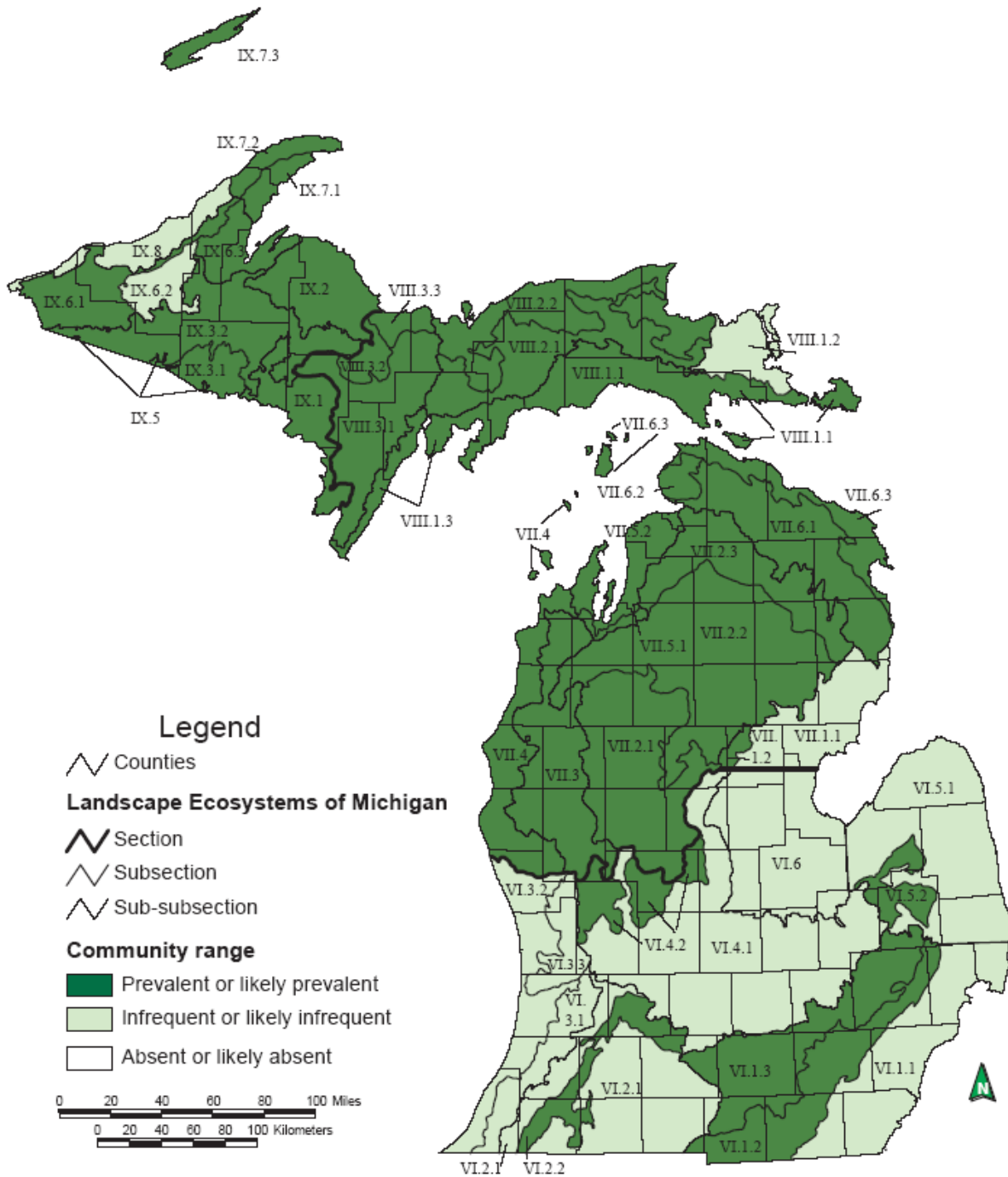


Figure 1. Distribution of bogs in Michigan.

1. Brinkman Bog

Natural Community Type: Bog

Rank: G3G5 S4, vulnerable to secure globally and secure within the state

Element Occurrence Rank: C

Size: 21 acres

Location: Grand Traverse County

Element Occurrence Identification Number: 6555

Threats: Fire suppression throughout the general landscape may have altered the fire regime of the bog. The road passing to the west of the bog may have impacted the bog's hydrology.

Management Recommendations: The main management recommendations are to maintain an undisturbed buffer adjacent to the bog to minimize the threat of hydrological alteration, consider burning the bog with the surrounding uplands, and monitor for invasive species and following prescribed fire.



Photo 1. Brinkman Bog. Photo by Joshua G. Cohen.

2. Green Road Bogs

Natural Community Type: Bog

Rank: G3G5 S4, vulnerable to secure globally and secure within the state

Element Occurrence Rank: B

Size: 84 acres

Location: Mason County

Element Occurrence Identification Number: 6244

Threats: The road passing near the peatland may be locally impacting the bog hydrology. In addition, fire suppression throughout the general landscape may have altered the fire regime of the bog.

Management Recommendations: The main management recommendations are to maintain a forested buffer to preserve the hydrology, consider burning the bog with the surrounding uplands, and monitor for invasive species and following prescribed fire.



Photo 2. Green Road Bogs. Photo by Joshua G. Cohen.

3. Lost Lake Bog

Natural Community Type: Bog

Rank: G3G5 S4, vulnerable to secure globally and secure within the state

Element Occurrence Rank: BC

Size: 36 acres

Location: Leelanau County

Element Occurrence Identification Number: 4572

Threats: The road passing to the east of the bog may be impacting the bog hydrology. Minerotrophic species (cat-tails and willows) occur in flooded areas along the road margin. In addition, a powerline passes through the southeast portion of the bog.

Management Recommendations: The main management recommendations are to maintain a forested buffer to preserve the hydrology and monitor for invasive species.



Photo 3. Lost Lake Bog. Photo by Joshua G. Cohen.

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).

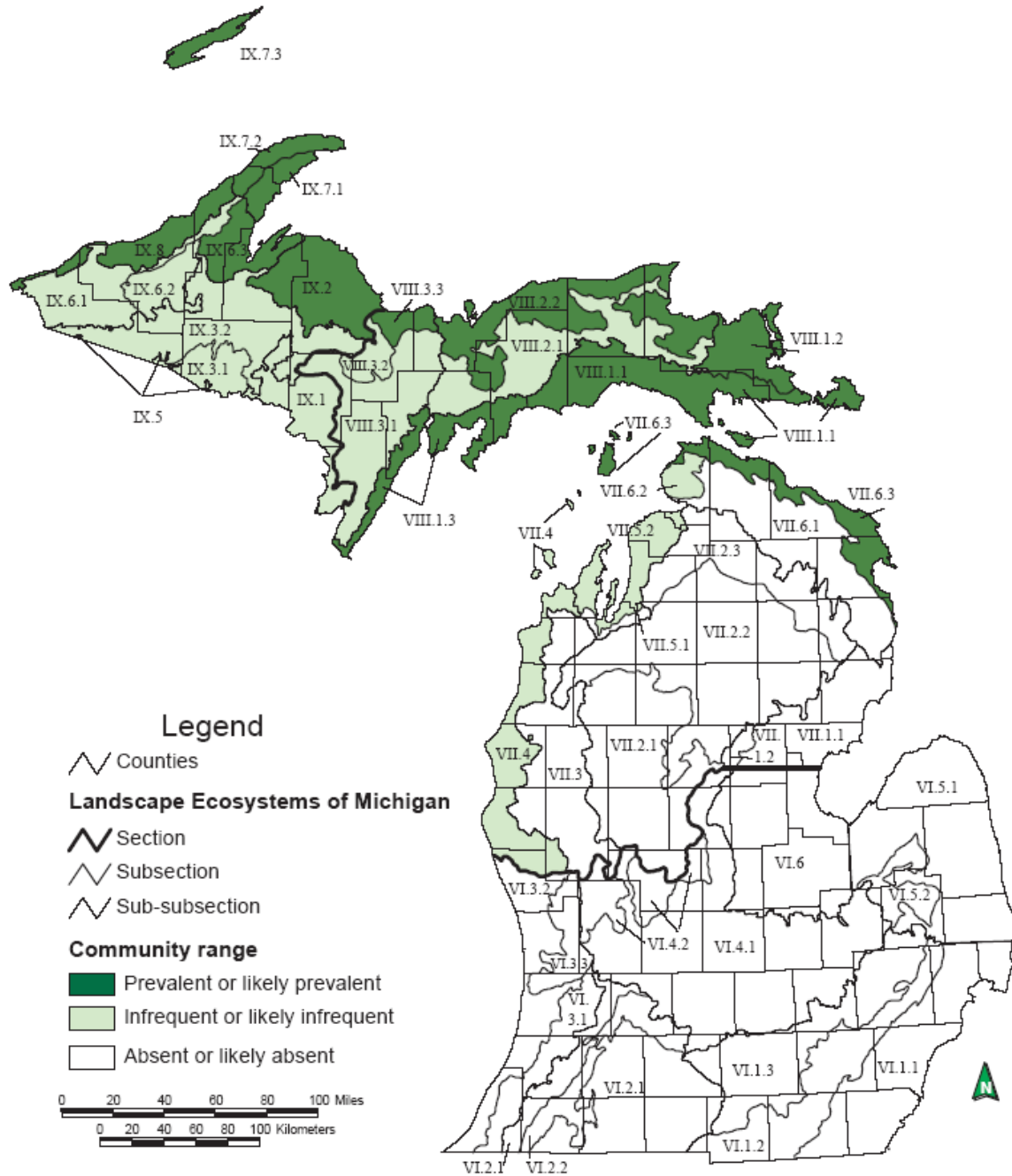


Figure 2. Distribution of boreal forest in Michigan.

4. Headlands Boreal Forest

Natural Community Type: Boreal Forest

Rank: GU S3, globally unrankable and vulnerable within the state

Element Occurrence Rank: BC

Size: 60 acres

Location: Emmet County

Element Occurrence Identification Number: 16925

Threats: The species composition and structure of this boreal forest is influenced by natural processes and deer herbivory. Potential threats include invasive species and deer herbivory. Currently observed non-natives [common speedwell (*Veronica officinalis*) and helleborine (*Epipactis helleborine*)] appear to be mainly weedy opportunists and not invasive. Deer herbivory appears to be limiting northern white-cedar (*Thuja occidentalis*) regeneration, which is noticeably missing from the understory. Deer trails were noted throughout the boreal forest and hiking trails also occur within the forest. Scattered, old cut stumps occur throughout the boreal forest. The canopy trees are bigger than the cut stumps.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to control non-native species, reduce deer herbivory, and monitor non-native species and deer browse impacts.



Photo 4. Headlands Boreal Forest. Photo by Joshua G. Cohen.

5. Leelanau Lighthouse

Natural Community Type: Boreal Forest

Rank: GU S3, globally unrankable and vulnerable within the state

Element Occurrence Rank: BC

Size: 22 acres

Location: Leelanau County

Element Occurrence Identification Number: 19137

Threats: No major threats were noted. Potential threats include invasive species and deer herbivory. Deer browse could limit the regeneration capacity of the overstory conifers.

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



Photo 5. Leelanau Lighthouse boreal forest. Photo by Joshua G. Cohen.

6. Point Betsie

Natural Community Type: Boreal Forest

Rank: GU S3, globally unrankable and vulnerable within the state

Element Occurrence Rank: BC

Size: 22 acres

Location: Benzie County

Element Occurrence Identification Number: 1867

Threats: Continued high deer densities will impact successional trajectories by reducing woody regeneration, reducing and/or eliminating populations of sensitive plant species, and facilitating the spread of invasive species, particularly garlic mustard (*Alliaria petiolata*), which was locally common.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, reduce deer densities to facilitate woody regeneration and recovery of sensitive ground layer species, and control and monitor for invasives species.



Photo 6. Point Betsie boreal forest. Photo by Bradford S. Slaughter.

7. Whaleback

Natural Community Type: Boreal Forest

Rank: GU S3, globally unrankable and vulnerable within the state

Element Occurrence Rank: C

Size: 15 acres

Location: Leelanau County

Element Occurrence Identification Number: 19140

Threats: Potential threats include invasive species and deer herbivory. Currently observed non-natives [common speedwell (*Veronica officinalis*) and sweet woodruff (*Galium odoratum*)] appear to be mainly weedy opportunists and not invasive. In addition Tartarian honeysuckle (*Lonicera tatarica*) occurs scattered along the forest edge. Deer herbivory appears to be limiting northern white-cedar (*Thuja occidentalis*) regeneration, which is noticeably missing from the understory. Deer trails traverse the bluff. Towards the northern portion of the boreal forest, close to the residence north of Whaleback, there has been some cutting in the forest.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, control non-native species, reduce deer herbivory, and monitor non-native species and deer browse impacts.



Photo 7. Whaleback boreal forest. Photo by Joshua G. Cohen.

CLAY BLUFFS

Overview: Clay bluffs is a forb-, graminoid-, and shrub-dominated and erosion-dependent community that occurs infrequently on steep to near-vertical slopes along the shorelines of Lake Michigan and Lake Superior. Clay bluffs is less commonly found localized along eroding banks of rivers and streams that form ravines through clay soils and drain into these Great Lakes. Clay bluffs range from three to 30 meters (10 to 100 feet) tall. Clay bluffs are dynamic systems with active sloughing occurring following frost heave and spring thaw and vegetation varying from year to year. Clay bluffs occurs on alkaline clays that are locally exposed following these landslide events. Species composition and vegetative structure of clay bluffs is patterned by sloughing of clay slopes due to ground-water seepage. Clay bluffs is characterized by sparse forb, graminoid, and low shrub cover, dense patches of tall shrubs, and scattered and stunted overstory trees.

