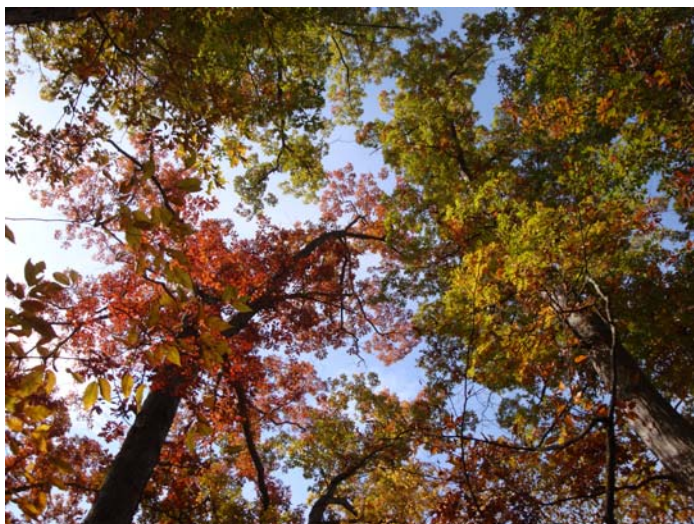# Natural Community Surveys of Known Element Occurrences on State Park and Recreation Area Lands

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For:
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Parks and Recreation Division

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Cover photos: top left, Hartwick Pines dry-mesic northern forest from Hartwick Pines State Park; top right, Killarney Beach lakeplain oak openings from Bay City State Recreation Area; lower left, Thompson's Harbor limestone cobble shore from Thompson's Harbor State Park; and lower right, Haven Hill dry-mesic southern forest from Highland State Recreation Area. Photos by Joshua G. Cohen.

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INTRODUCTION

The Michigan Department of Natural Resources (DNR), Parks and Recreation Division (PRD) is responsible for managing Michigan's State Parks, Recreation Areas, Boating Access Sites, and Harbors. Part of PRD's stated mission is to "acquire, protect, and preserve the natural, historic, and cultural features of Michigan's unique resources". Within the division, the Stewardship Unit is charged with preserving, protecting, and restoring the natural and cultural features. Preservation and restoration of the natural communities within State Parks and Recreation Areas, along with their constituent plants and animals, are core parts of the mission. The PRD is in the process of writing and updating management plans for State Parks and Recreation Areas. In these plans, the land is zoned for various levels of protection and use based on the location and type of natural and cultural features on the ground. In addition, the DNR's Biodiversity Conservation Planning Process (BCPP) is identifying biodiversity stewardship areas, many of which will include portions of State Parks and Recreation Areas where the management priority will be for biodiversity conservation. The goal of the BCPP is to establish a network of representative natural communities that contribute to functioning landscape ecosystems across the state.

A baseline inventory of natural communities was conducted by Michigan Natural Features Inventory (MNFI) in all State Parks and Recreation Areas in the late 1990s to early 2000s. However, this initial inventory effort did not include comprehensive boundary mapping, detailed condition assessments, or threat assessments. To inform the PRD Management Planning process, the DNR BCPP, and the overall protection, preservation, and restoration of natural communities throughout Michigan's State Parks and Recreation Areas, up-to-date information is needed on the boundaries, condition, landscape context, and current threats to the ecological integrity of natural communities. Through work on this project, MNFI has initiated a multi-year survey and assessment on State Park and Recreation Area lands of known natural community element occurrences.

A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances. 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). During the summer of 2009, MNFI scientists conducted surveys of 21 high-quality natural communities previously identified on State Park and Recreation Area lands. According to MNFI's natural community classification, there are 76 natural community types in Michigan (Kost et al. 2007). Seventeen different natural community types are represented in the 21 element occurrences surveyed (Table 1). Surveys assessed the current 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 BCPP. This report summarizes the findings of MNFI's first year of ecological surveys.

METHODS

Field Preparation
Prioritization of sites to visit during the first survey year was determined in consultation with PRD staff. The initial 21 sites selected were within the Highland State Recreation Area (9 sites), Thompson's Harbor State Park (5 sites), Bay City State Recreation Area (3 sites), Hartwick Pines State Park (2 sites), and Algonac State Park (2 sites). These sites were made a priority because PRD is in the process of writing and updating management plans for all of these areas except Algonac State Park, and significant restoration work is in progress within Algonac State Park and Bay City Recreation Area.

Site preparation involved the creation by MNFI and PRD staff of Arcview GIS projects utilizing several layers, including the intersection of the natural community boundaries in MNFI's Biotics database (MNFI 2009) with PRD lands, topographic maps, 1998 digital orthographic photos, 2005 color aerial imagery, MNFI's circa 1800 vegetation map (Comer et al. 1995), and Rockford PLAT maps. For each of the 21 occurrences, a site package was printed that included the polygon of the natural community overlaying the aforementioned data layers and a copy of the existing Element Occurrence Record. In addition to printed site packages, digital site packages were created for use with handheld GPS units and ArcPad. The element occurrence polygons, PRD boundary maps, topographic maps, PLAT maps, and aerial imagery were saved to one- and four-GB storage cards compatible with HP iPAQ units, which were paired with Bluetooth GPS receivers.

In preparation for the 2009 field surveys, the Ecological Community Field Survey Form was revised and converted to a writable portable document format (pdf) to facilitate electronic archiving of the collected data (see Appendix 1). In addition, MNFI staff worked with PRD staff to develop a Threat Assessment Form to allow for the scoring of each observed threat in terms of severity, scope, and reversibility (see Appendix 2). For the purposes of this form, severity was defined as the level of damage to the site caused by the threat, scope was defined as the geographic extent of impact of the threat, and reversibility was defined as the probability of controlling the threat and reversing the damage.

Field Surveys
Natural Heritage and MNFI methodology 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 growing season (from June 18, 2009 through September 2, 2009) 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. For sites that occur on multiple ownerships, surveys were restricted to public portions of the occurrences. For each site visited, an Ecological Community Field Survey Form (Appendix 1) and a Threat Assessment Form (Appendix 2) were completed. The 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 (using the Threat Assessment Form, each observed threat was ranked in terms of its severity, scope, and reversibility, and scores for these categories were summed to generate an overall threat score)
g) ground-truthing aerial photographic interpretation using Global Positioning Systems (both Garmin and HP iPAQ 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) 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 the element occurrence records in MNFI's statewide biodiversity conservation database (MNFI 2009). When necessary, natural community boundaries were re-mapped. Information from the 2009 field surveys and from surveys conducted prior to this project was used to produce threat assessments and management recommendations for each natural community occurrence, which appear within the following Results section.

RESULTS

Twenty-one occurrences of high-quality natural communities were surveyed within the Highland State Recreation Area (9 sites), Thompson's Harbor State Park (5 sites), Bay City State Recreation Area (3 sites), Hartwick Pines State Park (2 sites), and Algonac State Park (2 sites). A total of 17 different natural communities were visited including coastal fen, dry northern forest, dry-mesic northern forest, dry-mesic southern forest (2 occurrences), hardwood-conifer swamp, lakeplain oak openings, lakeplain wet-mesic prairie (2 occurrences), lakeplain wet prairie, limestone bedrock glade (2 occurrences), limestone cobble shore, mesic sand prairie, mesic southern forest, prairie fen, rich conifer swamp, rich tamarack swamp, southern hardwood swamp, and southern wet meadow. Table 1 lists the visited sites, their previous element occurrence ranks, and their current element occurrence ranks. The majority of sites (13 of the 21 occurrences) maintained their prior element occurrence ranking, and one site's ranking improved (Killarney Beach lakeplain wet prairie). However, seven sites received lower element occurrence ranks compared to their prior ranking (Table 1). Of the 21 sites surveyed, all but the Tobico Swamp southern hardwood swamp were re-mapped.

The following site summaries contain a detailed discussion for each of these 21 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 3 for ranking criteria)
d) current element occurrence rank
e) size
f) locational information
g) digital photograph(s)
h) threat assessment
i) management recommendations

Table 1. Summary of 2009 Surveys.

Community Type	EO ID	County	Survey Site	Management Area	PRIOR EO RANK	CURRENT EO RANK	Surveyor
Coastal Fen	11086	Presque Isle	Thompson's Harbor	Thompson's Harbor State Park	A	A	J. Cohen
Dry Northern Forest	11225	Crawford	Hartwick Pines	Hartwick Pines State Park	BC	BC	J. Cohen
Dry-Mesic Northern Forest	918	Crawford	Hartwick Pines	Hartwick Pines State Park	A	BC	J. Cohen
Dry-Mesic Southern Forest	5782	Oakland	Beaumont Road Forest	Highland State Recreation Area	C	C	J. Cohen
Dry-Mesic Southern Forest	12627	Oakland	Haven Hill	Highland State Recreation Area	AB	B	J. Cohen
Hardwood-Conifer Swamp	2520	Oakland	Haven Hill	Highland State Recreation Area	BC	D	J. Cohen
Lakeplain Oak Openings	10350	Bay	Killarney Beach	Bay City State Recreation Area	C	C	J. Cohen
Lakeplain Wet Prairie	2188	Bay	Killarney Beach	Bay City State Recreation Area	C	BC	J. Cohen
Lakeplain Wet-Mesic Prairie	515	St. Clair	Algonac South Drain Prairie	Algonac State Park	B	B	J. Cohen
Lakeplain Wet-Mesic Prairie	12385	St. Clair	Jankow Road Prairie	Algonac State Park	C	C	J. Cohen
Limestone Bedrock Glade	144	Presque Isle	Thompson's Harbor	Thompson's Harbor State Park	C	C	J. Cohen
Limestone Bedrock Glade	9418	Presque Isle	Thompson's Harbor Observatory	Thompson's Harbor State Park	B	B	J. Cohen
Limestone Cobble Shore	10477	Presque Isle	Thompson's Harbor	Thompson's Harbor State Park	AB	AB	J. Cohen
Mesic Sand Prairie	694	Oakland	Teeple Lake	Highland State Recreation Area	BC	C	J. Cohen
Mesic Southern Forest	3124	Oakland	Haven Hill	Highland State Recreation Area	AB	B	J. Cohen
Prairie Fen	5650	Oakland	Teeple Lake	Highland State Recreation Area	C	C	J. Cohen
Rich Conifer Swamp	10051	Presque Isle	Thompson's Harbor	Thompson's Harbor State Park	AB	B	J. Cohen
Rich Tamarack Swamp	4621	Oakland	Haven Hill	Highland State Recreation Area	C	D	J. Cohen
Southern Hardwood Swamp	8806	Oakland	Haven Hill	Highland State Recreation Area	BC	BC	J. Cohen
Southern Hardwood Swamp	4116	Bay	Tobico Swamp	Bay City State Recreation Area	BC	BC	J. Cohen
Southern Wet Meadow	7705	Oakland	Teeple Lake	Highland State Recreation Area	C?	C	J. Cohen

SITE SUMMARIES

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).
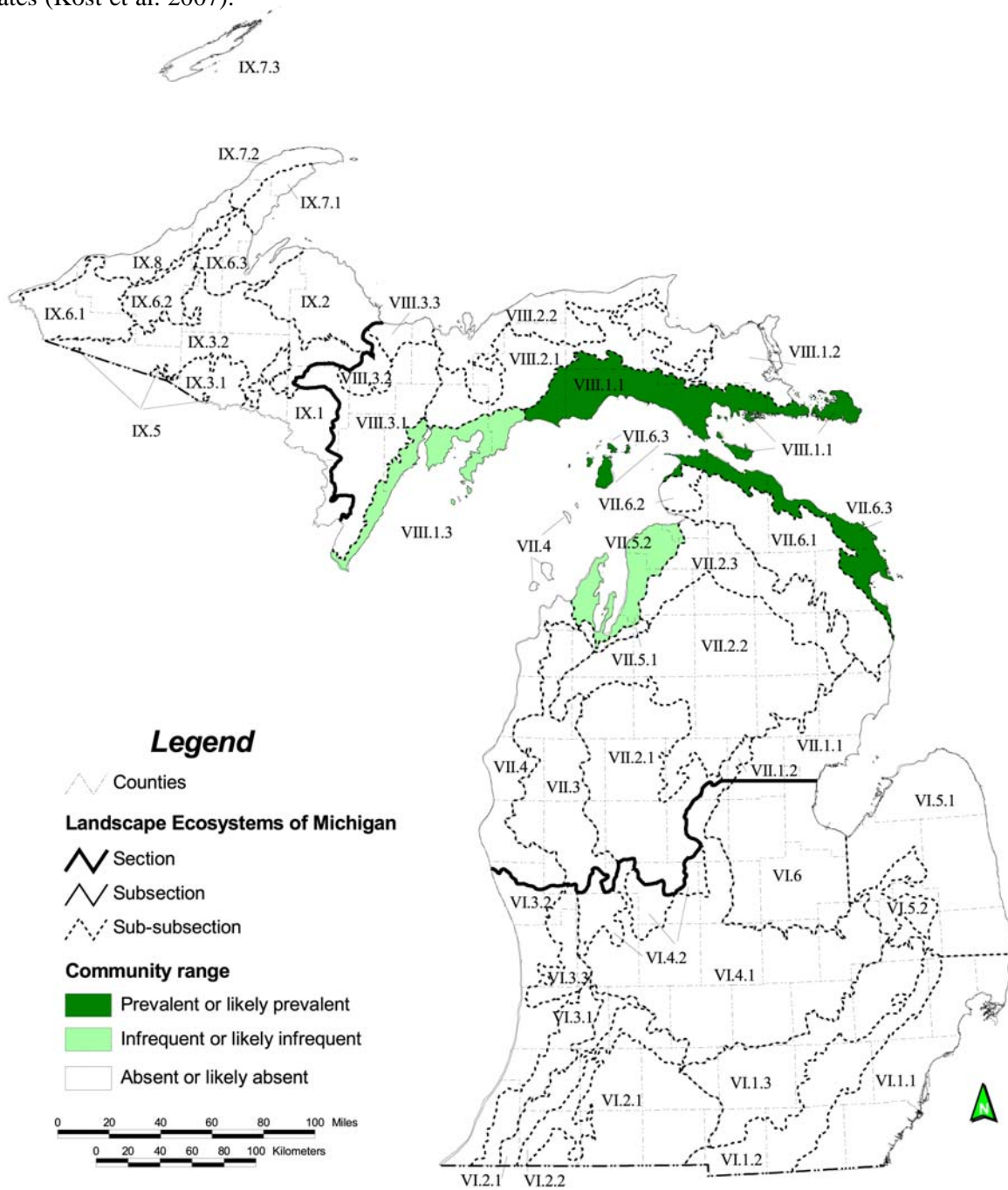
Figure 1. Distribution of coastal fen in Michigan.

1. Thompson's Harbor (Coastal Fen)
Natural Community Type: Coastal Fen
Rank: G1G2 S2, globally critically imperiled to imperiled, and imperiled within the state
Element Occurrence Rank: A
Size: 11 acres
Location: Thompson's Harbor State Park
Element Occurrence Identification Number: 11086

Threats: In the areas nearby the coastal fen, the shoreline is characterized by localized infestations of non-native weeds, especially in areas of sand and gravel beach. Non-native plant species found in these areas include common St. John's-wort (*Hypericum perforatum*), wild carrot (*Daucus carota*), and spotted knapweed (*Centaurea maculosa*). The non-native lawn prunella (*Prunella vulgaris*) was noted but does not pose a threat to the community. Spread of non-native species may be facilitated by human foot traffic emanating from the established hiking trail in the adjacent uplands. Foot traffic in areas of fen have caused some trampling of vegetation and localized alteration of the site's hydrology.

Management Recommendations: The primary stewardship need is to control the populations of invasive species in adjacent areas of shoreline and monitor control efforts. Eliminating foot traffic through the areas of fen adjacent to the established hiking trail in the nearby uplands is recommended to minimize impacts to the site's hydrology and to reduce the potential spread of non-native plants into the wetland.

Photo 1. Thompson's Harbor coastal fen along the Lake Huron shoreline. Photo by Joshua G. Cohen.

DRY NORTHERN FOREST

Overview: Dry northern forest is a pine- or pine-hardwood-dominated forest type that occurs on dry sandy sites lying mostly north of the climatic tension zone. Dry northern forest occurs principally on sandy glacial outwash and sandy glacial lakeplains, and also commonly on sand ridges within peatlands on glacial outwash or glacial lakeplains. Soils are coarse-textured, well-sorted, excessively drained dry sands with low amounts of organic matter and low water-holding capacity. The droughty soils are extremely acid to very strongly acid with low nutrient content and high frost proclivity. Two distinct variants are included within this community type, one dominated by jack pine (*Pinus banksiana*) or jack pine and hardwoods, and the other dominated by red pine (*P. resinosa*). Prior to European settlement, dry northern forest typically originated in the wake of catastrophic fire. Frequent, low-intensity ground fires maintained red pine systems (Kost et al. 2007).
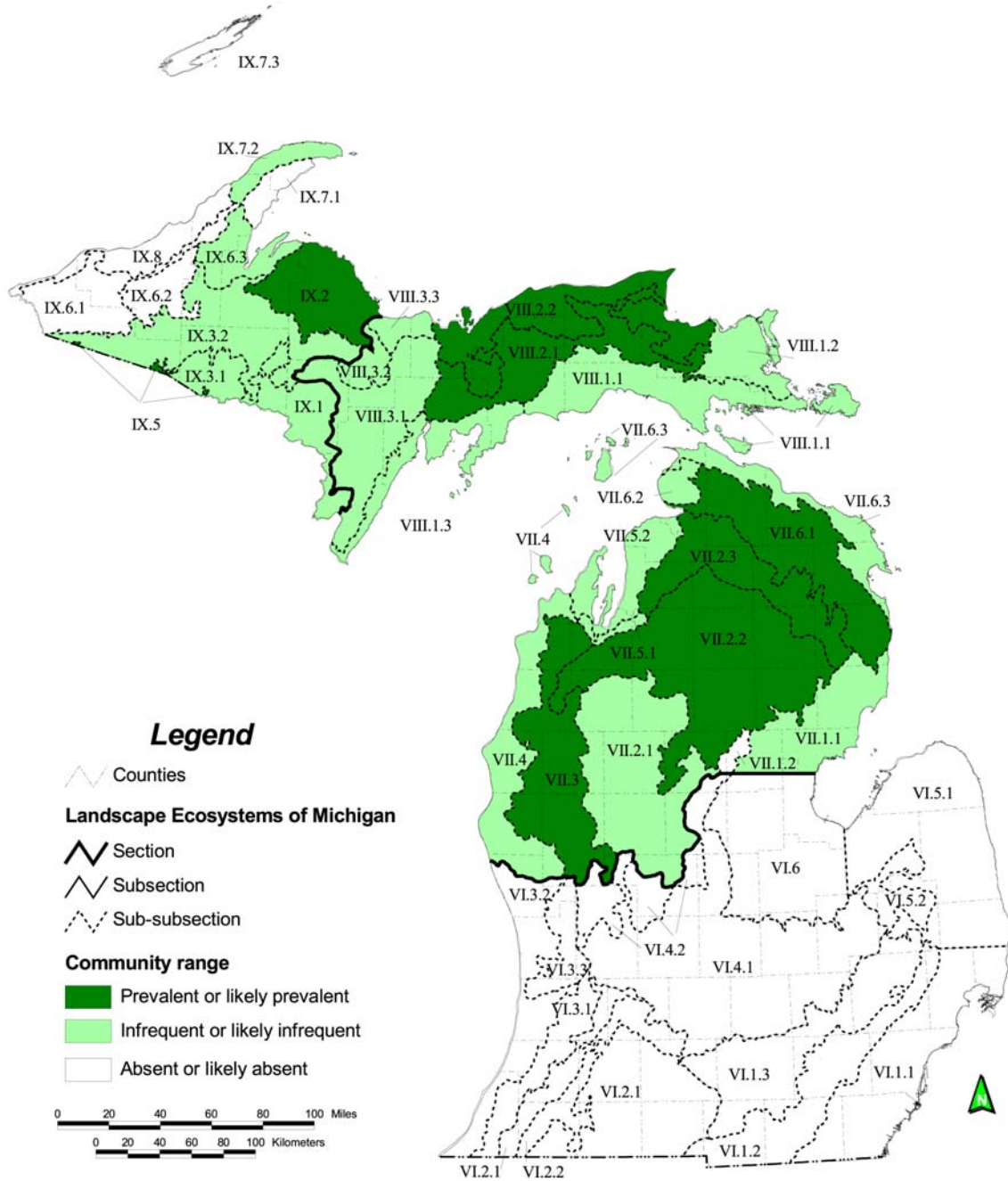
Figure 2. Distribution of dry northern forest in Michigan.

2. Hartwick Pines (Dry Northern Forest)
Natural Community Type: Dry Northern Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 34 acres
Location: Hartwick Pines State Park
Element Occurrence Identification Number: 11225

Threats: The primary threat to the site is posed by continued fire suppression, which has resulted in the prevalence of red maple (*Acer rubrum*) and white pine (*Pinus strobus*) in the subcanopy and understory and will likely result in the conversion of this site to a more dry-mesic system without intervention. Invasive species are restricted to the road margins and include St. John's-wort (*Hypericum perforatum*), timothy (*Phleum pratense*), and spotted knapweed (*Centaurea maculosa*). No invasive species were documented within the interior of the forest.

Management Recommendations: If feasible, employ prescribed catastrophic fire to reintroduce fire as the primary disturbance factor influencing species composition, vegetative structure, and successional trajectory. If use of prescribed crown fire is not possible, resource managers could allow the stand to convert to white pine–dominated dry-mesic northern forest and manage for dry northern forest elsewhere in the park. Girdling the subcanopy red maple is recommended to impart a competitive advantage to pines.

Photo 2. Senescent jack pine dominate the canopy of the Hartwick Pines dry northern forest. 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 and 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).
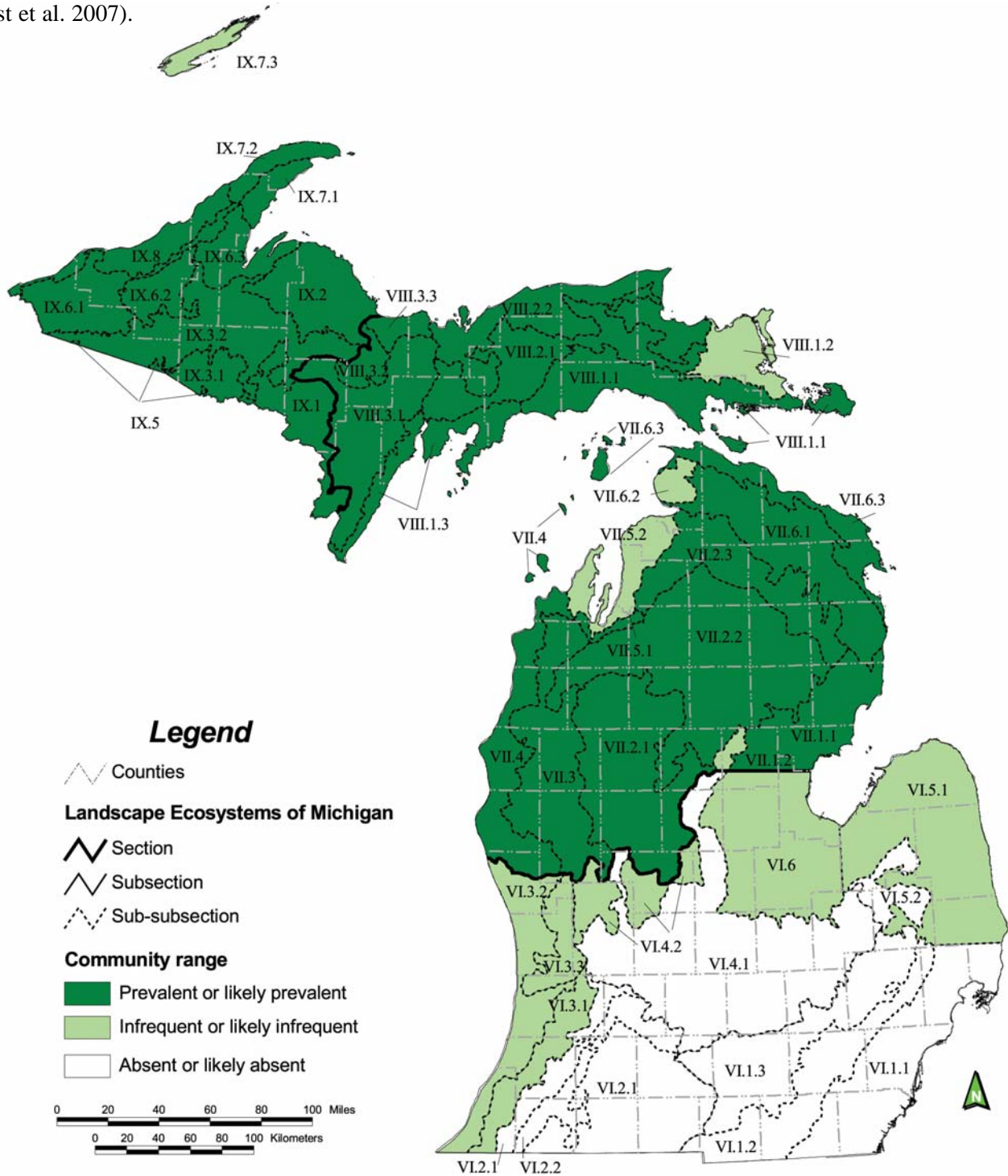
Figure 3. Distribution of dry-mesic northern forest in Michigan.