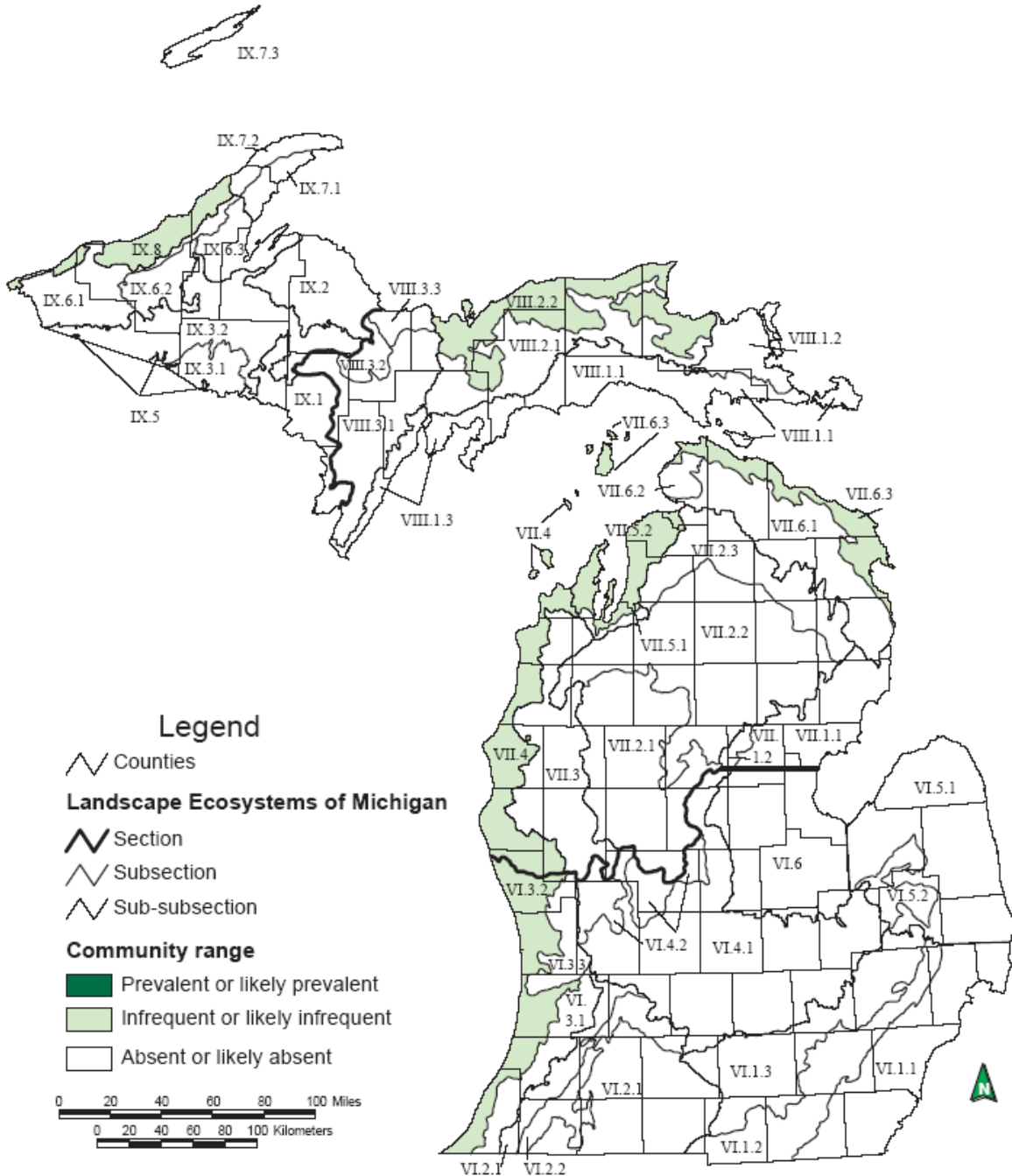


Figure 3. Distribution of clay bluffs in Michigan.

8. Clay Cliffs

Natural Community Type: Clay Bluffs

Rank: GNR S2, not ranked globally and imperiled within the state

Element Occurrence Rank: BC

Size: 14 acres

Location: Leelanau County

Element Occurrence Identification Number: 19142

Threats: The natural processes of seepage and landslide drive the species composition and structure of this community. However, non-native species are prevalent along the clay bluffs and include white sweet-clover (*Melilotus alba*), spotted knapweed (*Centaurea stoebe*), Oriental bittersweet (*Celastrus orbiculatus*), red clover (*Trifolium pratense*), Canada bluegrass (*Poa compressa*), and autumn olive (*Elaeagnus umbellata*). Non-native species occurring in the forest at the top of the bluffs could potentially seed into the clay bluffs. A stairway passes down the bluffs to the lakeshore.

Management Recommendations: The primary management recommendation is to maintain a buffer of natural communities to reduce the risk of altering the site's hydrology and introducing non-native species. Invasive species occurring along the bluffs should be controlled and these control efforts should be monitored.



Photo 8. Clay Cliffs clay bluffs. Photo by Joshua G. Cohen.

9. North Manitou Bluffs

Natural Community Type: Clay Bluffs

Rank: GNR S2, not ranked globally and imperiled within the state

Element Occurrence Rank: AB

Size: 18 acres

Location: Leelanau County

Element Occurrence Identification Number: 19147

Threats: The natural processes of erosion, seepage, and landslide drive the species composition and structure of this community. Invasives are the primary threat to the bluffs and are locally common to abundant. Documented invasives include white sweet-clover (*Melilotus alba*) (locally common), bladder campion (*Silene vulgaris*) (locally abundant), and Canada bluegrass (*Poa compressa*) (locally abundant).

Management Recommendations: The primary management recommendation is to maintain a buffer of natural communities to reduce the risk of altering the site's hydrology and introducing non-native species. Invasive species occurring along the bluffs should be controlled and these control efforts should be monitored.



Photo 9. North Manitou Bluffs clay bluffs. 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).

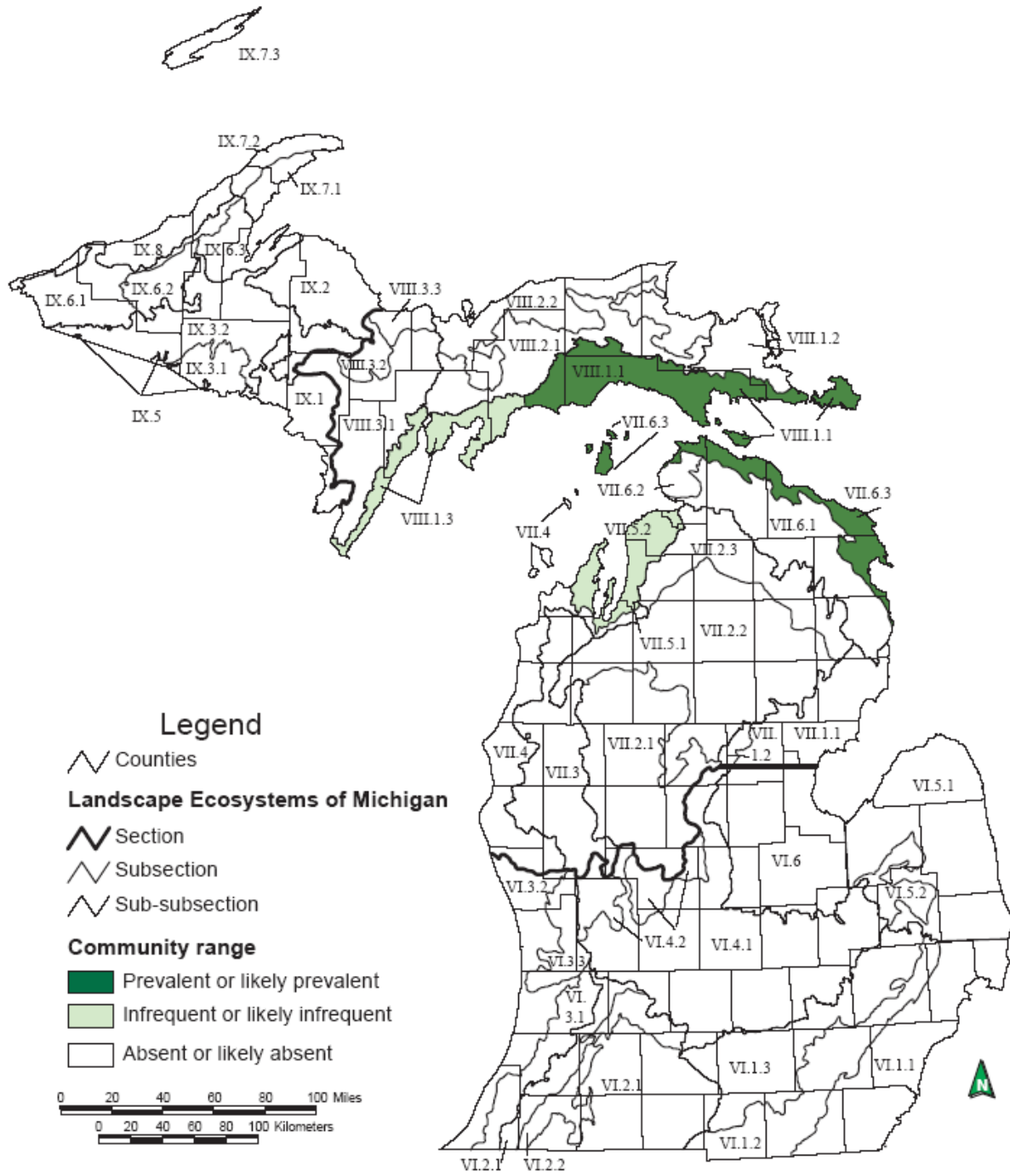


Figure 4. Distribution of coastal fen in Michigan.

10. Trail's End Bay

Natural Community Type: Coastal Fen

Rank: G1G2 S2, globally critically imperiled to imperiled and imperiled within the state

Element Occurrence Rank: B

Size: 29 acres

Location: Emmet County

Element Occurrence Identification Number: 19148

Threats: The coastal fen is relatively undisturbed. The hydrology of the fen is locally impacted by the adjacent paved road. In addition, a clump of narrow-leaved cat-tail (*Typha angustifolia*) was noted along the upland margin of the coastal fen.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain canopy closure of the surrounding wetlands and uplands to minimize surface water flow into the fen and to maintain groundwater seepage, make sure the culverts under the adjacent road are operating, control the clump of narrow-leaved cat-tail, and monitor for invasive plant populations.



Photo 10. Trail's End Bay coastal fen. Photo by Joshua G. Cohen.

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).

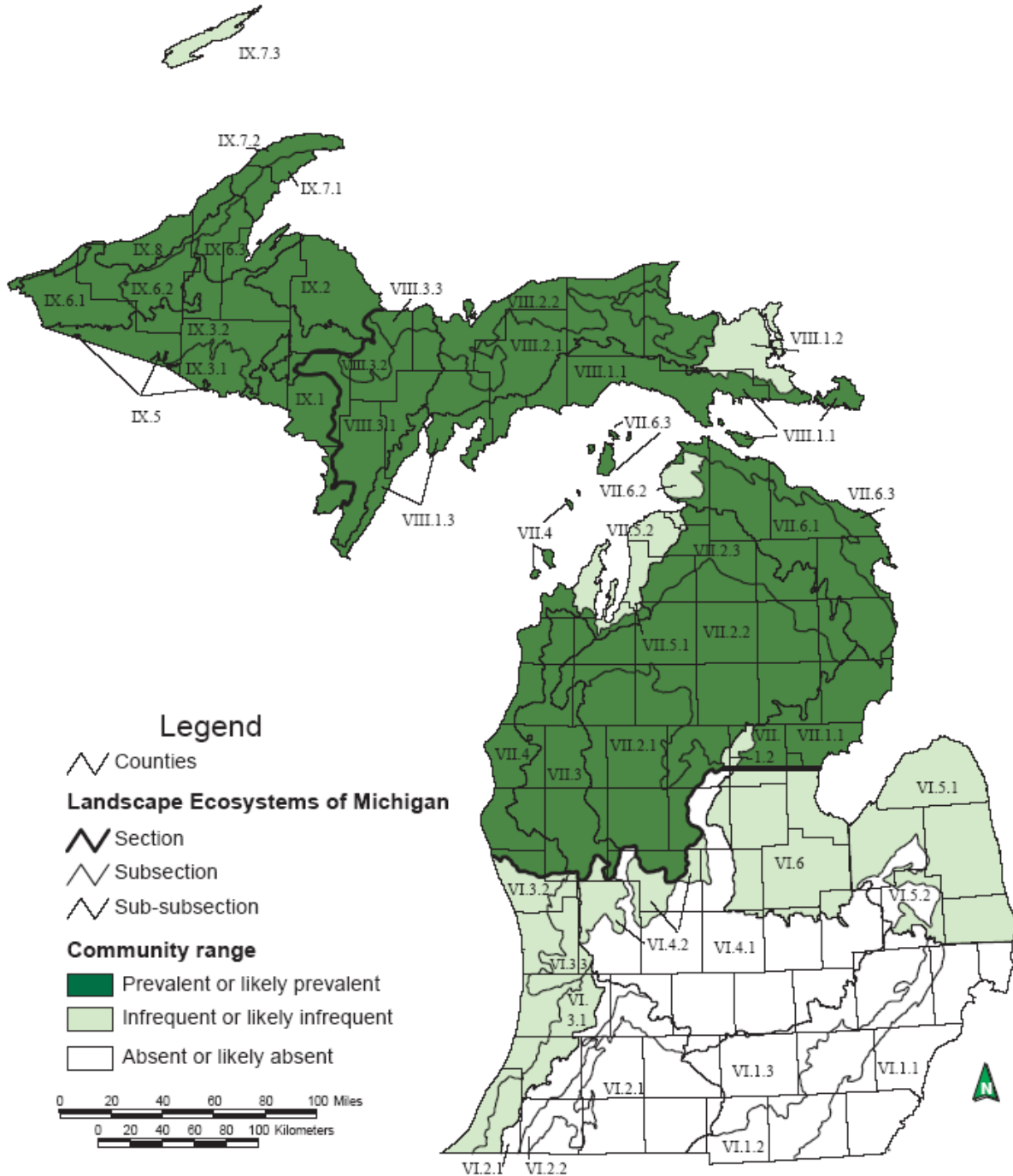


Figure 5. Distribution of dry-mesic northern forest in Michigan.

11. Kehl Lake

Natural Community Type: Dry-mesic Northern Forest

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: C

Size: 45 acres

Location: Leelanau County

Element Occurrence Identification Number: 19139

Threats: No major threats were noted during the course of the survey. Hiking trails occur within the dry-mesic northern forest.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding wetlands). The site should be monitored to ascertain if pines are recruiting and whether or not surface fires are occurring. If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and, if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used.



Photo 11. Kehl Lake dry-mesic northern forest. Photo by Joshua G. Cohen.

12. Leffingwell Point

Natural Community Type: Dry-mesic Northern Forest

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: C

Size: 12 acres

Location: Grand Traverse County

Element Occurrence Identification Number: 3082

Threats: Mesophytic invasion in the subcanopy and understory indicates that the stand has been fire suppressed for many decades. Cut stumps occur scattered throughout the forest complex and some of this cutting may be local harvest for firewood.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site). The site should be monitored to ascertain if pine and oak are recruiting and whether or not surface fires are occurring. If no fire occurs in 10 to 30 years, then pine and oak regeneration should be assessed, and, if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and trails) should be used. Existing mesophytic understory species could be controlled through girdling, herbicide, and/or mechanical felling.



Photo 12. Leffingwell Point dry-mesic northern forest. Photo by Joshua G. Cohen.

13. Piney Ridge

Natural Community Type: Dry-mesic Northern Forest

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: BC

Size: 110 acres

Location: Mason County

Element Occurrence Identification Number: 19149

Threats: No major threats were noted during the course of the survey. Scattered cut stumps were noted within the forest and deer browse was noted on understory northern white-cedar (*Thuja occidentalis*).