3. Hartwick Pines (Dry-mesic Northern Forest)
Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 54 acres
Location: Hartwick Pines State Park
Element Occurrence Identification Number: 918

Threats: Fire suppression has altered the site's species composition, vegetative structure, and successional trajectory. As a result, this forest is transitioning to a more mesic forest through gap-phase dynamics. In addition, the high level of deer herbivory is likely limiting the regeneration of white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*). Paved foot trails pass through the site and serve as conduits for non-native weedy species. However, no significant invasives were noted within the forest interior during the course of the survey.

Management Recommendations: The succession of this dry-mesic northern forest to more mesic conditions is well underway. Management to maintain the dominance of white pine would be intensive, expensive, and prolonged. The reintroduction of fire at this point is likely unfeasible, and mechanical management could potentially damage or reduce the old-growth characteristics of the site. Therefore, it is recommended that the succession to more mesic conditions be allowed and that fire management to sustain dry-mesic northern forest be utilized in other areas of the park. Reducing deer densities throughout the park will allow for the understory and ground cover to recuperate from years of intensive browse pressure. Finally, non-native species concentrated along the trails should be monitored and controlled if they become established within the forest interior.
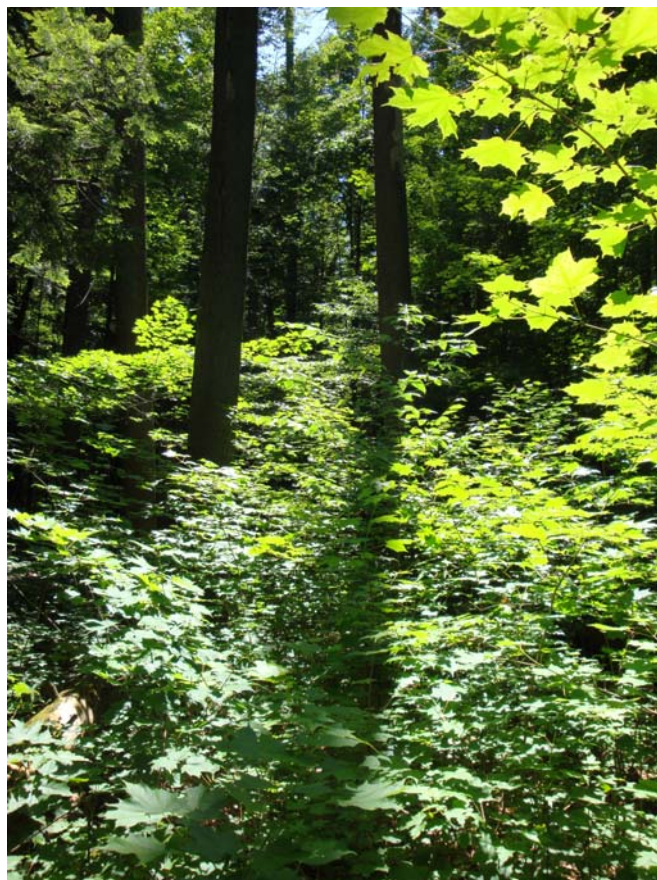
Photos 3 and 4. Hartwick Pines dry-mesic northern forest is succeeding to a more mesic ecosystem as sugar maple and beech regeneration invade light gaps generated by the windthrow of canopy white pine. Photos by Joshua G. Cohen.

DRY-MESIC SOUTHERN FOREST

Overview: Dry-mesic southern forest is a fire-dependent, oak or oak-hickory forest type on generally dry-mesic sites found south of the climatic tension zone in southern Lower Michigan. This natural community occurs principally on glacial outwash, coarse-textured moraines, sandy glacial lakeplains, kettle-kame topography, and sand dunes. Soils are typically sandy loam or loam and slightly acid to neutral in pH. Frequent fires maintain semi-open conditions, promoting oak regeneration and ground and shrub layer diversity (Kost et al. 2007).

Figure 4. Distribution of dry-mesic southern forest in Michigan.

4. Beaumont Road Forest
Natural Community Type: Dry-mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
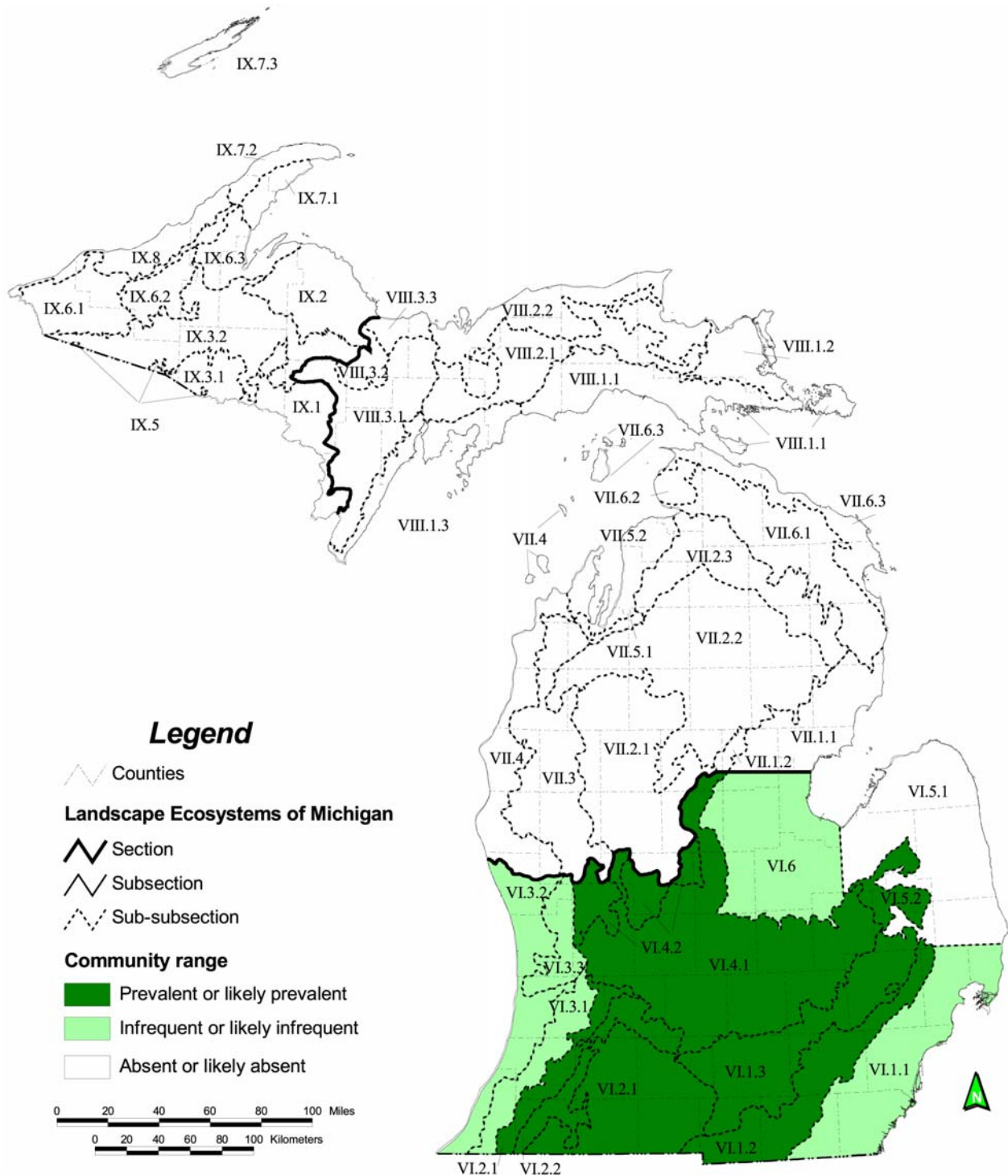**Element Occurrence Rank: C**
Size: 325 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 5782

Threats: Due to fire suppression and high deer herbivory, oak regeneration is sparse to absent. The prevalence of the mesophytic invader red maple (*Acer rubrum*) in the subcanopy and understory indicates that the site has experienced many decades of fire suppression. High deer densities have resulted in high deer browse pressure on the understory and ground cover species. High levels of invasive species occur throughout the forest and are typically concentrated along the trails. The trails serve as conduits for invasive species, and areas along the margins of the forest contain high concentrations of invasive species. The high levels of invasive species are beginning to impact species composition and vegetative structure as non-native shrubs and forbs outcompete native species, and in some cases alter the soil properties of the forest. Garlic mustard (*Alliaria petiolata*) and Oriental bittersweet (*Celastrus orbiculatus*) have established as local dominants in several areas of the forest. Common invasives within the site include common buckthorn (*Rhamnus cathartica*), autumn olive (*Elaeagnus umbellata*), Japanese barberry (*Berberis thunbergii*), smooth Tartarian honeysuckle (*Lonicera tatarica*), and multiflora rose (*Rosa multiflora*). In addition, emerald ash borer (*Agrilus planipennis*) has killed most of the canopy white ash (*Fraxinus americana*) that occurred scattered in the forest.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor and a means of reducing invasive shrubs and red maple. Subcanopy and understory red maple could be girdled if repeated fires do not control this mesophytic invader. In addition, cutting and herbiciding invasive shrubs and vines will also complement the use of fire to control invasives. Hand-pulling of garlic mustard is also recommended. Control of invasive plant populations will require a major long-term effort. Reducing local deer densities will help decrease browse pressure. Monitoring should be implemented to assess efforts to control non-native plant populations, gauge the impact of deer herbivory, and evaluate the success of fire management, particularly its impact to oak regeneration.

Photo 5. Beaumont Road dry-mesic southern forest. Photo by Joshua G. Cohen.

5. Haven Hill (Dry-mesic Southern Forest)
Natural Community Type: Dry-mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 77 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 12627

Threats: Due to fire suppression and high deer herbivory, oak regeneration is sparse to absent. The prevalence of the mesophytic invader red maple (*Acer rubrum*) in the subcanopy and understory indicates that the site has experienced many decades of fire suppression. High deer densities have resulted in high deer browse pressure on the understory and ground cover species. Invasive species are occasional and are concentrated on the margins of the forest, in areas of younger forest, and along trails. Invasives that occur locally within the site include garlic mustard (*Alliaria petiolata*), common buckthorn (*Rhamnus cathartica*), autumn olive (*Elaeagnus umbellata*), Japanese barberry (*Berberis thunbergii*), and multiflora rose (*Rosa multiflora*). In addition, emerald ash borer (*Agrilus planipennis*) has killed most of the canopy white ash (*Fraxinus americana*) that occurred scattered in the forest.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor and a means of reducing invasive shrubs and red maple. Subcanopy and understory red maple could be girdled if repeated fires do not control this mesophytic invader. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasives. Hand-pulling of garlic mustard is also recommended. Control of invasive plant populations will require a major long-term effort. Reducing local deer densities will help reduce browse pressure. Monitoring should be implemented to assess efforts to control non-native plant populations, gauge the impact of deer herbivory, and evaluate the success of fire management, particularly its impact to oak regeneration.

Photo 6. Haven Hill dry-mesic southern forest. 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).
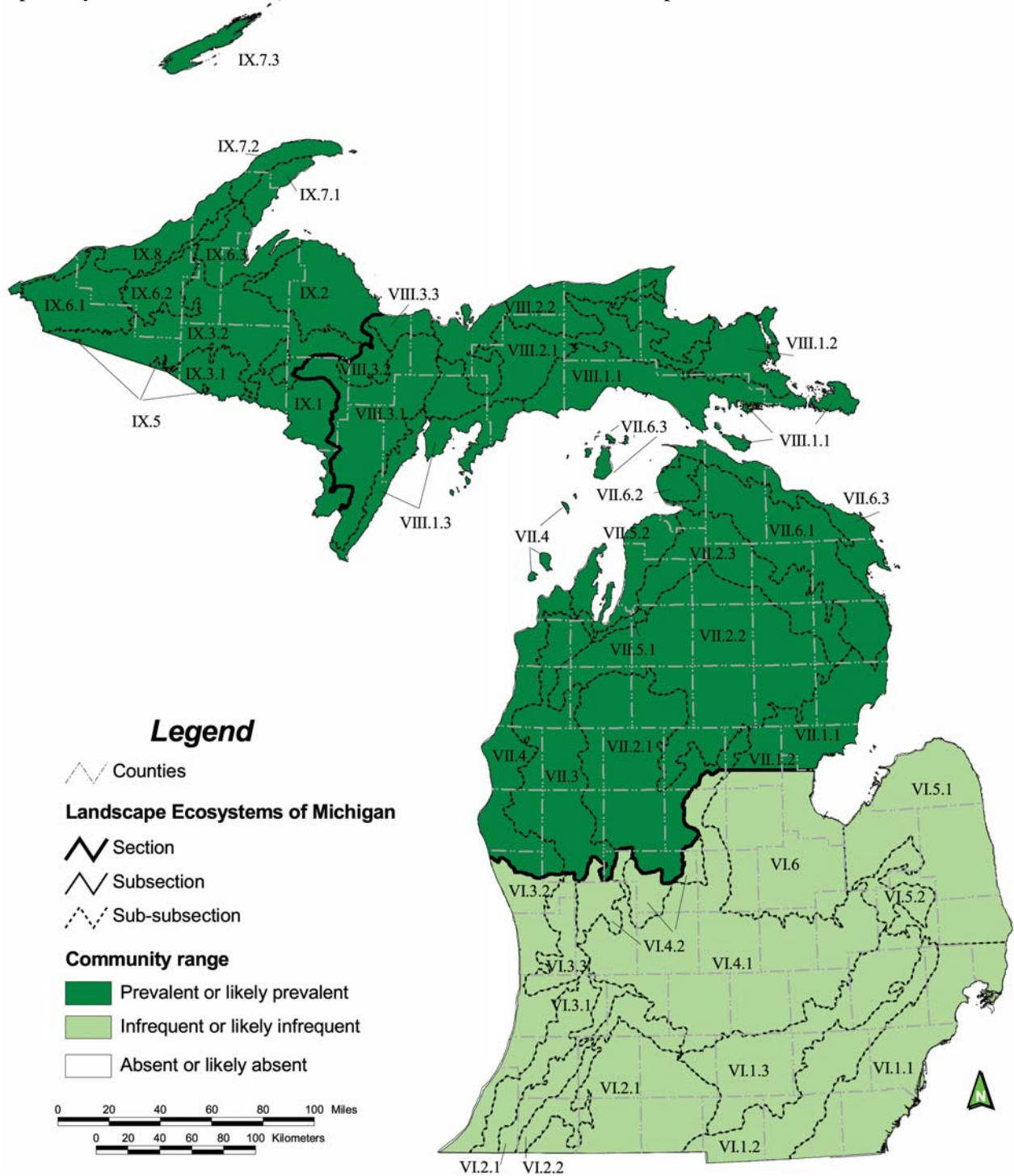
Figure 5. Distribution of hardwood-conifer swamp in Michigan.

6. Haven Hill (Hardwood-Conifer Swamp)
Natural Community Type: Hardwood-Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: D
Size: 49 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 2520

Threats: Invasive plants have drastically altered the species composition, vegetative structure, successional trajectory, and hydrology of the swamp. Invasives dominate the ground layer and understory layer and include reed (*Phragmites australis*), narrow-leaved cat-tail (*Typha angustifolia*), and glossy buckthorn (*Rhamnus frangula*), with lesser amounts of purple loosestrife (*Lythrum salicaria*), honeysuckles (*Lonicera* spp.), and Japanese barberry (*Berberis thunbergii*). Dutch elm disease and emerald ash borer (*Agrilus planipennis*) have resulted in the death of canopy elm and ash, creating an open canopy that is favorable to these invasive plants. The hydrology of the site has likely been altered by the nearby road and is also impacted by the invasive plant populations. High levels of deer densities have resulted in high deer browse pressure on the understory and ground cover species.

Management Recommendations: This site may be degraded beyond rehabilitation. Control of invasive plant populations will require a major long-term effort to reduce the widespread dominance of reed and narrow-leaved cat-tail. In addition, populations of glossy buckthorn and Japanese barberry should be controlled within the site and in surrounding wetlands. Reducing local deer densities will help reduce browse pressure. Monitoring should be implemented for efforts to control non-native plant populations and to gauge the impact of deer herbivory.

Photo 7. Invasive species, such as reed, have dramatically altered the species composition and vegetative structure of the Haven Hill hardwood-conifer swamp. Photo by Joshua G. Cohen.

LAKEPLAIN OAK OPENINGS

Overview: Lakeplain oak openings are a fire-dependent savanna community, dominated by oaks and characterized by a graminoid-dominated ground layer of species associated with both lakeplain prairie and forest communities. Lakeplain oak openings occur within the southern Lower Peninsula on glacial lakeplains on sand ridges, level sandplains, or adjacent depressions. Soils are typically mildly alkaline, very fine sandy loams, loamy sands, or sands with moderate water-retaining capacity. Open conditions were historically maintained by frequent fire, and in depressions, by seasonal flooding (Kost et al. 2007).
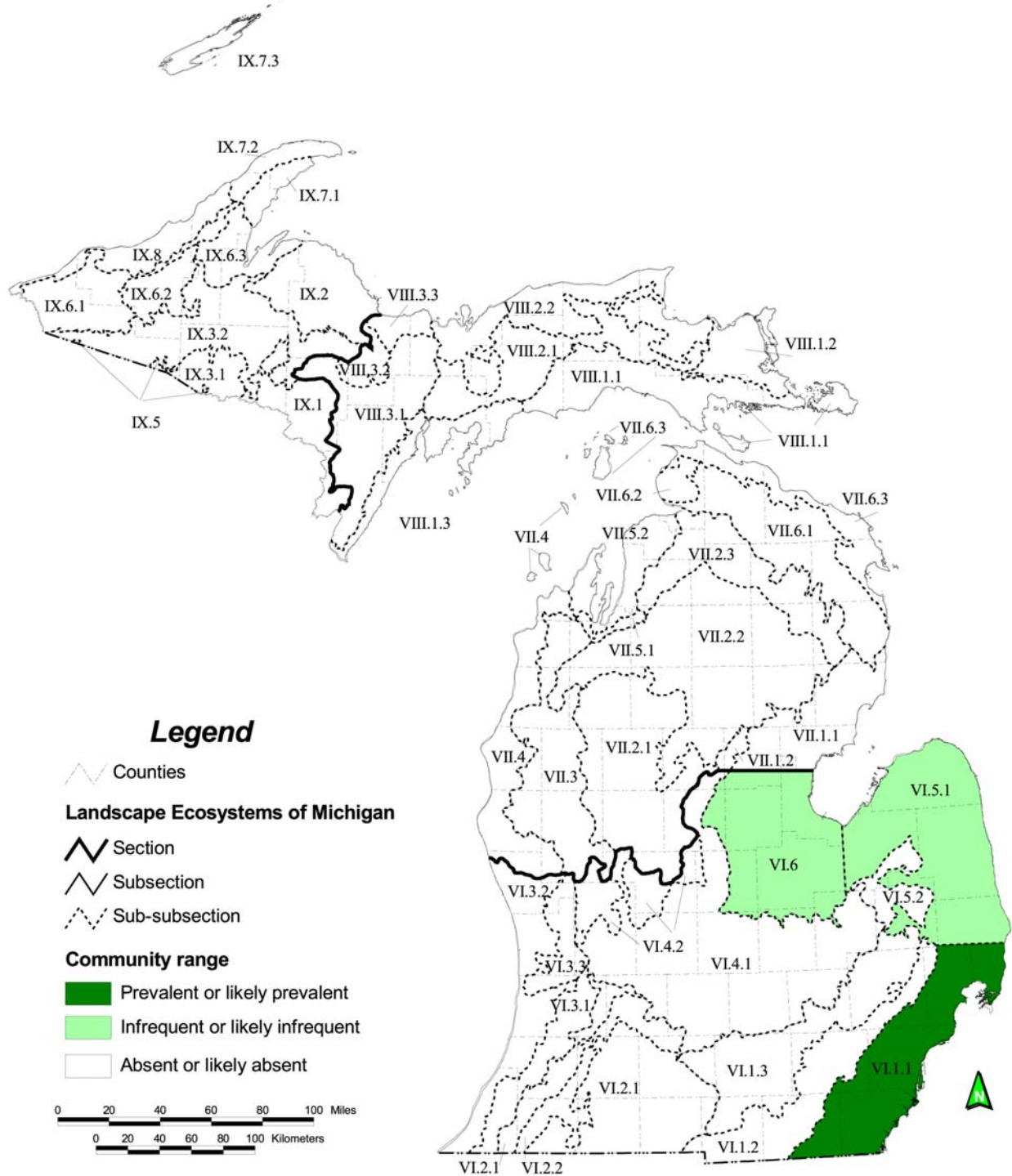
Figure 5. Distribution of lakeplain oak openings in Michigan.

7. Killarney Beach (Lakeplain Oak Openings)
Natural Community Type: Lakeplain Oak Openings
Rank: G2? S1, globally imperiled and critically imperiled in the state
Element Occurrence Rank: C
Size: 28 acres
Location: Bay City State Recreation Area
Element Occurrence Identification Number: 10350

Threats: Fire suppression has resulted in the increase of tree and shrub cover. Scattered non-native plants occur locally and include glossy buckthorn (*Rhamnus frangula*), autumn olive (*Elaeagnus umbellata*), honeysuckles (*Lonicera* spp.), and wild carrot (*Daucus carota*). Deer herbivory is likely impacting species composition and vegetative structure. The road and residential development have isolated this complex from Saginaw Bay, resulting in long-term, large-scale, and likely irrevocable changes to the landscape's hydrologic regime.

Management Recommendations: The primary management recommendation is to reintroduce fire as a disturbance factor influencing species composition and vegetative structure. Control of invasive plant populations is recommended, especially reduction of glossy buckthorn, autumn olive, and honeysuckles. Reducing local deer densities will help decrease browse pressure. Monitoring should be implemented to assess efforts to control non-native plant populations, gauge the impact of deer herbivory, and evaluate the success of fire management.

Photo 8. Killarney Beach lakeplain oak openings. Photo by Joshua G. Cohen.

LAKEPLAIN WET PRAIRIE

Overview: Lakeplain wet prairie is a species-rich prairie community that occurs on the seasonally wet ground of glacial lakeplains in the southern Great Lakes region. The community occurs along the shoreline of Lake Huron in Saginaw Bay, within the St. Clair River Delta, and near Lake Erie. Soils are medium- to fine-textured, slightly acid to moderately alkaline sands, sandy loams, or silty clays with poor to moderate water-retaining capacity. Seasonal flooding, cyclic changes in Great Lakes water levels, beaver flooding, and fire historically maintained the species composition and community structure of lakeplain wet prairies (Kost et al. 2007).

Figure 7. Distribution of lakeplain wet prairie in Michigan.