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding wetlands). The site should be monitored to ascertain if overstory species are recruiting and whether or not surface fires are occurring. If no fire occurs in 20 to 40 years, then advanced regeneration should be assessed, and, if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. In addition, monitoring should be implemented to evaluate deer browse impacts.



Photo 13. Piney Ridge dry-mesic northern forest. Photo by Joshua G. Cohen.

EMERGENT MARSH

Overview: Emergent marsh is a shallow-water wetland along the shores of lakes and streams characterized by emergent narrow- and broad-leaved herbs and grass-like plants as well as floating-leaved herbs. Common plants include water plantains (*Alisma* spp.), sedges (*Carex* spp.), spike-rushes (*Eleocharis* spp.), pond-lilies (*Nuphar* spp.), pickerel weed (*Pontederia cordata*), arrowheads (*Sagittaria* spp.), bulrushes (*Schoenoplectus* spp.), and cat-tails (*Typha* spp.). The community occurs on both mineral and organic soils (Kost et al. 2007).



Figure 6. Distribution of emergent marsh in Michigan.

14. Petobego Marsh

Natural Community Type: Emergent Marsh

Rank: GU S4, globally unrankable and secure within the state

Element Occurrence Rank: D

Size: 273 acres

Location: Grand Traverse County

Element Occurrence Identification Number: 12715

Threats: The Petobego Marsh has been greatly influenced by anthropogenic disturbance including marl harvesting by a cement company and the damming of the stream to create the flooding in 1951. In addition, invasives are prevalent and locally dominant [i.e., narrow-leaved cat-tail (*Typha angustifolia*) and hybrid cattail (*Typha xglauca*)]. Multiflora rose (*Rosa multiflora*) and glossy buckthorn (*Frangula alnus*) occur along the edges of the emergent marsh.

Management Recommendations: The main management recommendations are to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of further hydrological alteration and to reduce and monitor invasive species.



Photo 14. Petobego Marsh. Photo by Joshua G. Cohen.

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).

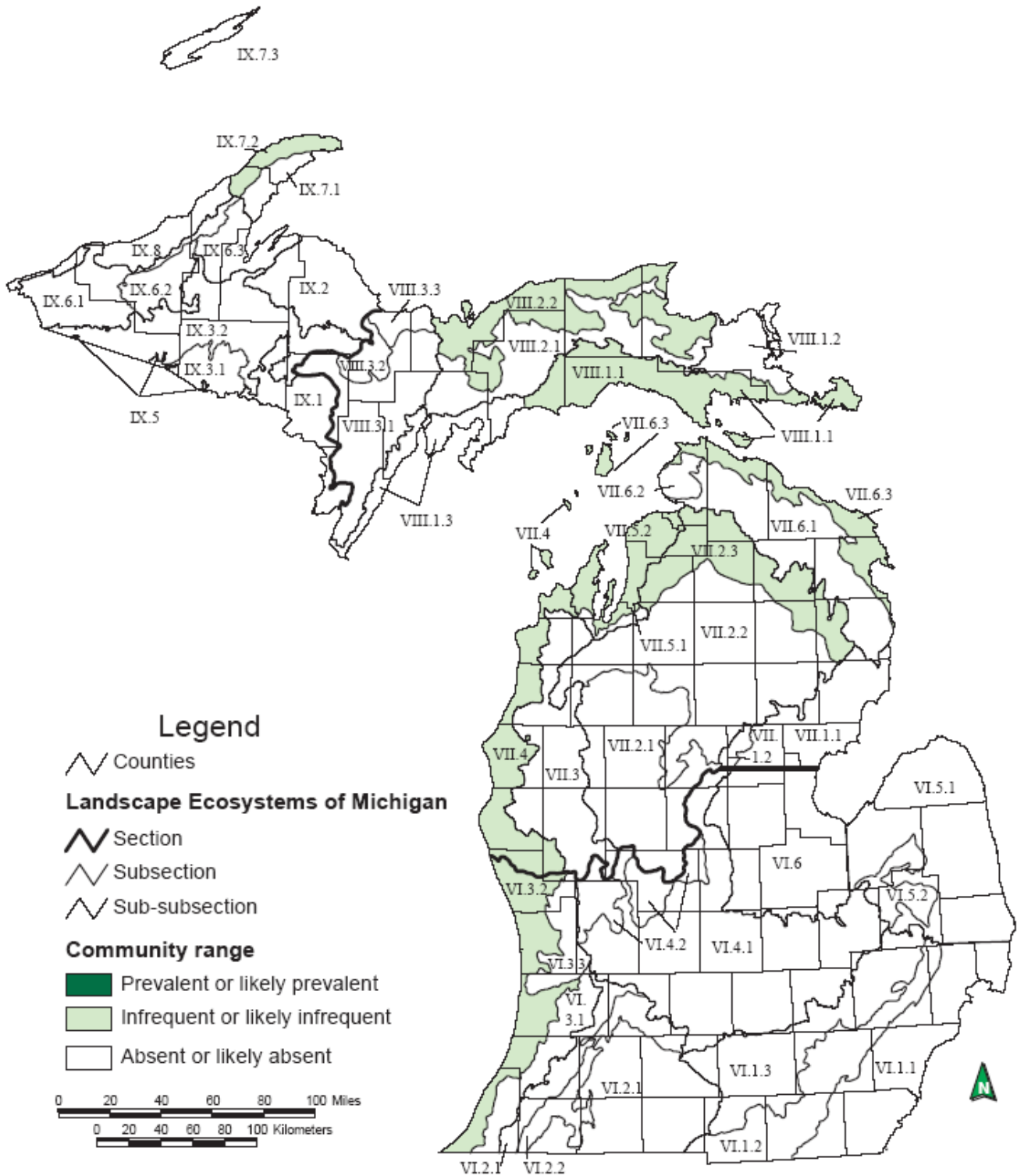


Figure 7. Distribution of Great Lakes barrens in Michigan.

15. Kitchel Dunes

Natural Community Type: Great Lakes Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: CD

Size: 21 acres

Location: Ottawa County

Element Occurrence Identification Number: 10494

Threats: The primary threats are continued severe deer browse and the spread of invasive plant species. Deer browse has eliminated jack pine (*Pinus banksiana*) regeneration and has likely reduced or eliminated populations of native ground layer species. Invasive species, including Canada bluegrass (*Poa compressa*), provide much of the groundcover in places. In addition to deer browse, lack of fire and climatic warming may threaten jack pine regeneration here near its southern range limit.

Management Recommendations: The primary management recommendations are to control and monitor invasive plant species and reduce deer densities.



Photo 15. Kitchel Dunes Great Lakes barrens. Photo by Bradford S. Slaughter.

16. Platte Bay East

Natural Community Type: Great Lakes Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: B

Size: 93 acres

Location: Benzie County

Element Occurrence Identification Number: 7312

Threats: Threats include deer browsing and invasive plants. Invasives that are common within these Great Lakes barrens include baby's breath (*Gypsophila paniculata*), spotted knapweed (*Centaurea stoebe*), and common St. John's-wort (*Hypericum perforatum*). Deer browse is likely limiting jack pine (*Pinus banksiana*) regeneration. In addition, a potential long-term threat is climatic warming, which may alter the microclimate favored by jack pine.

Management Recommendations: The primary management recommendations are to eliminate clusters of invasive plants, especially spotted knapweed, baby's breath, and common St. John's-wort, monitor for invasive species following such control efforts, and reduce deer densities and study the impacts of deer on vegetative structure and composition. Many of the barrens patches are more forest-like in structure and support sensitive ground layer species that favor shaded conditions, so care should be taken when considering management activities to ensure persistence of these conditions.



Photo 16. Platte Bay East Great Lakes barrens. Photo by Bradford S. Slaughter.

17. Platte Bay West

Natural Community Type: Great Lakes Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: AB

Size: 226 acres

Location: Benzie County

Element Occurrence Identification Number: 19144

Threats: Threats include deer browsing and invasive plants. Deer trails and pellets were noted throughout the Great Lakes barrens. Invasive plants can eliminate native dune plants through competition for resources. Spotted knapweed (*Centaurea stoebe*) was noted as locally common within the Great Lakes barrens. Spotted knapweed is especially prevalent near clumps of trees, suggesting that perching birds introduced the seeds.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the larger dune complex, especially spotted knapweed, baby's breath (*Gypsophila paniculata*), and Austrian pine (*Pinus nigra*). Large areas with baby's breath and Austrian pine have been treated this past year in the adjacent open dunes. It is important to monitor for invasive species following such control efforts.



Photo 17. Platte Bay West Great Lakes barrens. Photo by Joshua G. Cohen.

18. North Manitou Barrens

Natural Community Type: Great Lakes Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: B

Size: 11 acres

Location: Leelanau County

Element Occurrence Identification Number: 19150

Threats: Threats include invasive plants and foot traffic and erosion. Invasives noted within the Great Lakes barrens and nearby open dunes include spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the dune complex, especially spotted knapweed and bladder campion. It is important to monitor for invasive species following such control efforts.



Photo 18. North Manitou Barrens Great Lakes barrens. Photo by Joshua G. Cohen.

19. Shalda Creek, Good Harbor Bay

Natural Community Type: Great Lakes Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: BC

Size: 94 acres

Location: Leelanau County

Element Occurrence Identification Number: 273

Threats: These Great Lakes barrens are fragmented by roads, trails, and associated soil erosion. Roads also provide conduits for invasive plant species. Spotted knapweed (*Centaurea stoebe*), reedtop (*Agrostis gigantea*), and several other non-native species were common. Potential long-term threats include fire suppression and climatic warming, which may alter the microclimate favored by jack pine (*Pinus banksiana*).

Management Recommendations: The primary management recommendations are to eliminate clusters of non-native plants, monitor for invasive species, and monitor unsanctioned access roads and trails for human disturbance. The application of prescribed fire could be considered to promote jack pine regeneration.



Photo 19. Shalda Creek, Good Harbor Bay Great Lakes barrens. Photo by Bradford S. Slaughter.

20. South Manitou Barrens

Natural Community Type: Great Lakes Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: B

Size: 40 acres

Location: Leelanau County

Element Occurrence Identification Number: 19151

Threats: Threats include invasive plants and foot traffic and erosion. Several rustic camp sites and hiking trails occur within the Great Lakes barrens and the dry northern forest just west of the barrens. Several invasive plants are concentrated along these trails including spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the dune complex, especially spotted knapweed and bladder campion. It is important to monitor for invasive species following such control efforts. Rustic camp sites set in the Great Lakes barrens could be removed to help reduce erosion and spread of non-native species and limit human impact within the barrens.



Photo 20. South Manitou 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).

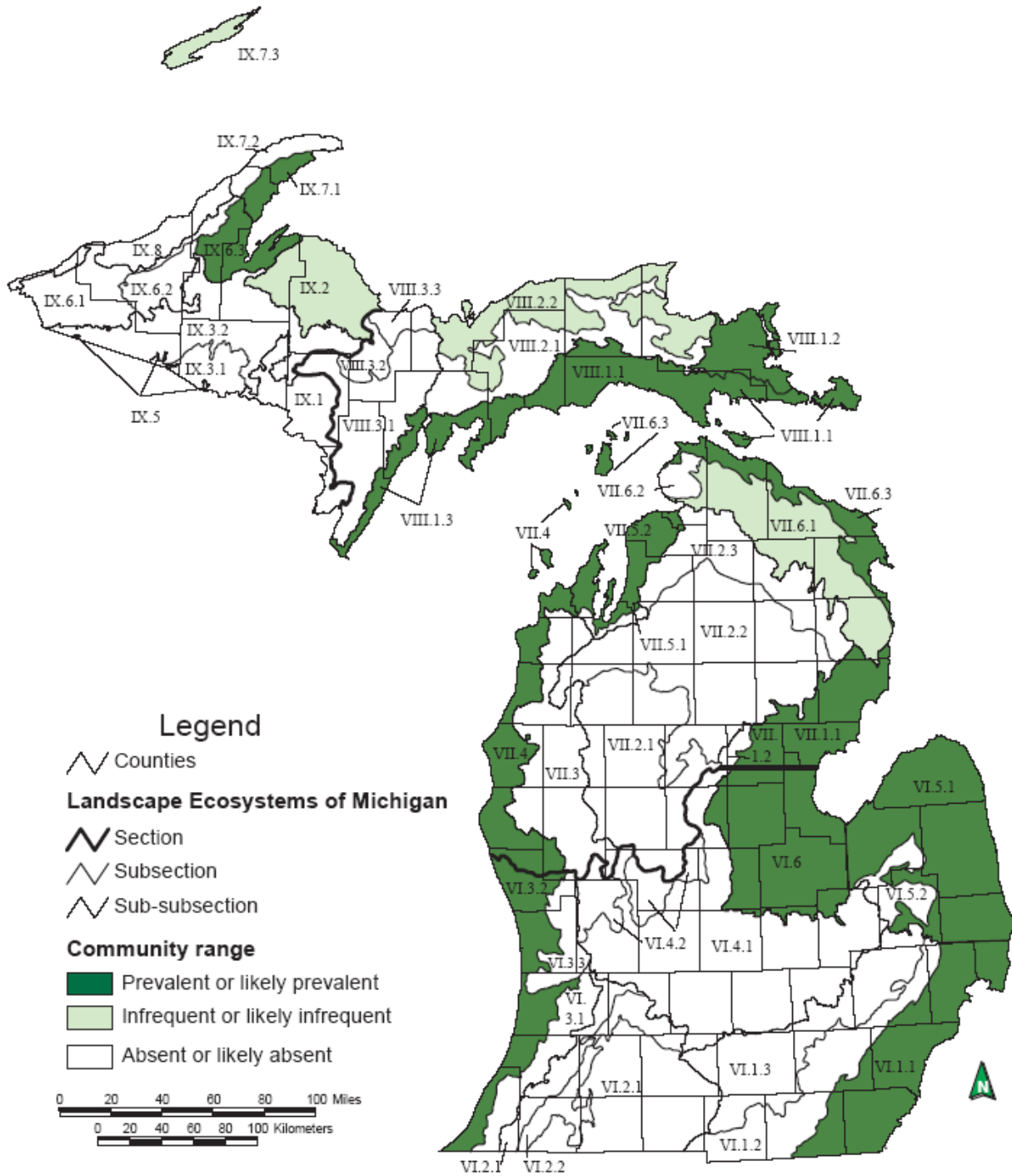


Figure 8. Distribution of Great Lakes marsh in Michigan.