8. Killarney Beach (Lakeplain Wet Prairie)
Natural Community Type: Lakeplain Wet Prairie
Rank: G2? S1, globally imperiled and critically imperiled in the state
Element Occurrence Rank: BC
Size: 12 acres
Location: Bay City State Recreation Area
Element Occurrence Identification Number: 2188

Threats: Fire suppression has resulted in the increase of tree and shrub cover. Scattered patches of non-native plants occur locally and include glossy buckthorn (*Rhamnus frangula*), honeysuckles (*Lonicera* spp.), multiflora rose (*Rosa multiflora*), and European marsh thistle (*Cirsium palustre*). Deer herbivory is likely impacting species composition and vegetative structure. The road and residential development have isolated this complex from Saginaw Bay, resulting in long-term, large-scale, and likely irrevocable changes to the landscape's hydrologic regime.

Management Recommendations: The primary management recommendation is to reintroduce fire as a disturbance factor influencing species composition and vegetative structure. Control of invasive plant populations is recommended, especially reduction of glossy buckthorn, multiflora rose, and honeysuckles. Reducing local deer densities will help decrease browse pressure. Monitoring should be implemented to assess efforts to control non-native plant populations, gauge the impact of deer herbivory, and evaluate the success of fire management.

Photo 9. Killarney Beach lakeplain wet prairie. Photo by Joshua G. Cohen.

LAKEPLAIN WET-MESIC PRAIRIE

Overview: Lakeplain wet-mesic prairie is a species-rich, lowland prairie community that occurs on moist, level, seasonally inundated glacial lakeplains of the Great Lakes. Soils of this natural community are fine-textured, slightly acid to moderately alkaline sands, sandy loams, or silty clays with poor to moderate water-retaining capacity. Seasonal flooding, cyclic changes in Great Lakes water levels, beaver flooding, and fire historically maintained the species composition and community structure of lakeplain wet-mesic prairies (Kost et al. 2007).
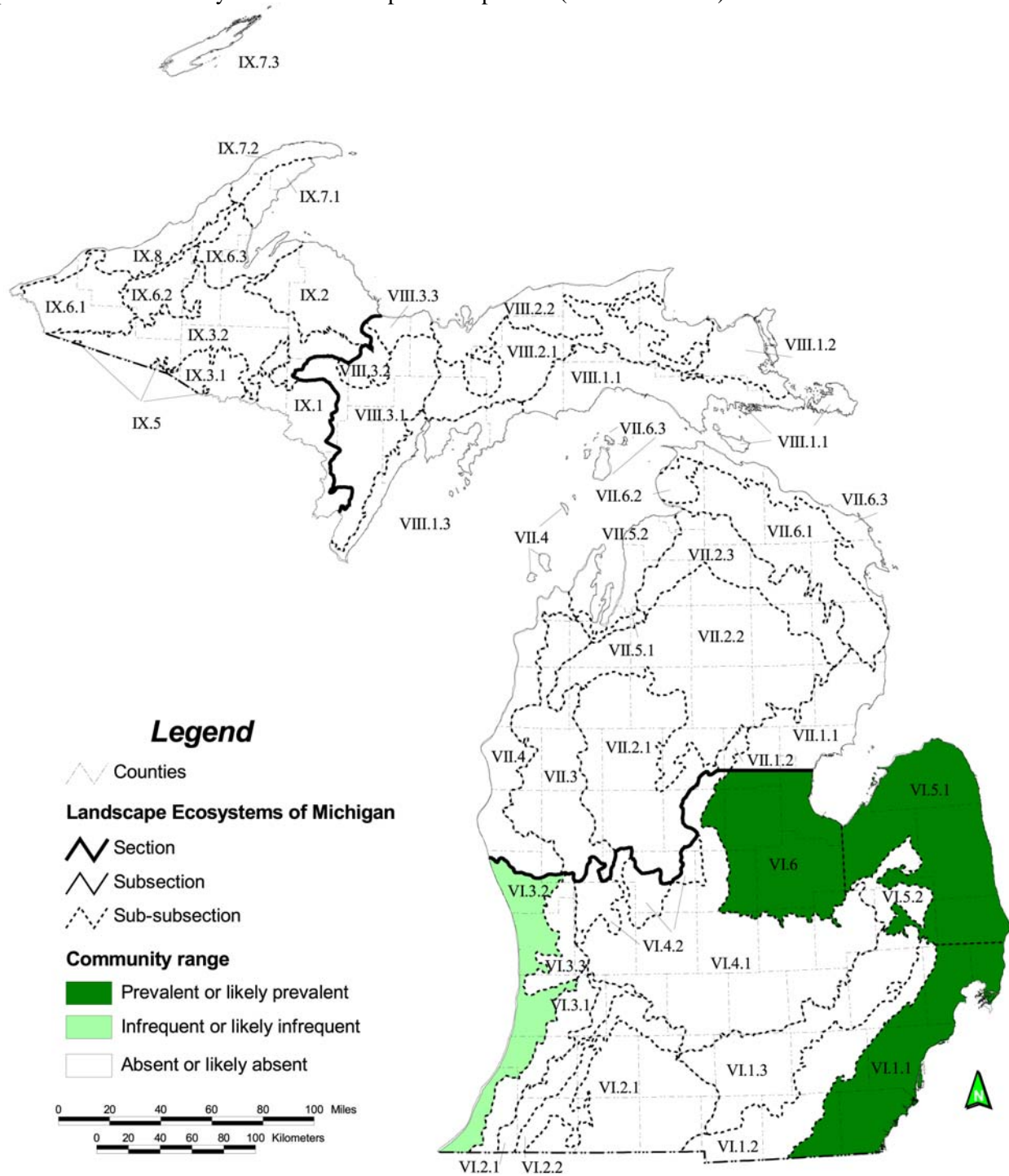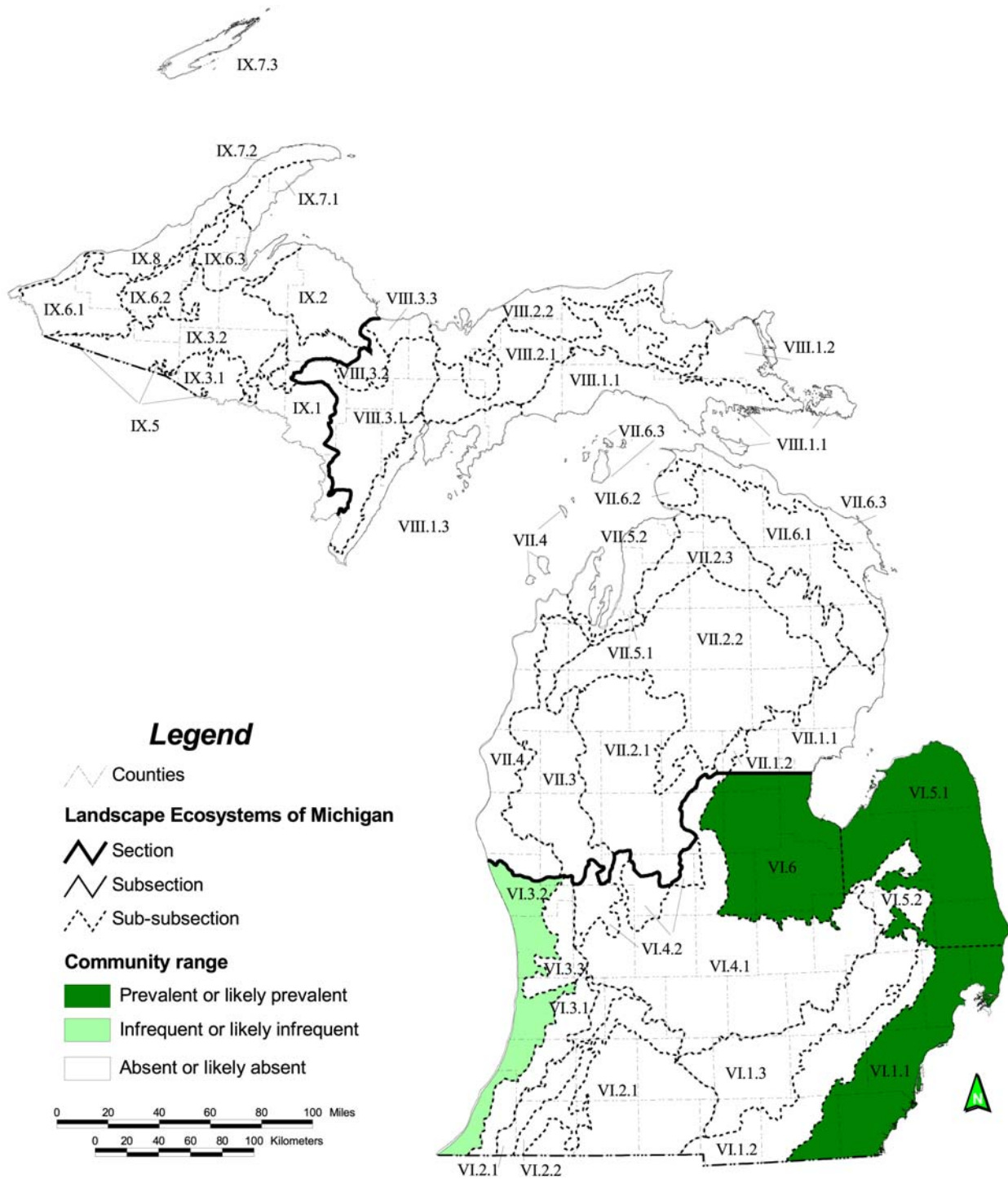

Figure 8. Distribution of lakeplain wet-mesic prairie in Michigan.

9. Algonac South Drain Prairie
Natural Community Type: Lakeplain Wet-mesic Prairie
Rank: G1? S1, critically imperiled globally and in the state
Element Occurrence Rank: B
Size: 14 acres
Location: Algonac State Park
Element Occurrence Identification Number: 515

Threats: Invasive plant species tend to be concentrated in areas that have been recently hydro-axed but do not appear to be spreading into areas of long-established prairie. Common non-native species within hydro-axed areas include multiflora rose (*Rosa multiflora*), European marsh thistle (*Cirsium palustre*), reed canary grass (*Phalaris arundinacea*), and white sweet-clover (*Melilotus alba*). Some scattered reed canary grass, honeysuckles (*Lonicera* spp.), glossy buckthorn (*Rhamnus frangula*), and wild carrot (*Daucus carota*) occur throughout the prairie. In addition, several purple loosestrife (*Lythrum salicaria*) occur along the trail that passes through the prairie. Drains throughout the area indicate that the hydrology of the landscape has likely been altered.

Management Recommendations: The primary management recommendations are to continue using fire as a critical disturbance factor influencing species composition and vegetative structure and to continue the aggressive management to expand the existing prairie remnant and soften the edges of the prairie with the adjacent lakeplain oak openings remnant using fire and mechanical removal (i.e., hydro-axing). Monitoring is recommended to evaluate the impacts of prescribed fire and hydro-axing on invasive species, rare species populations, and mound ant species. Hydro-axing when soils are frozen and following cutting treatments with herbicide application to invasive species may help reduce the higher levels of non-native species within the intensively managed portions of the prairie.

Photo 10. Algonac South Drain Prairie lakeplain wet-mesic prairie. Photo by Joshua G. Cohen.

10. Jankow Road Prairie
Natural Community Type: Lakeplain Wet-mesic Prairie
Rank: G1? S1, critically imperiled globally and in the state
Element Occurrence Rank: C
Size: 3 acres
Location: Private Lands adjacent to Algonac State Park
Element Occurrence Identification Number: 12385

This prairie occurs entirely on private lands just south of the Algonac State Park. To avoid trespass, the site was observed from public lands to the north. Following granting of land owner permission, a full survey is recommended.

Threats: Fire suppression is the primary threat to this site. Historically, frequent fires and a seasonally fluctuating water table maintained the open prairie conditions. The ubiquitous litter layer suggests that the site is fire suppressed. Drains throughout the area indicate that the hydrology of the landscape has likely been altered.

Management Recommendations: Given that this prairie occurs on private lands, pursuit of acquisition and the establishment of conservation easements are warranted. The primary management recommendation is to reintroduce fire as a fundamental disturbance factor maintaining open conditions. Monitoring following prescribed fire is recommended as is monitoring to ascertain the level and impacts of non-native plants.

Photo 11. Jankow Road Prairie lakeplain wet-mesic prairie. Photo by Joshua G. Cohen.