21. Trail's End Bay

Natural Community Type: Great Lakes Marsh

Rank: G2 S3, globally imperiled and vulnerable within the state

Element Occurrence Rank: BC

Size: 68 acres

Location: Emmet County

Element Occurrence Identification Number: 12744

Threats: Threats include illegal off-road vehicle activity, diffuse impacts of hikers, and invasive plants [i.e., narrow-leaved cat-tail (*Typha angustifolia*)]. Off-road vehicle tracks were noted in portions of the Great Lakes marsh.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, eliminate illegal off-road vehicle activity along the shoreline, control non-native plants along the shoreline (i.e., narrow-leaved cat-tail), make sure the culverts under the adjacent road are operating, and monitor for invasive species following control efforts.



Photo 21. Trail's End Bay Great Lakes marsh. Photo by Joshua G. Cohen.

HARDWOOD-CONIFER SWAMP

Overview: Hardwood-conifer swamp is a minerotrophic forested wetland dominated by a mixture of lowland hardwoods and conifers, occurring on organic (i.e., peat) and poorly drained mineral soils throughout Michigan. The community occurs on a variety of landforms, often associated with headwater streams and areas of groundwater discharge. Species composition and dominance patterns can vary regionally. Windthrow and fluctuating water levels are the primary natural disturbances that structure hardwood-conifer swamp (Kost et al. 2007).

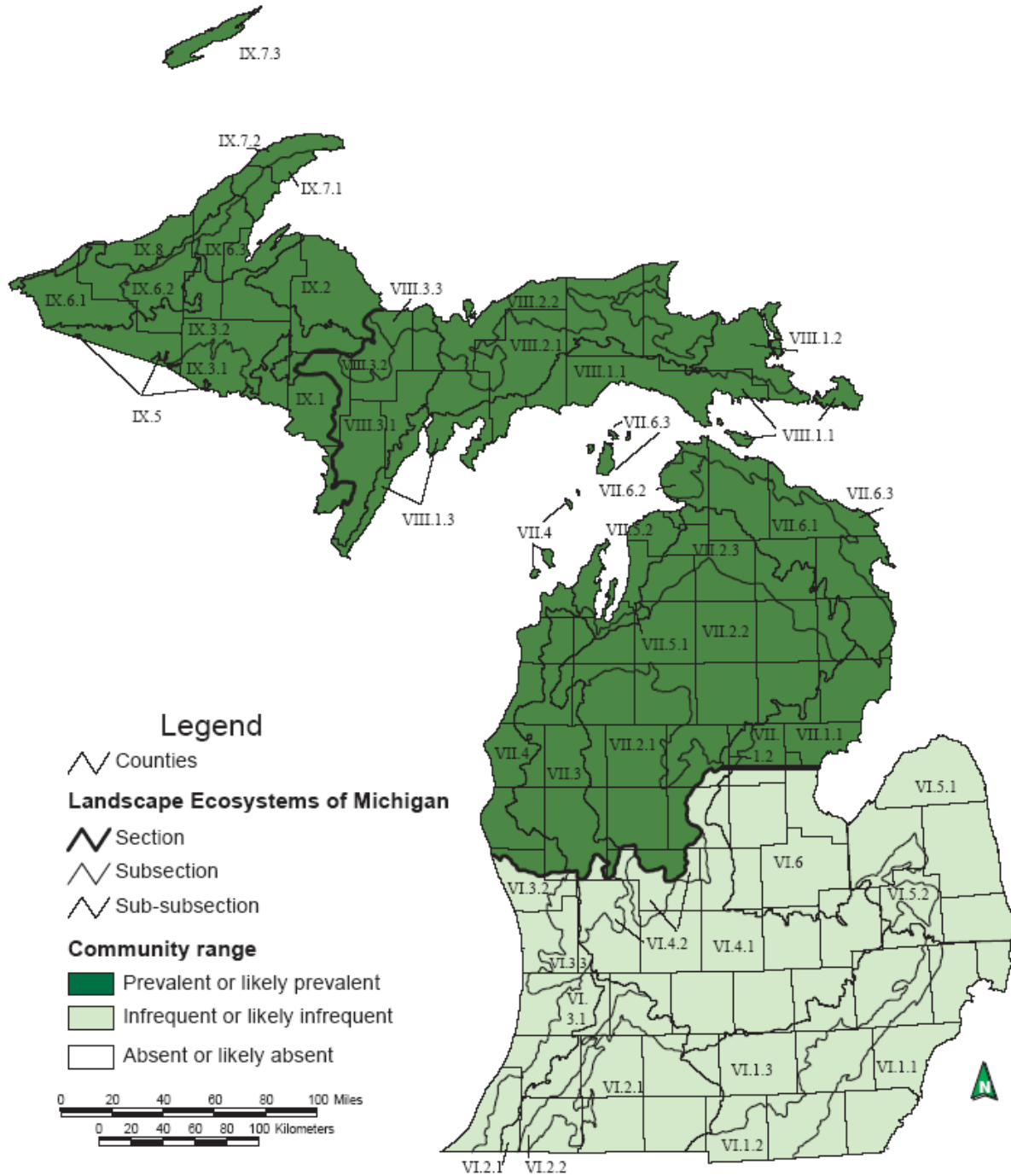


Figure 9. Distribution of hardwood-conifer swamp in Michigan.

22. Kehl Lake

Natural Community Type: Hardwood-Conifer Swamp

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: C

Size: 74 acres

Location: Leelanau County

Element Occurrence Identification Number: 19138

Threats: Threats to this hardwood-conifer swamp include invasive species and deer herbivory. Japanese barberry (*Berberis thunbergii*) and autumn olive (*Elaeagnus umbellata*) were noted in the understory and deer trails occur within the complex. In addition, non-natives documented in the ground cover include lawn prunella (*Prunella vulgaris*) (locally common), common speedwell (*Veronica officinalis*) (locally common), and bittersweet nightshade (*Solanum dulcamara*) (locally common).

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding uplands). Control and monitoring of non-native plants is recommended. Monitoring for deer browse is also recommended.



Photo 22. Kehl Lake hardwood-conifer swamp. Photo by Joshua G. Cohen.

INTERDUNAL WETLAND

Overview: Interdunal wetland is a rush-, sedge-, and shrub-dominated wetland situated in depressions within open dunes or between beach ridges along the Great Lakes, experiencing a fluctuating water table seasonally and yearly in synchrony with lake level changes (Kost et al. 2007).

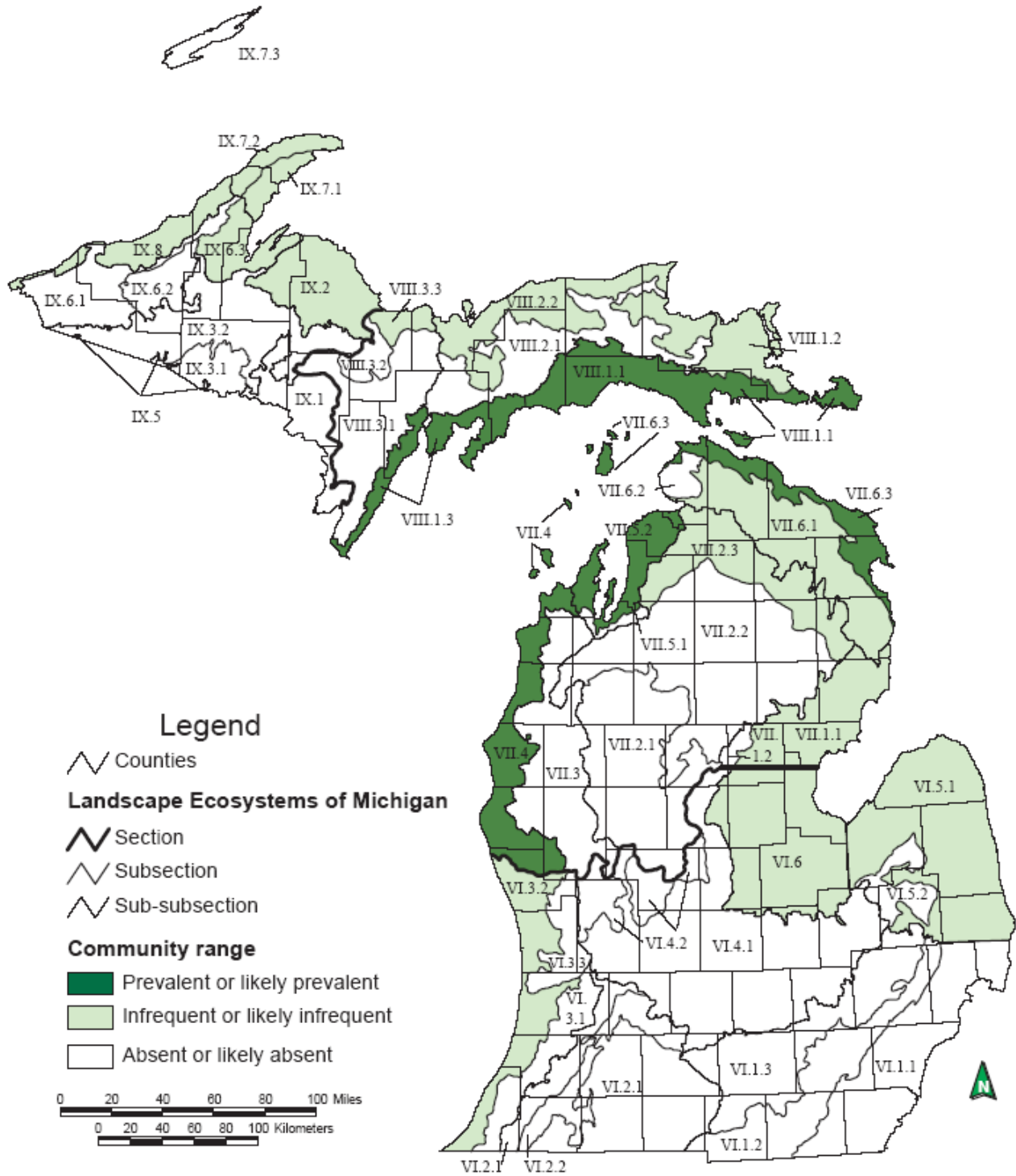


Figure 10. Distribution of interdunal wetland in Michigan.

23. Kitchel Dune Wetlands

Natural Community Type: Interdunal Wetland

Rank: G2? S2, imperiled throughout range

Element Occurrence Rank: C

Size: 7.1 acres

Location: Ottawa County

Element Occurrence Identification Number: 2008

Threats: Invasive species particularly spotted knapweed (*Centaurea stoebe*), are the primary threat to this interdunal wetland, particularly if Great Lakes water levels remain low and the wetlands continue to dry out. In addition, deer browse is likely reducing populations of browse-sensitive species. Off-road vehicles could cause considerable damage to the wetland, but no incursions were noted.

Management Recommendations: The primary management recommendations are to control invasive plants and monitor for invasive species and reduce deer densities.



Photo 23. Kitchel Dune Wetlands interdunal wetland. Photo by Bradford S. Slaughter.

24. Platte Bay East

Natural Community Type: Interdunal Wetland

Rank: G2? S2, imperiled throughout range

Element Occurrence Rank: BC

Size: 1.1 acres

Location: Benzie County

Element Occurrence Identification Number: 6666

Threats: Invasive plant species are the primary threat to the integrity of the interdunal wetlands. In particular, baby's breath (*Gypsophila paniculata*) and spotted knapweed (*Centaurea stoebe*) are common, particularly in desiccated pannes. Deer browse is also a concern, especially where interdunal wetlands occur within stands of jack pine.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, control invasive plants (i.e., spotted knapweed, baby's breath) within the dunes complex, monitor for invasive species following such control efforts, and monitor deer browse impacts.



Photo 24. Platte Bay East interdunal wetland. Photo by Bradford S. Slaughter.

25. Platte Bay West

Natural Community Type: Interdunal Wetland

Rank: G2? S2, imperiled throughout range

Element Occurrence Rank: B

Size: 25 acres

Location: Benzie County

Element Occurrence Identification Number: 239

Threats: Threats include deer browsing and invasive plants. Deer trails and pellets were noted throughout the open dunes complex. Spotted knapweed (*Centaurea stoebe*), Austrian pine (*Pinus nigra*), and baby's breath (*Gypsophila paniculata*) were noted as locally common within the adjacent open dunes.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, control invasive plants (i.e., spotted knapweed, Austrian pine, and baby's breath) within the dunes complex, and monitor for invasive species following such control efforts.



Photo 25. Platte Bay West interdunal wetland. Photo by Joshua G. Cohen.

26. Point Betsie

Natural Community Type: Interdunal Wetland

Rank: G2? S2, imperiled throughout range

Element Occurrence Rank: C

Size: 4.1 acres

Location: Benzie County

Element Occurrence Identification Number: 19164

Threats: Invasive species, particularly baby's breath (*Gypsophila paniculata*), are the primary threat to the interdunal wetland. In addition, development of private parcels is a potential threat.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, control invasive plants, and monitor for invasive species following such control efforts.



Photo 26. Point Betsie interdunal wetland. Photo by Bradford S. Slaughter.

27. Shalda Creek, Good Harbor Bay

Natural Community Type: Interdunal Wetland

Rank: G2? S2, imperiled throughout range

Element Occurrence Rank: BC

Size: 1.1 acres

Location: Leelanau County

Element Occurrence Identification Number: 19163

Threats: Invasive species are occasional within the interdunal wetland, occurring at the margins of the pannes. Spotted knapweed (*Centaurea stoebe*) is of particular concern.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, control invasive plants (i.e., spotted knapweed), and monitor for invasive species following such control efforts.



Photo 27. Shalda Creek, Good Harbor Bay interdunal wetland. Photo by Bradford S. Slaughter.

28. South Manitou Island

Natural Community Type: Interdunal Wetland

Rank: G2? S2, imperiled throughout range

Element Occurrence Rank: BC

Size: 0.2 acres

Location: Leelanau County

Element Occurrence Identification Number: 19152

Threats: No threats were noted within the interdunal wetland. Invasive plant species [i.e., spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*)] could invade the interdunal wetland from the nearby open dunes and shoreline.

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



Photo 28. South Manitou Island interdunal wetland. Photo by Joshua G. Cohen.

29. Vessel Point

Natural Community Type: Interdunal Wetland

Rank: G2? S2, imperiled throughout range

Element Occurrence Rank: BC

Size: 1.3 acres

Location: Leelanau County

Element Occurrence Identification Number: 19146

Threats: No threats were noted within the interdunal wetland. Invasive plant species [i.e., spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*)] could invade the interdunal wetland from the nearby open dunes and shoreline.

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



Photo 29. Vessel Point interdunal wetland. 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).

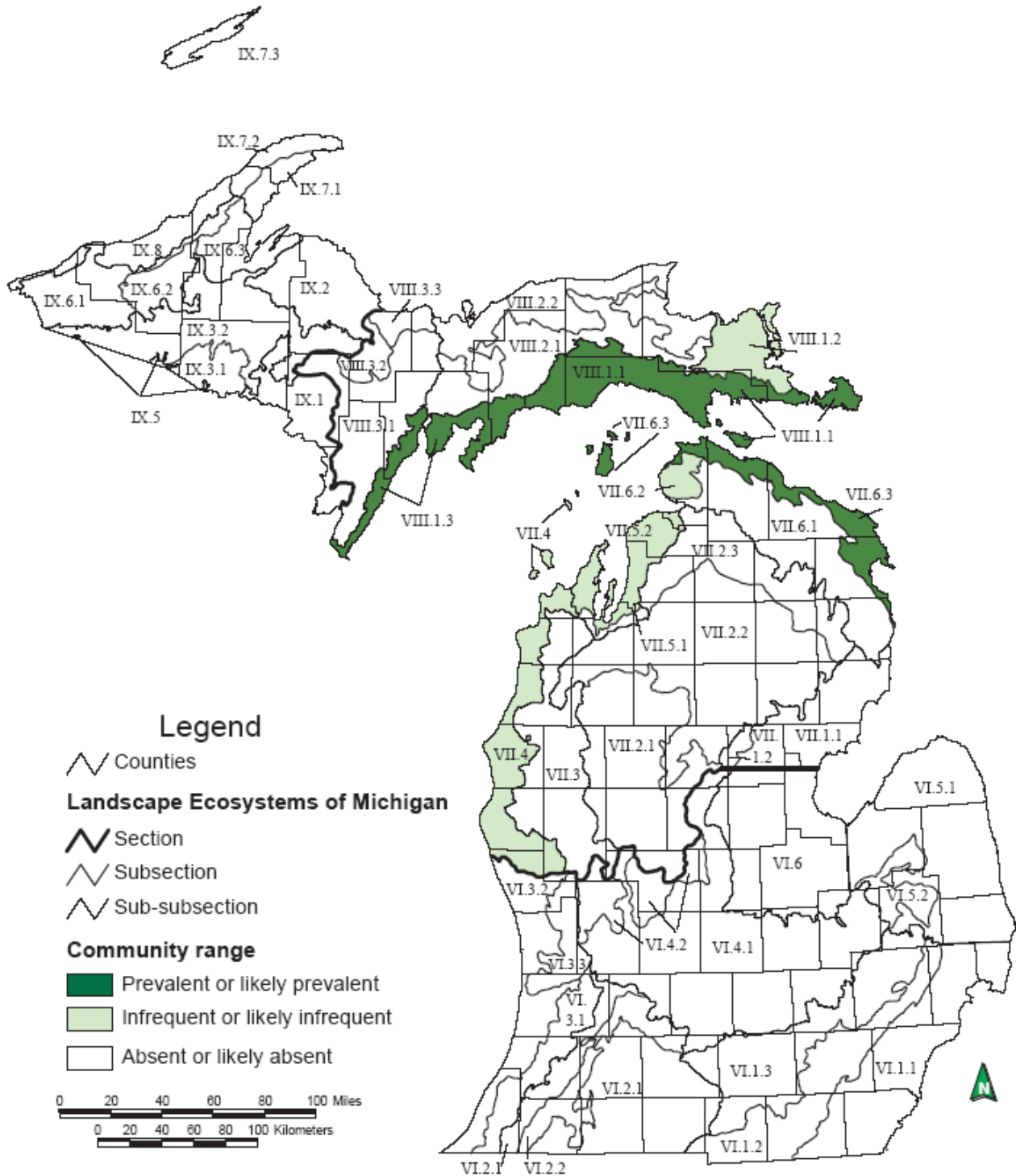


Figure 11. Distribution of limestone cobble shore in Michigan.

30. Headlands Cobble Shore

Natural Community Type: Limestone Cobble Shore

Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state

Element Occurrence Rank: B

Size: 28 acres

Location: Emmet County

Element Occurrence Identification Number: 19153

Threats: The limestone cobble shore is impacted by non-native species, diffuse impacts of hikers, and off-road vehicles. Off-road vehicle tracks were noted along the limestone cobble shore. Non-native species noted within the limestone cobble shore include spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*).

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain canopy closure of the surrounding uplands, monitor for invasive plant populations, and restrict off-road vehicle activity along the shoreline.



Photo 30. Headlands Cobble Shore limestone cobble shore. Photo by Joshua G. Cohen.

31. Old Mission Lighthouse

Natural Community Type: Limestone Cobble Shore

Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state

Element Occurrence Rank: B

Size: 49 acres

Location: Grand Traverse County

Element Occurrence Identification Number: 19135

Threats: The limestone cobble shore is impacted by non-native species [narrow-leaved cat-tail (*Typha angustifolia*)] and the diffuse impacts of people. The proximity of the lighthouse results in a significant amount of foot traffic and even some bicycle traffic. Many tourists are using the cobble to write and create structures.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., Great Lakes water level fluctuations) to operate unhindered, maintain canopy closure of the surrounding uplands, monitor for invasive plant populations, and limit foot and bicycle traffic along the shoreline.



Photo 31. Old Mission Lighthouse limestone cobble shore. Photo by Joshua G. Cohen.

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 occurred 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).

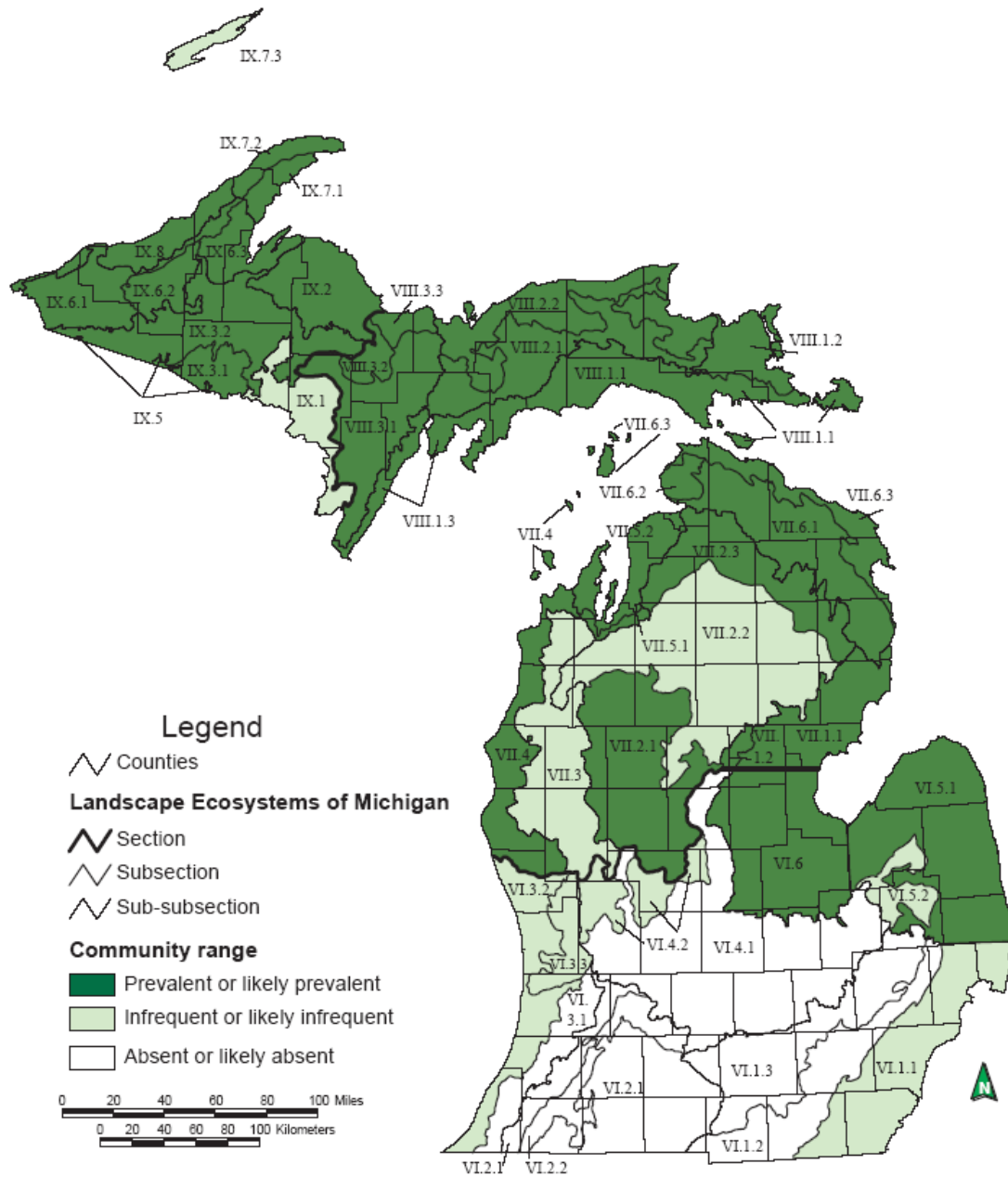


Figure 12. Distribution of mesic northern forest in Michigan.

32. Leffingwell Point

Natural Community Type: Mesic Northern Forest

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: BC

Size: 79 acres

Location: Grand Traverse County

Element Occurrence Identification Number: 10898

Threats: The species composition and structure of the mesic northern forest are driven by natural processes and past anthropogenic disturbance history. Past logging and/or fire within this forest complex likely allowed for the establishment of mid-tolerant species including red oak (*Quercus rubra*), white ash (*Fraxinus americana*), and basswood (*Tilia americana*). A clump of myrtle (*Vinca minor*) occurs within the forest and invasives occur along the adjacent road [i.e., Canada bluegrass (*Poa compressa*)] and shoreline [i.e., spotted knapweed (*Centaurea stoebe*)]. The canopy beech within the forest are infected with beech bark disease. Trails and old two-tracks occur within the forest.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., windthrow and fire) to operate unhindered and to control invasive species within the forest and in the adjacent landscape.



Photo 32. Leffingwell Point mesic northern forest. Photo by Joshua G. Cohen.

33. Point Betsie

Natural Community Type: Mesic Northern Forest

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: C

Size: 118 acres

Location: Benzie County

Element Occurrence Identification Number: 3786

Threats: Concentrated deer activity and severe browse are the primary threats to the mesic northern forest, threatening to alter successional pathways and reduce or eliminate populations of sensitive plant species. Garlic mustard (*Alliaria petiolata*) and other invasive species are also a threat, particularly in the vicinity of homes and M-22.

Management Recommendations: The primary management recommendations are to allow natural processes (i.e., windthrow and fire) to operate unhindered, reduce deer densities to facilitate woody regeneration and recovery of sensitive ground layer species, and control invasive species (i.e., garlic mustard).



Photo 33. Point Betsie mesic northern forest. Photo by Bradford S. Slaughter.

34. Rosy Mound

Natural Community Type: Mesic Northern Forest

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: C

Size: 135 acres

Location: Ottawa County

Element Occurrence Identification Number: 52

Threats: The primary threats to the forest are high deer densities, invasive species, and recreational misuse (i.e., firepits and dumping). Garlic mustard (*Alliaria petiolata*) and Morrow honeysuckle (*Lonicera morrowii*) are particularly common in the forest.

Management Recommendations: The primary management recommendation is to assess deer density and reduce deer populations in the area to promote recovery of the shrub layer, tree regeneration, and ground layer species. Invasive species (i.e., garlic mustard and Morrow honeysuckle) should be spot-treated.



Photo 34. Rosy Mound mesic northern forest. Photo by Bradford S. Slaughter.

NORTHERN FEN

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

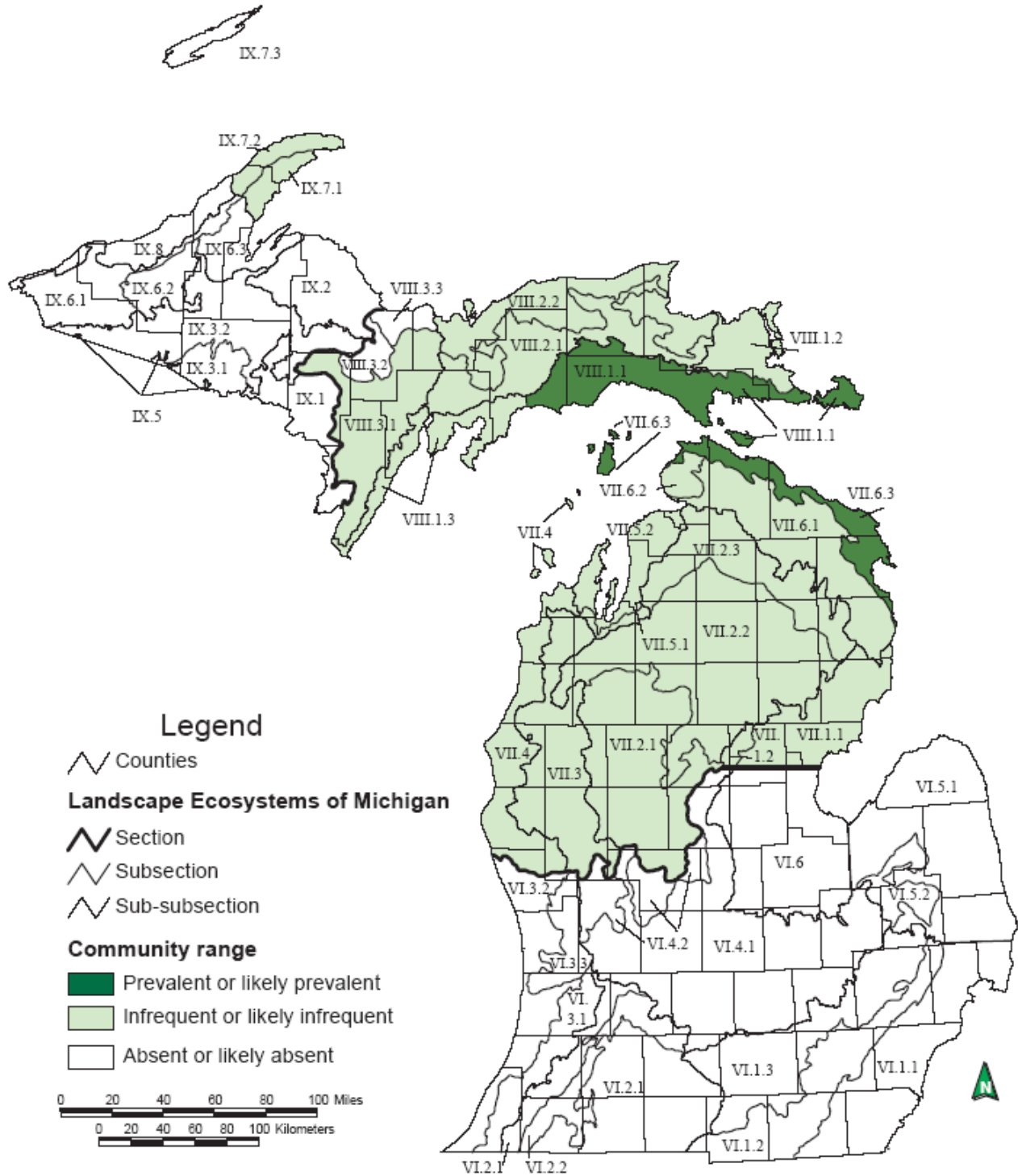


Figure 13. Distribution of northern fen in Michigan.