LIMESTONE BEDROCK GLADE (ALVAR GLADE)

Overview: Limestone bedrock glade consists of an herb- and graminoid-dominated plant community with scattered clumps of stunted trees and shrubs growing on thin soil over limestone or dolomite. Tree cover is typically 10 to 25%, but occasionally as high as 60%. Shrub and herb cover is variable, and there are typically areas of exposed bedrock. Mosses, lichens, and algae can be abundant on the exposed limestone bedrock or thin organic soils. Seasonal flooding and summer drought maintain the open conditions. In Michigan, limestone bedrock glade occurs in the Upper Peninsula near the shorelines of Lakes Huron and Michigan, concentrated in a band from Drummond Island to Cedarville and from Gould City to the Garden Peninsula. In the northern Lower Peninsula, limestone bedrock glade occurs along the Lake Huron shoreline near Rogers City, Alpena, and Thompson's Harbor. This community is also referred to as alvar glade (Kost et al. 2007).
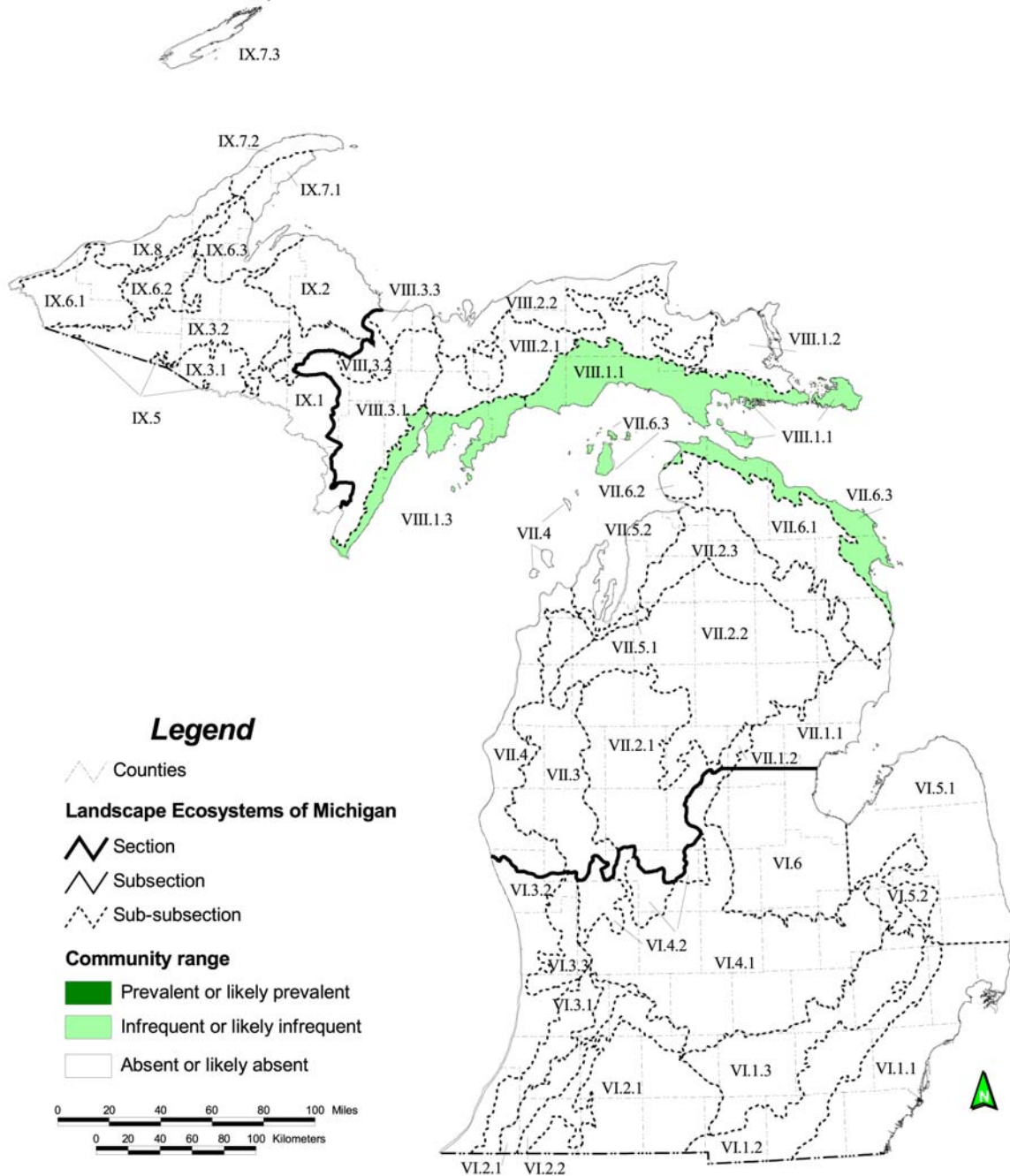
Figure 9. Distribution of limestone bedrock glade in Michigan.

11. Thompson's Harbor (Limestone Bedrock Glade)
Natural Community Type: Limestone Bedrock Glade (Alvar Glade)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: C
Size: 41 acres
Location: Thompson's Harbor State Park
Element Occurrence Identification Number: 144

Threats: Numerous roads, trails, and powerlines cross the site and act as pathways for invasive species. Invasives concentrated along road and trail margins include common St. John's-wort (*Hypericum perforatum*), ox-eye daisy (*Chrysanthemum leucanthemum*), white sweet-clover (*Melilotus alba*), and spotted knapweed (*Centaurea maculosa*). Ox-eye daisy, lawn prunella (*Prunella vulgaris*), and common hemp nettle (*Galeopsis tetrahit*) occur throughout the glade but do not appear to threaten species composition or vegetative structure. Deer herbivory is evident but mild. Fire suppression may be a threat, but little is known about fire as a natural disturbance factor of limestone bedrock glades.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn), to control populations of non-native species (especially spotted knapweed and common St. John's-wort), and to maintain a forested buffer surrounding the glade to prevent the increase of the weedy seed source. Monitoring should be implemented for non-native plant populations and to gauge the impact of deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities in the general landscape is also recommended.

Photo 12. Thompson's Harbor limestone bedrock glade. Photo by Joshua G. Cohen.

Photos 13 and 14. Tree-top views of Thompson's Harbor (above) and Thompson's Harbor Observatory (below) limestone bedrock glades. Photos by Joshua G. Cohen.

12. Thompson's Harbor Observatory
Natural Community Type: Limestone Bedrock Glade (Alvar Glade)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: B
Size: 97 acres
Location: Thompson's Harbor State Park
Element Occurrence Identification Number: 9418

Threats: Numerous roads and trails cross the site and act as pathways for invasive species. Invasives concentrated along road and trail margins include common St. John's-wort (*Hypericum perforatum*), ox-eye daisy (*Chrysanthemum leucanthemum*), and spotted knapweed (*Centaurea maculosa*). Ox-eye daisy, lawn prunella (*Prunella vulgaris*), and common hemp nettle (*Galeopsis tetrahit*) occur throughout the glade but do not appear to threaten species composition or vegetative structure. Deer herbivory is evident but mild. Fire suppression may be a threat, but little is known about fire as a natural disturbance factor of limestone bedrock glades.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn), to control populations of non-native species (especially spotted knapweed and common St. John's-wort), and to maintain a forested buffer surrounding the glade to prevent the increase of the weedy seed source. Monitoring should be implemented for non-native plant populations and to gauge the impact of deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities in the general landscape is also recommended.

Photo 15. Thompson's Harbor Observatory limestone bedrock glade. 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 easily 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).
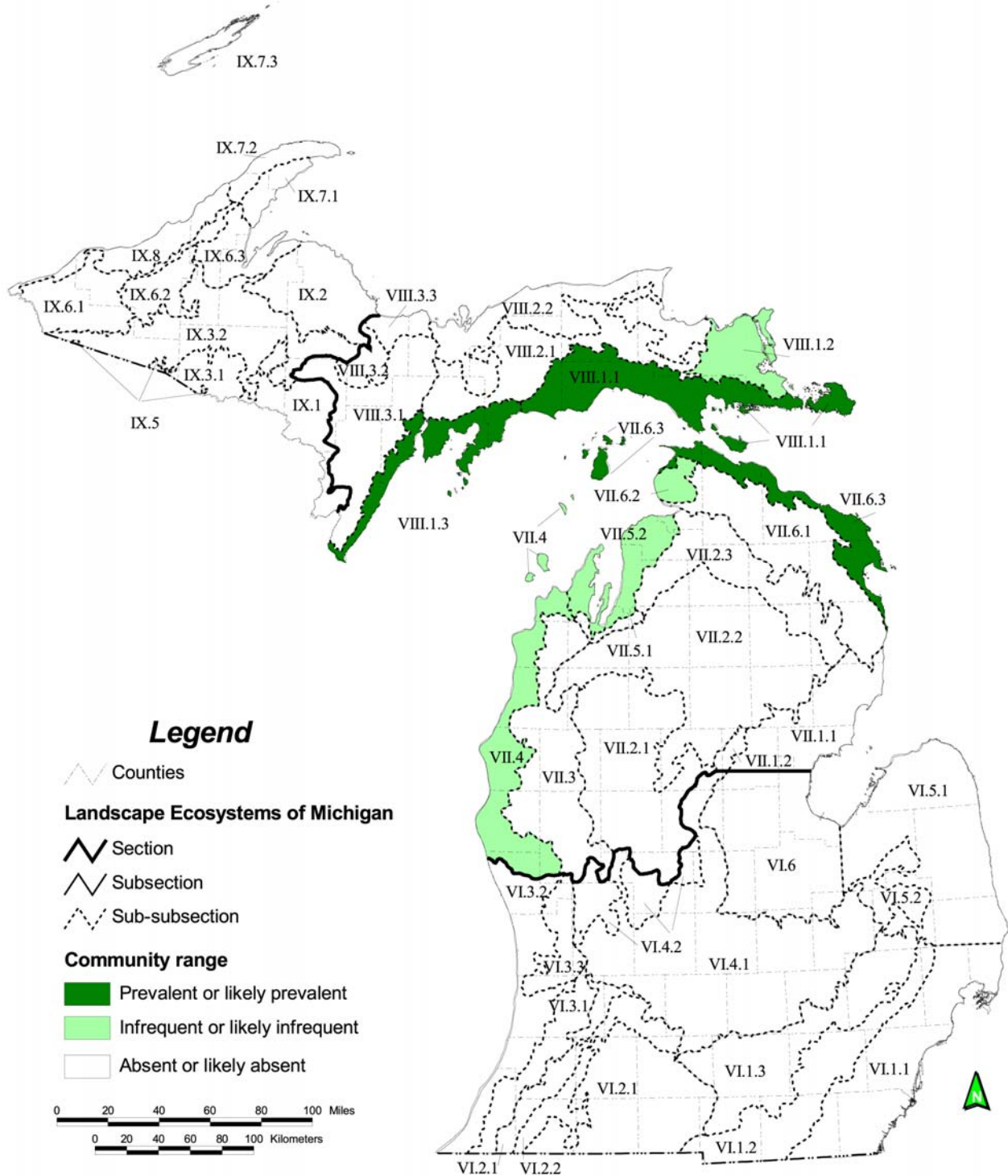
Figure 10. Distribution of limestone cobble shore in Michigan.

13. Thompson's Harbor (Limestone Cobble Shore)
Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: AB
Size: 68 acres
Location: Thompson's Harbor State Park
Element Occurrence Identification Number: 10477

Threats: The shoreline is characterized by localized infestations of non-native weeds, especially in sand and gravel beach inclusions. Non-native plant species found in these areas include common St. John's-wort (*Hypericum perforatum*), spotted knapweed (*Centaurea maculosa*), and wild carrot (*Daucus carota*). The most significant non-native threat to the site is posed by Siberian elm (*Ulmus pumila*), which is concentrated along the upland margin of the limestone cobble shore. Approximately 20 trees were observed ranging in DBH from 5 to 8 cm. Spread of non-native species may be facilitated by off-road vehicle traffic along the upper margin of the shoreline.

Management Recommendations: The primary management needs are to eliminate off-road vehicle activity along the shoreline and to control the invasive plant species. Eliminating off-road traffic along the shoreline will help reduce the disturbance to the substrate and soils and will help reduce the spread of non-native species. The clusters of Siberian elm should be removed through cutting and herbicide treatment. Monitoring should be implemented to evaluate efforts to control invasive species and off-road vehicle activity.

Photo 16. Tree-top view of Thompson's Harbor limestone cobble shore. Photo by Joshua G. Cohen.