35. North Point Road Fen

Natural Community Type: Northern Fen

Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state

Element Occurrence Rank: B

Size: 82 acres

Location: Alpena County

Element Occurrence Identification Number: 16763

Threats: The northern fen is characterized by high floristic diversity and distinct ecological zonation due to gradients in soil and water chemistry. Species composition and zonation are patterned by natural processes. However, glossy buckthorn (*Frangula alnus*) was observed on some of the sphagnum islands within the fen.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration, and remove and monitor for invasive species (i.e., glossy buckthorn). Reducing local deer densities is also recommended.



Photo 35. North Point Road Fen. Photo by Joshua G. Cohen.

36. Round Lake Fen

Natural Community Type: Northern Fen

Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state

Element Occurrence Rank: B

Size: 36 acres

Location: Benzie County

Element Occurrence Identification Number: 19145

Threats: The northern fen is characterized by high floristic diversity and distinct ecological zonation due to gradients in soil and water chemistry. Species composition and zonation are patterned by natural processes. However, narrow-leaved cat-tail (*Typha angustifolia*) is locally common and deer have been browsing northern white-cedar (*Thuja occidentalis*) and dogwoods (*Cornus* spp.). In addition, the hydrology of the fen may be locally impacted by M-22, which occurs adjacent to the fen.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration, and remove and monitor for invasive species (i.e., narrow-leaved cat-tail). Reducing local deer densities is also recommended.



Photo 36. Round Lake Fen. 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).

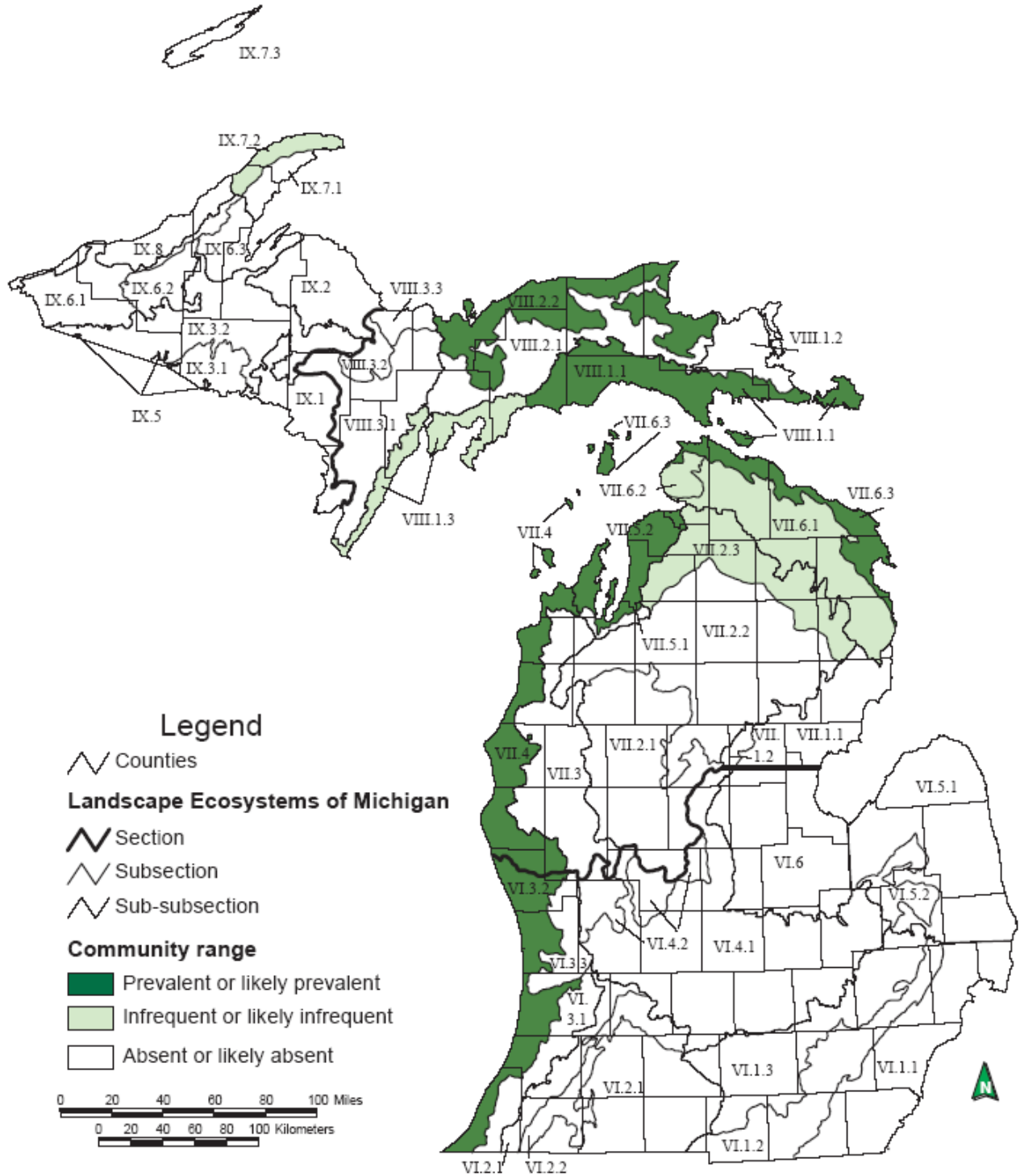


Figure 14. Distribution of open dunes in Michigan.

37. Bluffs Road

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: CD

Size: 3.6 acres

Location: Grand Traverse County

Element Occurrence Identification Number: 19136

Threats: Natural processes and competition from invasive species are determining species composition and structure. Invasives noted on the bluffs include white sweet-clover (*Melilotus alba*), spotted knapweed (*Centaurea stoebe*), common burdock (*Arctium minus*), and bladder campion (*Silene vulgaris*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, to control invasive species (spotted knapweed, white sweet-clover, common burdock, and bladder campion), and to monitor non-native species.



Photo 37. Bluffs Road open dunes. Photo by Joshua G. Cohen.

38. Elberta Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: CD

Size: 69 acres

Location: Benzie County

Element Occurrence Identification Number: 10670

Threats: Species composition and structure are driven by natural processes, off-road vehicle impacts, and competition from invasive species. Invasive species that are locally dominant in the dunes include spotted knapweed (*Centaurea stoebe*), baby's breath (*Gypsophila paniculata*), white sweet-clover (*Melilotus alba*), and bladder campion (*Silene vulgaris*). Locally common invasives include black locust (*Robinia pseudoacacia*), Austrian pine (*Pinus nigra*), multiflora rose (*Rosa multiflora*), ox-eye daisy (*Leucanthemum vulgare*), timothy (*Phleum pratense*), lyme grass (*Leymus arenarius*), and red clover (*Trifolium pratense*). Off-road vehicle activity is pervasive throughout the low foredunes and some activity was even noted along the steep eroding bluffs. This stretch of dunes receives heavy use and foot traffic and associated dune erosion is prevalent in the low foredunes. Numerous party spots are nestled within the low foredunes. A private staircase traverses the bluffs in the southern portion of the dune complex.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, remove clusters of non-native plants in the dune complex, eliminate illegal off-road vehicle activity, and monitor for invasive species following control efforts.



Photo 38. Elberta Dunes. Photo by Joshua G. Cohen.

39. Empire Bluffs

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: B

Size: 219 acres

Location: Benzie and Leelanau Counties

Element Occurrence Identification Number: 4199

Threats: Threats include invasive plants, deer browse, and foot traffic and erosion. Infrequent foot traffic from hikers along perched dunes and bluffs has resulted in localized erosion. Invasives noted in the dune complex include baby's breath (*Gypsophila paniculata*), bladder campion (*Silene vulgaris*), spotted knapweed (*Centaurea stoebe*), white sweet-clover (*Melilotus alba*), and Austrian pine (*Pinus nigra*). Deer trails were noted along the bluffs and northern white-cedar (*Thuja occidentalis*) and dogwoods (*Cornus* spp.) have been browsed by deer.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts. Foot traffic on the perched dunes and bluffs could be reduced by educating park users about the fragile nature of open dunes. In addition, the deer population in the local area could be decreased to reduce the deer browse pressure on the shoreline ecosystems.



Photo 39. Empire Bluffs open dunes. Photo by Joshua G. Cohen.

40. Frankfort Beach

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: CD

Size: 109 acres

Location: Benzie County

Element Occurrence Identification Number: 2678

Threats: Threats include invasive plants, deer browse, and foot traffic and erosion. Invasive species that are locally dominant include spotted knapweed (*Centaurea stoebe*), white sweet-clover (*Melilotus alba*), baby's breath (*Gypsophila paniculata*), and bladder campion (*Silene vulgaris*). Lyme grass (*Leymus arenarius*) and black locust (*Robinia pseudoacacia*) are locally common. In addition, foot traffic has impacted this dune system, especially in the low foredunes. A private staircase traverses the bluffs.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts.



Photo 40. Frankfort Beach open dunes. Photo by Joshua G. Cohen.

41. Gull Point Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: B

Size: 66 acres

Location: Leelanau County

Element Occurrence Identification Number: 19160

Threats: Threats include invasive plants and foot traffic and erosion. A hiking trail passes through these open dunes. Several invasive plants are concentrated along trails to the south of the open dunes including spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*), which was noted as locally common within the open dunes.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts.



Photo 41. Gull Point Dunes. Photo by Joshua G. Cohen.

42. Kitchel Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: CD

Size: 91 acres

Location: Ottawa County

Element Occurrence Identification Number: 8436

Threats: The primary threats are the continued spread of invasive species, particularly spotted knapweed (*Centaurea stoebe*) and cheatgrass (*Bromus tectorum*), and high levels of deer browse. Alterations to the Grand River mouth and the construction of homes between the dunefield and Lake Michigan alter natural dune erosional and depositional dynamics.

Management Recommendations: The primary management recommendations are to control invasive species, study the impacts of deer on the open dunes, and limit further development in sensitive dune areas.



Photo 42. Kitchel Dunes. Photo by Bradford S. Slaughter.

43. McCort Hill

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: C

Size: 40 acres

Location: Emmet County

Element Occurrence Identification Number: 6368

Threats: Threats include invasive plants and foot traffic and erosion. Numerous residences occur inland from the dunes, nestled in the forested dunes, and numerous beach access trails pass through the open dunes. Localized dune erosion and denuding of dune vegetation emanates from these trails and residences. Invasives documented within these dunes include lyme grass (*Leymus arenarius*) and bladder campion (*Silene vulgaris*).

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts. Efforts to educate the local landowners about the fragile dune ecosystems may reduce foot traffic and erosion within the dunes.



Photo 43. McCort Hill open dunes. Photo by Joshua G. Cohen.

44. North Shore Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: B

Size: 133 acres

Location: Leelanau County

Element Occurrence Identification Number: 19161

Threats: Threats include invasive plants and foot traffic and erosion. Bladder campion (*Silene vulgaris*) was noted as locally common within the open dunes.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts.



Photo 44. North Shore Dunes. Photo by Joshua G. Cohen.

45. Platte Bay East

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: B

Size: 423 acres

Location: Benzie County

Element Occurrence Identification Number: 12637

Threats: Threats include invasive plants, deer browse, and foot traffic and erosion. Invasive species that are common to locally abundant include spotted knapweed (*Centaurea stoebe*) and baby's breath (*Gypsophila paniculata*). Other invasive species of concern include bouncing bet (*Saponaria officinalis*) and Morrow honeysuckle (*Lonicera morrowii*). In addition, foot traffic off of sanctioned trails has locally impacted this dune system.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex, particularly baby's breath and spotted knapweed. It is important to monitor for invasive species following such control efforts. Foot traffic in the dunes could be reduced by educating park users about the fragile nature of open dunes.



Photo 45. Platte Bay East open dunes. Photo by Bradford S. Slaughter.

46. Platte Bay West

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: B

Size: 596 acres

Location: Benzie County

Element Occurrence Identification Number: 8311

Threats: Threats include invasive plants, deer browsing, and erosion from foot traffic. Invasive plants can eliminate native dune plants through competition for resources and by stabilizing dunes, which results in the loss of plants that rely on shifting sand and facilitates conversion to closed-canopy forest. Invasive plants that threaten the diversity and community structure of this open dunes include spotted knapweed (*Centaurea stoebe*), baby's breath (*Gypsophila paniculata*), and Austrian pine (*Pinus nigra*). A cut Austrian pine was estimated to be over 44 years old, indicating that the Austrian pines planted in these dunes have impacted the open dunes for a prolonged period of time. Foot traffic within the dune complex has locally caused erosion. Foot traffic is especially concentrated in the southwestern portion of the dunes where private houses occur. Invasives are also more prevalent in this portion of the dunes, and private residents are cutting the tops of trees within the dunes to enhance their views. In addition, deer sign was noted throughout the dune complex.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants within the dune complex, especially spotted knapweed, Austrian pine, and baby's breath. Extensive efforts to remove the Austrian pine and baby's breath have been undertaken in the open dunes. Austrian pine was cut and burned in large areas of the open dunes and an intensive control effort to remove baby's breath was concentrated in the southwestern portion of the open dunes. Large areas with Austrian pine and baby's breath have been treated this past year. It is important to monitor for invasive species following such control efforts.



Photo 46. Platte Bay West open dunes. Photo by Joshua G. Cohen.

47. Point Betsie

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: BC

Size: 264 acres

Location: Benzie County

Element Occurrence Identification Number: 10790

Threats: Threats include invasive plants, development of private parcels, and foot traffic and erosion. Spotted knapweed (*Centaurea stoebe*) and baby's breath (*Gypsophila paniculata*) infest large areas of somewhat stabilized dunes adjacent to the mesic northern forest.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants (i.e., spotted knapweed and baby's breath) in the dune complex. It is important to monitor for invasive species following such control efforts.



Photo 47. Point Betsie open dunes. Photo by Bradford S. Slaughter.

48. Pyramid Point

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: BC

Size: 94 acres

Location: Leelanau County

Element Occurrence Identification Number: 12961

Threats: Threats include invasive plants, deer browse, and foot traffic and erosion. Seasonal foot traffic from hikers in perched dunes and bluffs has resulted in localized erosion. Foot traffic is concentrated at the lookout. Invasives noted in the dune complex include white sweet-clover (*Melilotus alba*), Lombardy poplar (*Populus nigra*), white poplar (*P. alba*), common burdock (*Arctium minus*), spotted knapweed (*Centaurea stoebe*), autumn olive (*Elaeagnus umbellata*), Canada bluegrass (*Poa compressa*), multiflora rose (*Rosa multiflora*), and bladder campion (*Silene vulgaris*). Deer trails were noted along the bluffs and northern white-cedar (*Thuja occidentalis*) have been browsed by deer.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts. Foot traffic on the perched dunes and bluffs could be reduced by educating park users about the fragile nature of open dunes. The deer population in the local area could be decreased to reduce the deer browse pressure on the shoreline ecosystems.



Photo 48. Pyramid Point open dunes. Photo by Joshua G. Cohen.

49. Rosy Mound

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: C

Size: 70 acres

Location: Ottawa County

Element Occurrence Identification Number: 2247

Threats: Threats include invasive plants, particularly spotted knapweed (*Centaurea stoebe*), and high deer densities. Fire suppression is a potential long-term threat.

Management Recommendations: The primary management recommendations are to control invasive species, study the impacts of deer on the open dunes, and limit further development in sensitive dune areas.



Photo 49. Rosy Mound open dunes. Photo by Bradford S. Slaughter.

50. Section 17 Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: BC

Size: 34 acres

Location: Leelanau County

Element Occurrence Identification Number: 19156

Threats: Threats include invasive plants, deer browse, and foot traffic and erosion. Infrequent foot traffic from campers has resulted in localized erosion. Invasives noted in this dune complex include spotted knapweed (*Centaurea stoebe*), bladder campion (*Silene vulgaris*), and Oriental bittersweet (*Celastrus orbiculatus*). Deer trails were noted along the bluffs and northern white-cedar (*Thuja occidentalis*) have been browsed by deer.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts. Foot traffic in the dunes could be reduced by educating campers about the fragile nature of open dunes. The deer population on North Manitou Island could be decreased to reduce the deer browse pressure on the island's ecosystems.



Photo 50. Section 17 Dunes. Photo by Joshua G. Cohen.

51. Shalda Creek, Good Harbor Bay

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: BC

Size: 137 acres

Location: Leelanau County

Element Occurrence Identification Number: 11583

Threats: Threats include invasive plants and foot traffic and erosion. Spotted knapweed (*Centaurea stoebe*) is particularly common within the open dunes. Invasives common along the access road include bouncing bet (*Saponaria officinalis*), Morrow honeysuckle (*Lonicera morrowii*), quack grass (*Elymus repens*), and Kentucky bluegrass (*Poa pratensis*). In addition, foot traffic off of sanctioned trails has locally impacted this dune system.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts. Foot traffic in the dunes could be reduced by educating park users about the fragile nature of open dunes.



Photo 51. Shalda Creek, Good Harbor Bay. Photo by Bradford S. Slaughter.

52. South Arcadia Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: C

Size: 106 acres

Location: Manistee County

Element Occurrence Identification Number: 7756

Threats: Species composition and structure are driven by natural processes, competition from invasive species, and off-road vehicle impacts. Invasive species that are locally dominant include spotted knapweed (*Centaurea stoebe*), white sweet-clover (*Melilotus alba*), Canada bluegrass (*Poa compressa*), and bladder campion (*Silene vulgaris*). Lyme grass (*Leymus arenarius*) was observed locally. Off-road vehicle activity is pervasive throughout the low foredunes, especially in the northern portion of the occurrence. A private staircase traverses the bluffs in the southern portion of the dune complex. The forested dunes on the plateau above the bluffs have been cleared in the northeast quarter of section 28 and a golf course occurs adjacent to the bluffs here. Clearing of the forested dunes above the bluffs has likely increased the seed source for invasive species along this portion of the bluffs.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, maintain a buffer of natural communities adjacent to the bluffs to reduce the risk of introducing additional non-native species, eliminate clusters of non-native plants in the dune complex, and restrict illegal off-road vehicle activity within the dune complex. It is important to monitor for invasive species following control efforts.



Photo 52. South Arcadia Dunes. Photo by Joshua G. Cohen.

53. South Shore Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: AB

Size: 301 acres

Location: Leelanau County

Element Occurrence Identification Number: 19157

Threats: Species composition and structure are driven by natural processes, competition from invasive species, deer browse, and foot traffic and erosion. Wilderness campers infrequently and illegally camp within the perched dunes. Infrequent foot traffic from campers along the dunes has resulted in localized erosion. Invasives noted in the dune complex include spotted knapweed (*Centaurea stoebe*), bladder campion (*Silene vulgaris*), bittersweet nightshade (*Solanum dulcamara*), and mullein (*Verbascum thapsus*). Deer trails were noted along the dunes and northern white-cedar (*Thuja occidentalis*) have been browsed by deer. An old powerline runs through the dune complex with the old wooden posts and some wire remaining. The wooden posts can serve as perches for merlin, which prey on piping plover. The posts can also function as posts for other birds that can disperse non-native seed from these perches. More foot traffic and non-native species were noted in the open dune associated with Dimmick's Point compared to the dunes associated with Donner's Point.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts. The old telephone wire wooden poles within the dunes should be removed. These poles can serve as perching places for merlins that could potentially prey on piping plover and other birds that can disperse non-native seed. Illegal camping and foot traffic in the open dunes could be reduced by educating campers about the fragile nature of open dunes. The deer population on North Manitou Island could be decreased to reduce the deer browse pressure on the island's ecosystems.



Photo 53. South Shore Dunes. Photo by Joshua G. Cohen.

54. West Side Dunes

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: AB

Size: 111 acres

Location: Leelanau County

Element Occurrence Identification Number: 19154

Threats: Species composition and structure are driven by natural processes. Threats include invasive plants, deer browse, and foot traffic and erosion. Wilderness campers infrequently and illegally camp within the perched dunes. Infrequent foot traffic from campers along perched dunes and bluffs has resulted in localized erosion. Invasives noted in the dune complex include spotted knapweed (*Centaurea stoebe*), multiflora rose (*Rosa multiflora*) (rare), mullein (*Verbascum thapsus*), Canada bluegrass (*Poa compressa*), and bladder campion (*Silene vulgaris*). Non-native weeds are locally common along the bluff and include bladder campion, mullein, and Canada bluegrass. Deer trails were noted along the bluffs and northern white-cedar (*Thuja occidentalis*) have been browsed by deer.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered and to eliminate clusters of non-native plants in the dune complex. It is important to monitor for invasive species following such control efforts. Illegal camping and foot traffic in the perched dunes could be reduced by educating campers about the fragile nature of open dunes. The deer population on North Manitou Island could be decreased to reduce the deer browse pressure on the island's ecosystems.



Photo 54. West Side Dunes. Photo by Joshua G. Cohen.

55. Whaleback

Natural Community Type: Open Dunes

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: C

Size: 7.3 acres

Location: Leelanau County

Element Occurrence Identification Number: 19141

Threats: Threats include invasive plants and deer browse. Invasives noted on the bluffs include white sweet-clover (*Melilotus alba*) and spotted knapweed (*Centaurea stoebe*). Deer trails and browse impacts were noted within the adjacent boreal forest.

Management Recommendations: The primary management recommendations are to allow natural processes to operate unhindered, control invasive species (spotted knapweed and white sweet-cover), and monitor non-native species and deer browse impacts.



Photo 55. Whaleback open dunes. Photo by Joshua G. Cohen.

RICH CONIFER SWAMP

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

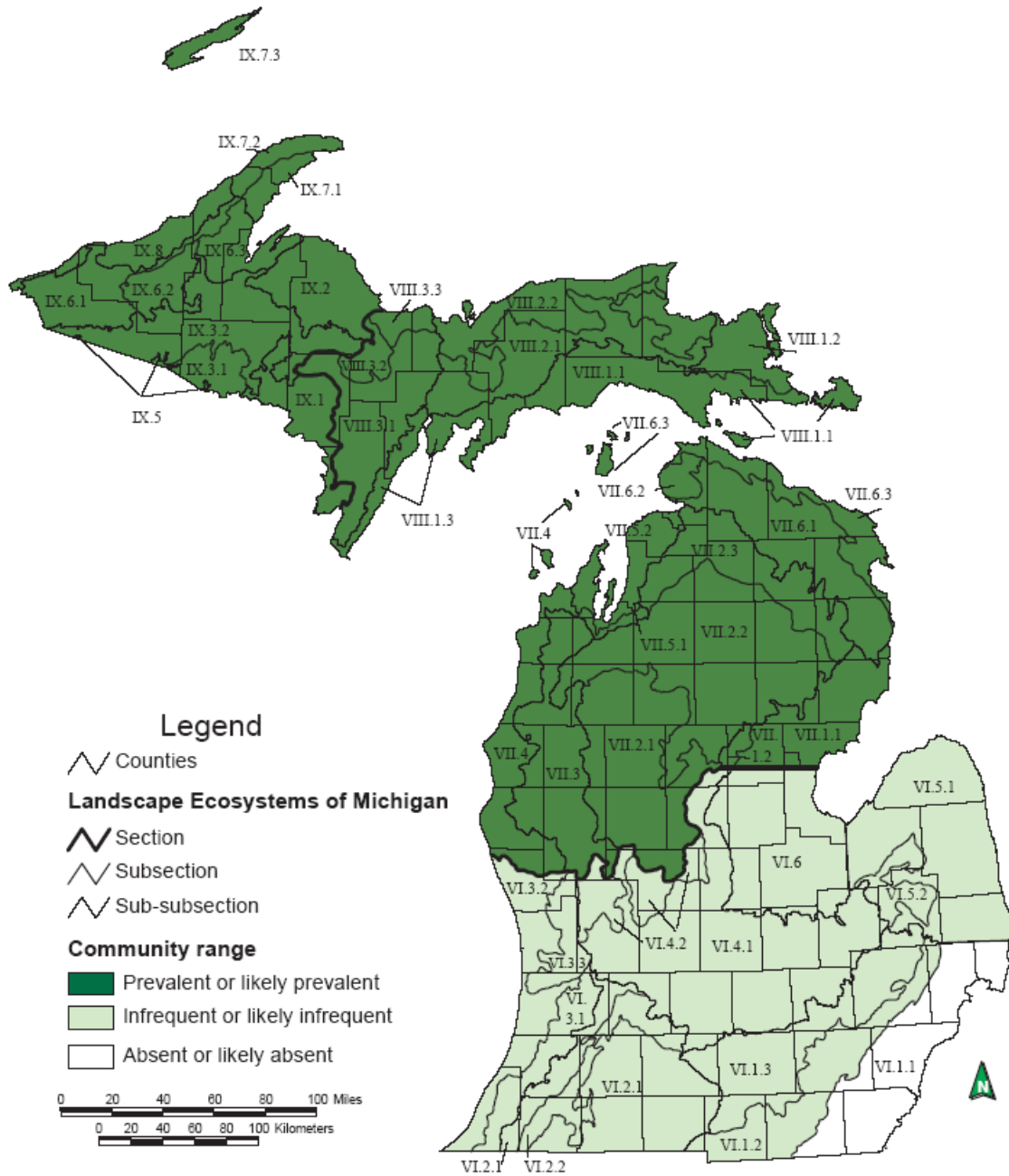


Figure 15. Distribution of rich conifer swamp in Michigan.

56. Otter Lake Swamp

Natural Community Type: Rich Conifer Swamp

Rank: G4 S3, apparently secure globally and vulnerable within the state

Element Occurrence Rank: C

Size: 76 acres

Location: Benzie County

Element Occurrence Identification Number: 19143

Threats: This swamp likely regenerated following cutting and fire. Deer trails occur throughout the swamp and deer browse is likely limiting northern white-cedar (*Thuja occidentalis*) regeneration. Cut stumps occur throughout the swamp, and many of the cut stumps are bigger than the canopy trees.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration. Reducing local deer densities is also recommended.



Photo 56. Otter Lake Swamp rich conifer swamp. 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).

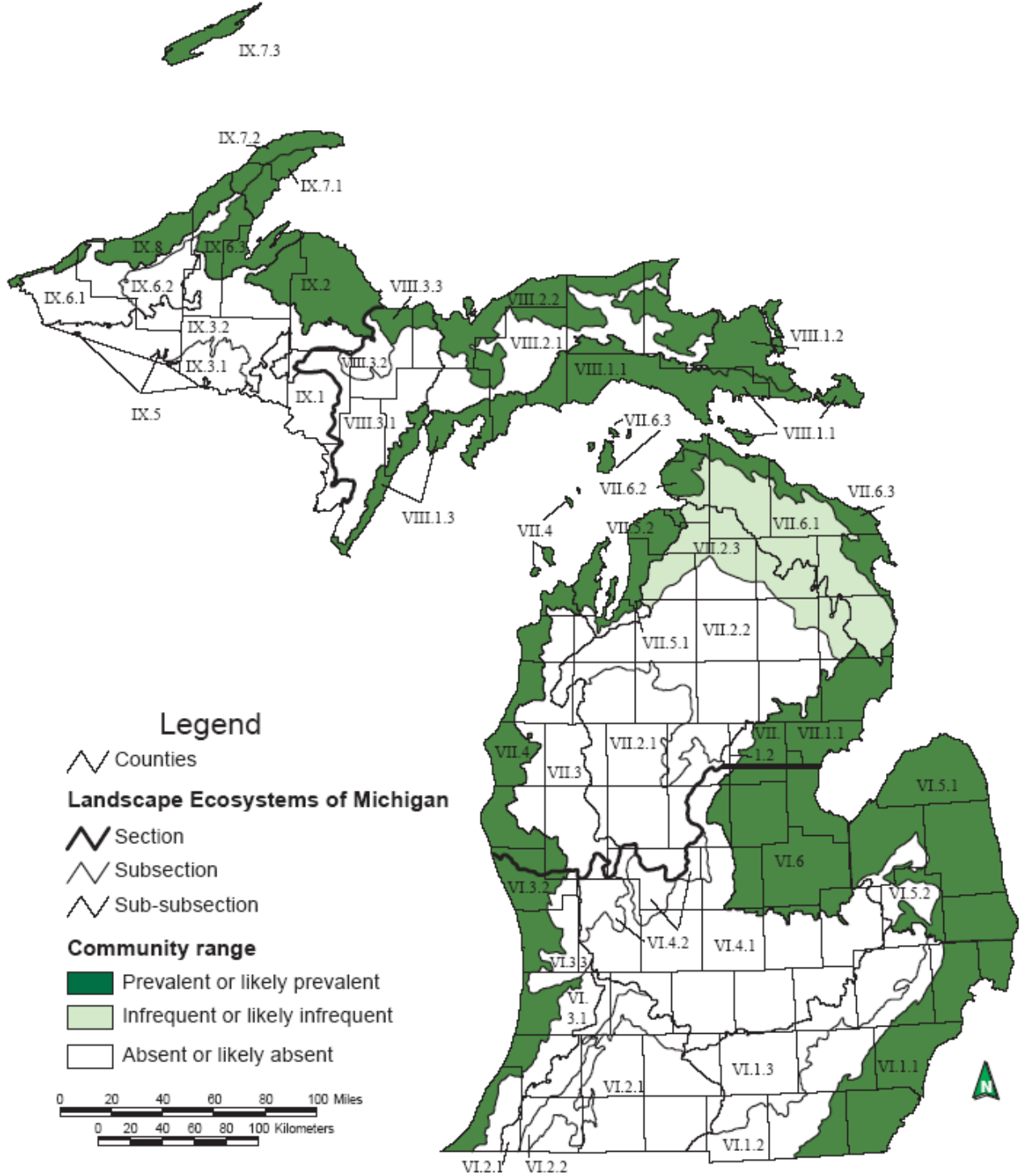


Figure 16. Distribution of sand and gravel beach in Michigan.