MESIC SAND PRAIRIE

Overview: Mesic sand prairie is a native grassland community occurring on sandy loam, loamy sand, or sand soils on nearly level glacial outwash plains and lakeplains in both the northern and southern Lower Peninsula. Mesic sand prairie occurs in shallow depressions within glacial outwash plains and lakeplains, and on old, abandoned glacial lakebeds, stream channels, and river terraces. Soils are predominantly strongly acid to neutral sandy loam and occasionally loamy sand. Sites that support mesic sand prairie experience fluctuating water tables, with relatively high water tables occurring in the spring followed by drought conditions in late summer and fall. The community contains species from a broad range of moisture classes, but is dominated by species of upland affinity. Dominant grasses include little bluestem (*Andropogon scoparius*), big bluestem (*Andropogon gerardii*), and Indian grass (*Sorghastrum nutans*) (Kost et al. 2007).
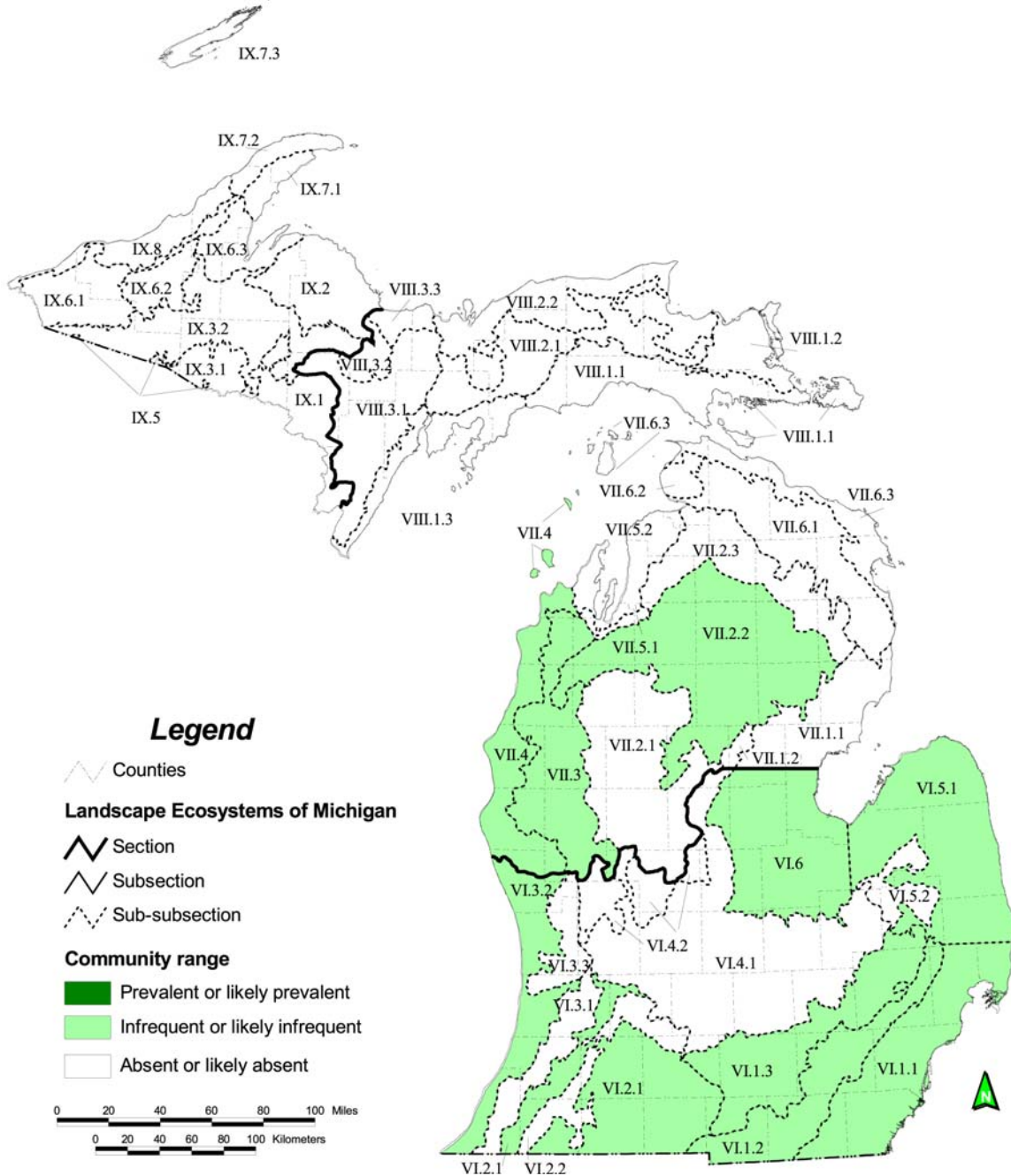
Figure 11. Distribution of mesic sand prairie in Michigan.

14. Teeple Lake (Mesic Sand Prairie)
Natural Community Type: Mesic Sand Prairie
Rank: G1? S1, critically imperiled globally and within the state
Element Occurrence Rank: C
Size: 0.4 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 694

Threats: Fire suppression has resulted in the invasion of trees and shrubs into the prairie. Woody encroachment of native and non-native species could potentially eliminate the open prairie physiognomy. Invasive species noted during the course of the survey included autumn olive (*Elaeagnus umbellata*) and glossy buckthorn (*Rhamnus frangula*), which both are concentrated along the margins of the prairie.

Management Recommendations: The primary management recommendation is to reintroduce fire as a fundamental disturbance factor maintaining open conditions. The prairie should be burned in concert with the surrounding wetlands. 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., trails, roads, and wetlands) should be used. New fire breaks could allow for additional invasive species encroachment. Cutting and herbiciding of glossy buckthorn and autumn olive are warranted. Monitoring should be implemented to assess efforts to control non-native plant populations and evaluate the success of fire management.

Photo 17. Teeple Lake mesic sand prairie. Photo by Joshua G. Cohen.

MESIC SOUTHERN FOREST

Overview: Mesic southern forest is an American beech– and sugar maple–dominated forest distributed south of the climatic tension zone and found on flat to rolling topography with predominantly loam soils. Mesic southern forest is found principally on medium- or fine-textured ground moraine, medium- or fine-textured end moraine, and on silty/clayey glacial lakeplains. Sand dunes and sandy lakeplains can support these systems where proximity to the Great Lakes modifies the local climate. The community can also occur on ice-contact topography and coarse-textured end moraines, as well as floodplain terraces in a diversity of landforms. Prevalent topographic positions of this community are gentle to moderate slopes and low, level areas with moderate to good drainage. The community occurs on a variety of soil types, but loam is the predominant texture. Soils supporting mesic southern forest include sand, sandy loam, loamy sand, loam, silt loam, silty clay loam, clay loam, and clay. Soils are typically well-drained with high water-holding capacity and high nutrient and soil organism content. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of shade-tolerant, canopy species. Historically, mesic southern forest occurred as a matrix system, dominating vast areas of rolling to level, loamy uplands of the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries (Kost et al. 2007).
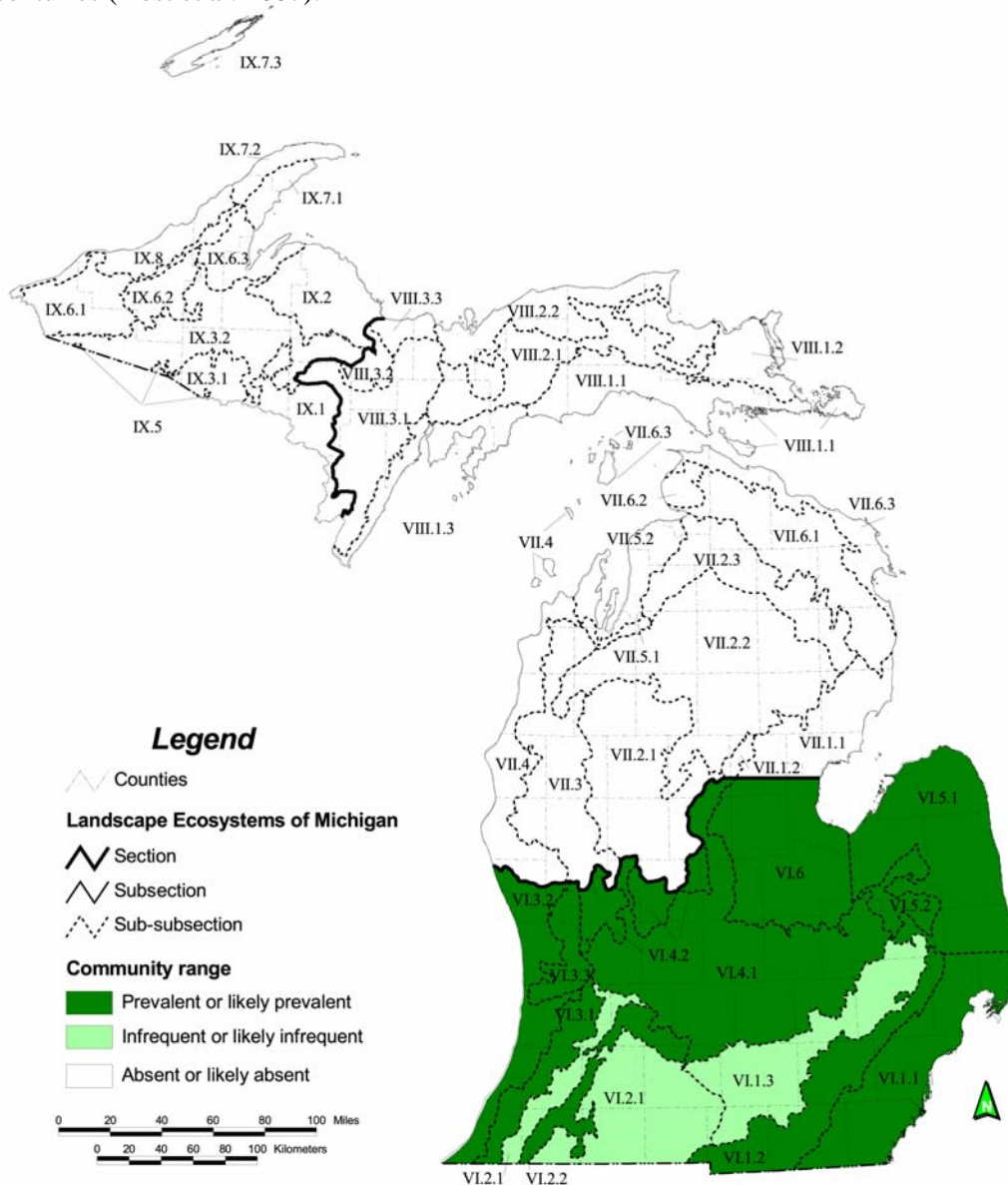
Figure 12. Distribution of mesic southern forest in Michigan.

15. Haven Hill (Mesic Southern Forest)
Natural Community Type: Mesic Southern Forest
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: B
Size: 115 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 3124

Threats: High deer densities have resulted in high deer browse pressure on the understory and ground cover species. Invasive species are occasional and are concentrated on the margins of the forest, in areas of younger forest, and along trails. Invasives that occur locally within the site include glossy buckthorn (*Rhamnus frangula*), autumn olive (*Elaeagnus umbellata*), Japanese barberry (*Berberis thunbergii*), garlic mustard (*Alliaria petiolata*), and multiflora rose (*Rosa multiflora*). In addition, emerald ash borer (*Agrilus planipennis*) has killed most of the canopy white ash (*Fraxinus americana*) that occurred scattered in the forest.

Management Recommendations: The primary management need is the control of invasive species. Cutting and herbiciding invasive shrubs and hand-pulling of garlic mustard are recommended. Control of invasive plant populations will require a major long-term effort. Reducing local deer densities will help decrease browse pressure. Monitoring should be implemented to assess efforts to control non-native plant populations and gauge the impact of deer herbivory.

Photo 18. Haven Hill mesic southern forest. Photo by Joshua G. Cohen.