57. South Manitou Beach

Natural Community Type: Sand and Gravel Beach

Rank: G3? S3, vulnerable throughout range

Element Occurrence Rank: AB

Size: 11 acres

Location: Leelanau County

Element Occurrence Identification Number: 19159

Threats: Species composition and structure are patterned by natural processes. No threats were observed during the survey. Invasive plant species [i.e., spotted knapweed (*Centaurea stoebe*) and bladder campion (*Silene vulgaris*)] could invade the sand and gravel beach from the adjacent dunes. Foot traffic along the shoreline can cause erosion and destabilization of vegetation. Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the lakeshore.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a forested buffer surrounding the lakeshore to prevent the increase of a weedy seed source. If found, non-native species occurring along the shoreline should be removed. Monitoring efforts to detect invasive species and evaluate control efforts should be implemented.



Photo 57. South Manitou Beach sand and gravel beach. Photo by Joshua G. Cohen.

58. Vessel Point

Natural Community Type: Sand and Gravel Beach

Rank: G3? S3, vulnerable throughout range

Element Occurrence Rank: AB

Size: 14 acres

Location: Leelanau County

Element Occurrence Identification Number: 19158

Threats: Species composition and structure are patterned by natural processes. Threats are limited to foot traffic and non-native species spread. Spotted knapweed (*Centaurea stoebe*) was noted as locally common along this stretch of shoreline. Foot traffic along the shoreline can cause erosion and destabilization of vegetation. Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the lakeshore.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a forested buffer surrounding the lakeshore to prevent the increase of a weedy seed source. Non-native species occurring along the shoreline should be removed (i.e., spotted knapweed). Monitoring efforts to detect invasive species and evaluate control efforts should be implemented.



Photo 58. Vessel Point sand and gravel beach. Photo by Joshua G. Cohen.

59. West Side Beach

Natural Community Type: Sand and Gravel Beach

Rank: G3? S3, vulnerable throughout range

Element Occurrence Rank: AB

Size: 12 acres

Location: Leelanau County

Element Occurrence Identification Number: 19155

Threats: Species composition and structure are patterned by natural processes. Threats are limited to foot traffic and non-native species spread. Spotted knapweed (*Centaurea stoebe*) was noted as locally common along this stretch of shoreline. Foot traffic along the shoreline can cause erosion and destabilization of vegetation. Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the lakeshore.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a natural community buffer surrounding the lakeshore to prevent the increase of a weedy seed source. Non-native species occurring along the shoreline should be removed (i.e., spotted knapweed). Monitoring efforts to detect invasive species and evaluate control efforts should be implemented.



Photo 59. West Side Beach 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).

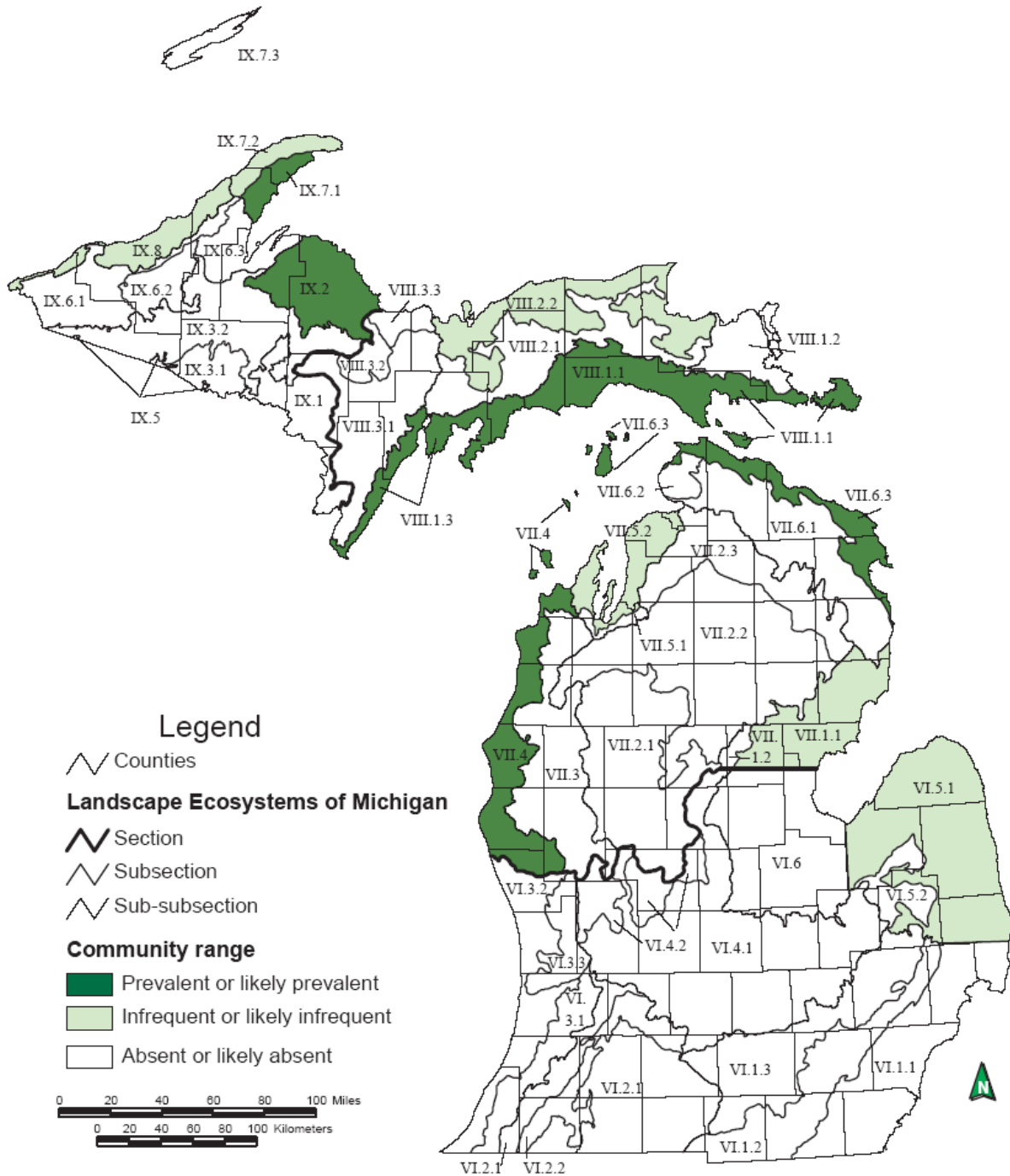


Figure 17. Distribution of wooded dune and swale complex in Michigan.

60. Bower's Harbor Swamp

Natural Community Type: Wooded Dune and Swale Complex

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: C

Size: 171 acres

Location: Grand Traverse County

Element Occurrence Identification Number: 4223

Threats: The site is characterized by complex ecological patterning that results in high species and community diversity in an area with moderate anthropogenic disturbance. Several linear anthropogenic disturbances have impacted the complex. Summer residences occur along the adjacent shoreline and off of Peninsula Road along the western margin of the complex. Roads and trails have likely provided a conduit for non-native species. Narrow-leaved cat-tail (*Typha angustifolia*) was noted in an open swale with northern wet meadow and northern shrub thicket along the margin. Selective logging has occurred in portions of the complex. Cut 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.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Invasive species (i.e., narrow-leaved cat-tail) within open swales should be controlled and monitored. Reducing local deer populations can help reduce deer browse pressure.



Photo 60. Bower's Harbor Swamp wooded dune and swale complex. Photo by Joshua G. Cohen.

61. Crystal River

Natural Community Type: Wooded Dune and Swale Complex

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: BC

Size: 449 acres

Location: Leelanau County

Element Occurrence Identification Number: 6428

Threats: The primary threat to the Crystal River wooded dune and swale complex is continued high levels of deer browse, which threatens to prevent woody regeneration and reduce and/or eliminate populations of browse-sensitive herbaceous species. Invasive plant species, including reed canary grass (*Phalaris arundinacea*) and marsh thistle (*Cirsium palustre*) are also a threat.

Management Recommendations: Management recommendations for this site include reducing deer densities and controlling and monitoring invasive species.



Photo 61. Crystal River wooded dune and swale complex. Photo by Bradford S. Slaughter.

62. Platte Bay East

Natural Community Type: Wooded Dune and Swale Complex

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: B

Size: 3,544 acres

Location: Benzie County

Element Occurrence Identification Number: 13045

Threats: The primary threats are invasive plant species, deer browse, and fire suppression. Invasive species of particular concern include reed canary grass (*Phalaris arundinacea*), which dominates several swales, and local and presumably recent infestations of the non-native subspecies of common reed (*Phragmites australis* subsp. *australis*). The native subspecies of common reed (*Phragmites australis* subsp. *americanus*) is also locally common in the complex. Narrow-leaved cat-tail (*Typha angustifolia*) was also noted as uncommon within this complex. In addition, park development is also a potential threat.

Management Recommendations: Management recommendations for this site include considering prescribed fire along the ridges to promote oak and pine regeneration, monitoring deer browse impacts, avoiding further development within the complex, and controlling and monitoring invasive plant species, focusing on the non-native subspecies of common reed and reed canary grass and also treating the pockets of narrow-leaved cat-tail.



Photo 62. Platte Bay East wooded dune and swale complex. Photo by Bradford S. Slaughter.

63. Platte Bay West

Natural Community Type: Wooded Dune and Swale Complex

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: B

Size: 2,490 acres

Location: Benzie County

Element Occurrence Identification Number: 1409

Threats: Complex ecological patterning results in high species and community diversity in an area with moderate anthropogenic disturbance. Natural ecological processes (windthrow, beaver flooding, wildfire) are the dominant factors structuring patterning and succession. However, the site has a history of selective logging (cut stumps occur throughout the dry-mesic ridges and in some of the forested swales) and many of the open swales are being invaded by reed canary grass (*Phalaris arundinacea*), which is becoming locally dominant. Non-native reed (*Phragmites australis* subsp. *australis*) is also locally common in open swales as well. Several roads and trails pass through the wooded dune and swale complex. Invasives along roads within the wooded dune and swale complex include bladder campion (*Silene vulgaris*), ox-eye daisy (*Leucanthemum vulgare*), and multiflora rose (*Rosa multiflora*). Many cut stumps are charred, suggesting that the complex or portions of the complex were cut and then burned.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Invasive species (i.e., reed canary grass and reed) within open swales should be controlled and monitored.



Photo 63. Platte Bay West wooded dune and swale complex. Photo by Joshua G. Cohen.

64. Shalda Creek, Good Harbor Bay

Natural Community Type: Wooded Dune and Swale Complex

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: BC

Size: 2,547 acres

Location: Leelanau County

Element Occurrence Identification Number: 2334

Threats: The primary threats are invasive plant species, deer browse, and emerald ash borer (*Agrilus planipennis*). Reed canary grass (*Phalaris arundinacea*), narrow-leaved cat-tail (*Typha angustifolia*), and the non-native subspecies of common reed (*Phragmites australis* subsp. *australis*) are locally common, particularly in swales that have been impounded by beaver. Emerald ash borer has killed many of the black ash (*Fraxinus nigra*) in the remaining swales. Deer browse was especially severe in upland mixed hardwood-conifer forest.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow, permitting wildfires to burn, and allowing early to mid-successional forest to mature. Invasive species (i.e., reed canary grass, reed, and narrow-leaved cat-tail) within open swales should be controlled and monitored. Reducing local deer populations can help reduce deer browse pressure.



Photo 64. Shalda Creek, Good Harbor Bay wooded dune and swale complex. Photo by Bradford S. Slaughter.

65. Trail's End Bay

Natural Community Type: Wooded Dune and Swale Complex

Rank: G3 S3, vulnerable throughout range

Element Occurrence Rank: C

Size: 958 acres

Location: Emmet County

Element Occurrence Identification Number: 12324

Threats: The site is characterized by complex ecological patterning that results in high species and community diversity in an area with moderate anthropogenic disturbance. Several linear anthropogenic disturbances have impacted the complex. Summer residences occur along adjacent shoreline and off of Wilderness Park Road along the western margin of the complex. Roads and trails have likely provided a conduit for deer and non-native species. Deer browse is prevalent within this dune and swale complex. Bittersweet nightshade (*Solanum dulcamara*) was documented within the wooded dune and swale complex. Selective logging has occurred in portions of the complex. 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.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Invasive species (i.e., bittersweet nightshade) should be controlled and monitored. Reducing local deer populations can help reduce deer browse pressure.



Photo 65. Trail's End Bay wooded dune and swale complex. Photo by Joshua G. Cohen.

DISCUSSION

This report provides site-based assessments of 65 natural community element occurrences within Michigan's coastal zone. 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.

This project was designed as a five-year survey effort. During the first year of this project, MNFI not only conducted field surveys but also developed a survey prioritization scheme for the entire project area, which includes Berrien, Van Buren, Allegan, Ottawa, Muskegon, Oceana, Mason, Manistee, Benzie, Leelanau, Grand Traverse, Antrim, Charlevoix, Emmet, Cheboygan, Presque Isle, Alpena, Alcona, Iosco, Arenac, Bay, Tuscola, Huron, Gogebic, Ontonagon, Houghton, Keweenaw, Baraga, Marquette, Alger, Luce, Chippewa, Menominee, Delta, Schoolcraft, and Mackinac Counties. Furthermore, sites for survey were prioritized for the entire Lower Peninsula. It is our hope that the continuation of this survey effort will be funded in the near future. In addition to this continued survey effort, a much needed future step is the development of a framework for prioritizing stewardship efforts across these sites. This process should involve assessing the conservation significance of each site from both an ecoregional and statewide perspective and evaluating the severity of threats across sites. This analysis should be conducted using an ecological hierarchical framework, such as Albert's (1995) Regional Landscape Ecosystems of Michigan, Minnesota, and Wisconsin. Understanding how each site relates to other examples of the same natural community and how rare that community is within an ecological region will help facilitate difficult decisions regarding the distribution of finite stewardship resources.



Photo 66. South Shore Dunes, South Manitou Island. 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.