PRAIRIE FEN

Overview: Prairie fen is a wetland community dominated by sedges, grasses, and other graminoids that occurs on moderately alkaline organic soil and marl south of the climatic tension zone in southern Lower Michigan. Prairie fens occur predominantly within poorly drained outwash channels and outwash plains in the interlobate regions of southern Lower Michigan. This area is comprised of coarse-textured end moraines and ice-contact features (eskers and kames) that are bordered by glacial outwash. Prairie fen occurs on saturated organic soil and marl. Prairie fens occur where cold, calcareous, groundwater-fed springs reach the surface. The flow rate and volume of groundwater through a fen strongly influence vegetation patterning; thus, the community typically contains multiple, distinct zones of vegetation, some of which contain prairie grasses and forbs (Kost et al. 2007).
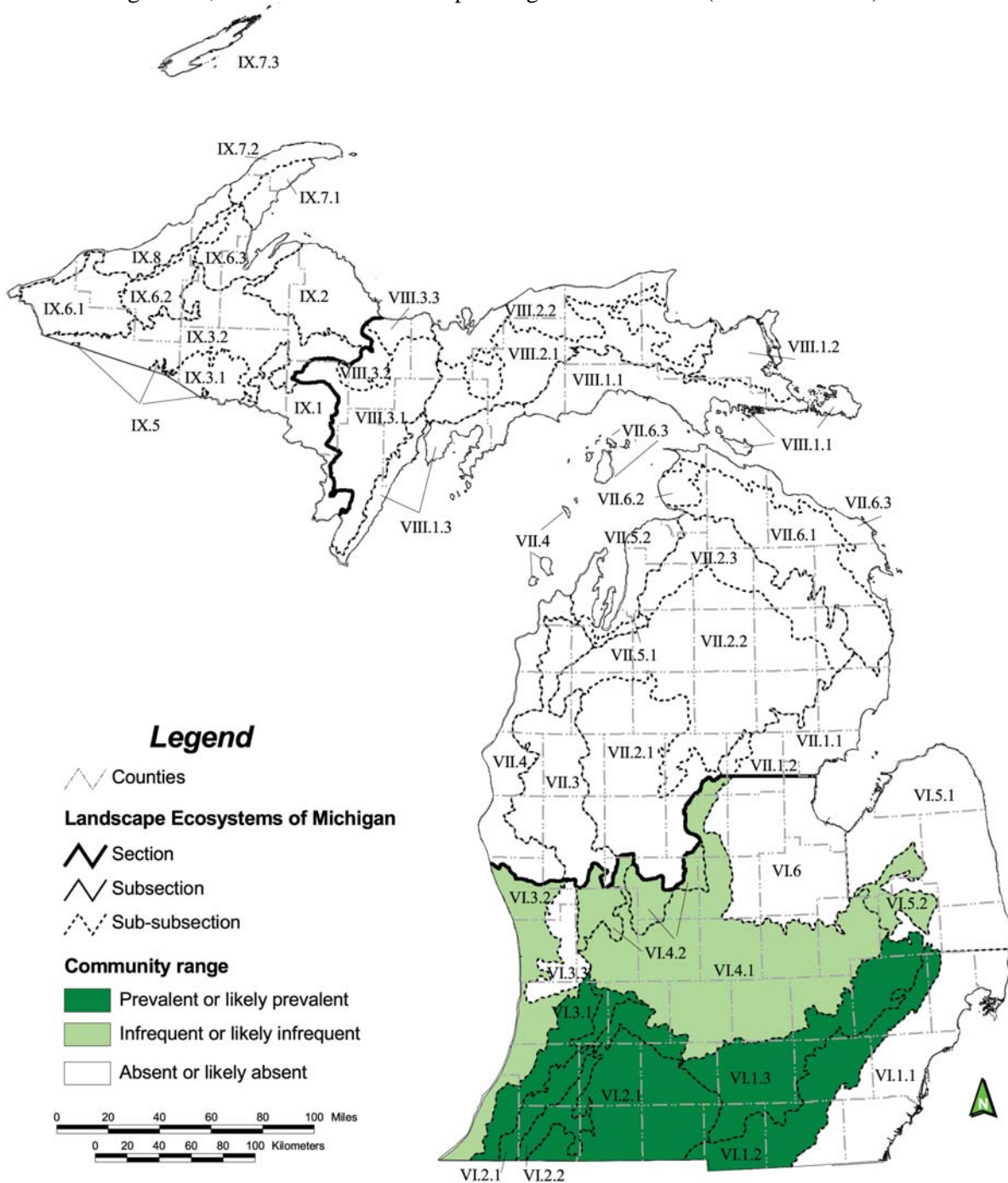
Figure 13. Distribution of prairie fen in Michigan.

16. Teeple Lake (Prairie Fen)
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 1 acre
Location: Highland State Recreation Area
Element Occurrence Identification Number: 5650

Threats: Fire suppression has resulted in the invasion of trees and shrubs into the prairie fen. Localized infestation of invasive plants also threatens to alter the fen's species composition and vegetative structure. Glossy buckthorn (*Rhamnus frangula*), multiflora rose (*Rosa multiflora*), and purple loosestrife (*Lythrum salicaria*) are common within the fen.

Management Recommendations: The primary management recommendation is to reintroduce fire as a fundamental disturbance factor maintaining open conditions. The prairie fen should be burned in concert with the surrounding wetlands. 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., trails, roads and adjacent wetlands) should be used. New fire breaks could allow for additional invasive species encroachment. Cutting and herbiciding of glossy buckthorn and multiflora rose are warranted. Populations of purple loosestrife throughout the Teeple Lake wetland should be controlled through biocontrol (i.e., leaf-feeding beetles, *Galerucella* spp.). Monitoring should be implemented to assess efforts to control non-native plant populations and evaluate the success of fire management.

Photo 19. Teeple Lake prairie fen. 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 14. Distribution of rich conifer swamp in Michigan.

17. Thompson's Harbor (Rich Conifer Swamp)
Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 120 acres
Location: Thompson's Harbor State Park
Element Occurrence Identification Number: 10051

Threats: The primary threat is posed by deer herbivory, which could limit northern white-cedar regeneration and alter the swamp's species composition and vegetative structure. In addition, the network of paths and roads in the surrounding landscape may provide pathways for invasive species encroachment.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens to jeopardize northern white-cedar regeneration and how herbivory is impacting species composition and vegetative structure.

Photo 20. Thompson's Harbor rich conifer swamp. Photo by Joshua G. Cohen.

RICH TAMARACK SWAMP

Overview: Rich tamarack swamp is a groundwater-influenced, minerotrophic, forested wetland dominated by tamarack (*Larix laricina*) that occurs on deep organic soils predominantly south of the climatic tension zone in southern Lower Michigan. Rich tamarack swamp occurs in outwash channels, outwash plains, and kettle depressions. Rich tamarack swamp typically occurs in association with headwater streams and adjacent to inland lakes. The organic soils underlying rich tamarack swamp are typically comprised of deep peat containing large amounts of woody debris and occasionally layers of sedge-dominated peat. Windthrow, insect outbreak, beaver flooding, and fire are all important forms of natural disturbance for rich tamarack swamp. This natural community type was known as relict conifer swamp in previous versions of the natural community classification (Kost et al. 2007).
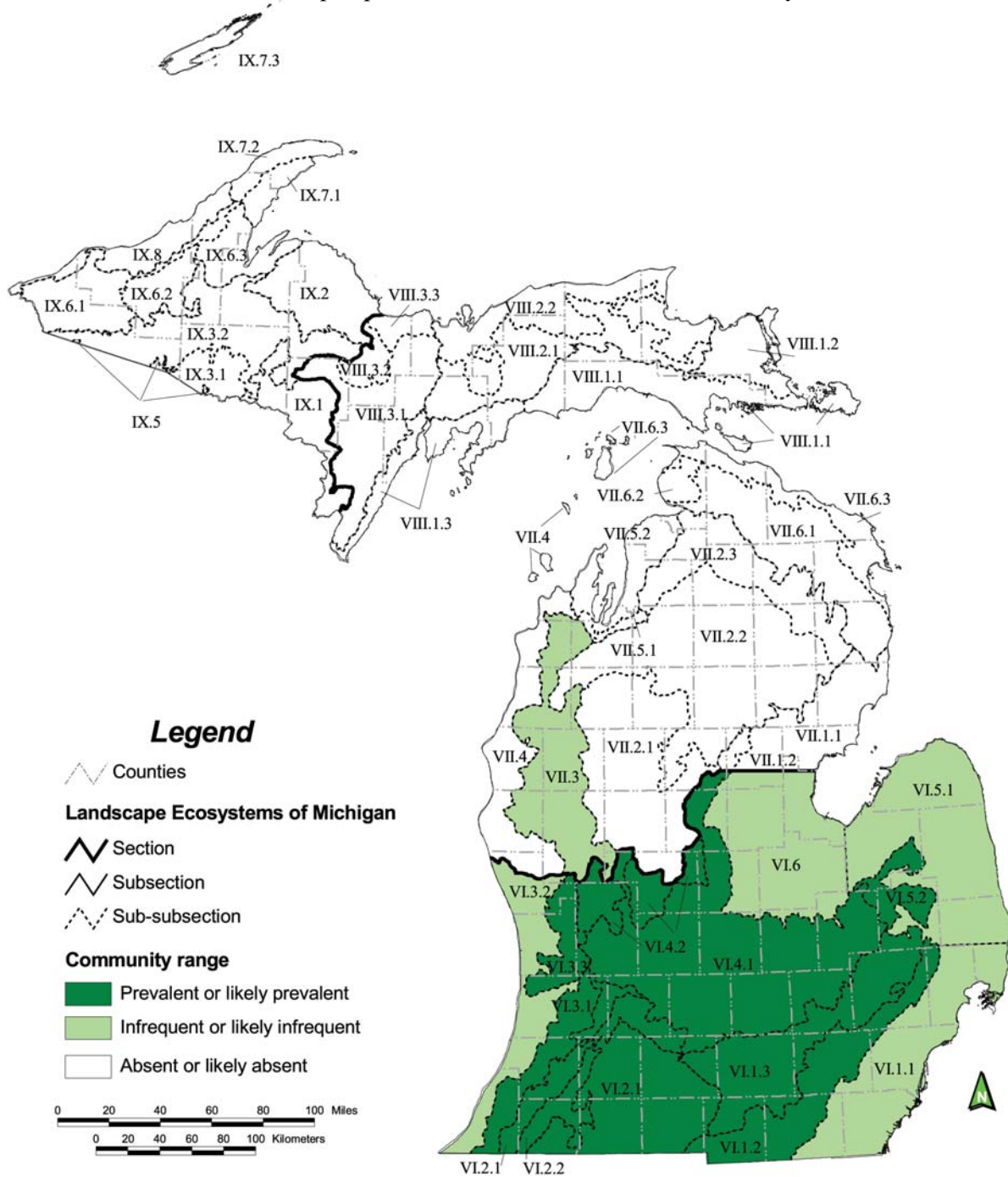
Figure 15. Distribution of rich tamarack swamp in Michigan.

18. Haven Hill (Rich Tamarack Swamp)
Natural Community Type: Rich Tamarack Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: D
Size: 19 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 4621

Threats: Invasive plants have drastically altered the species composition, vegetative structure, successional trajectory, and hydrology of the swamp. Invasives dominate the ground layer and understory layer and include reed (*Phragmites australis*), narrow-leaved cat-tail (*Typha angustifolia*), and glossy buckthorn (*Rhamnus frangula*), with lesser amounts of purple loosestrife (*Lythrum salicaria*) and bittersweet nightshade (*Solanum dulcamara*). Flooding and run-off of road salts have likely contributed to the high levels of canopy mortality, creating an open canopy that is favorable to these invasive plants. The hydrology of the site has probably been altered by the nearby road and is also impacted by the invasive plant populations. High levels of deer densities have resulted in high deer browse pressure on the understory and ground cover species.

Management Recommendations: This site may be degraded beyond rehabilitation. Control of invasive plant populations will require a major long-term effort to reduce the widespread dominance of reed and narrow-leaved cat-tail. In addition, populations of glossy buckthorn and purple loosestrife should be controlled within the site and in surrounding wetlands. Reducing local deer densities will help decrease browse pressure. Monitoring should be implemented for efforts to control non-native plant populations and to gauge the impact of deer herbivory.

Photo 21. Haven Hill rich tamarack swamp has been severely degraded by flooding and invasive species, especially narrow-leaved cat-tail (pictured above) and reed. Photo by Joshua G. Cohen.

SOUTHERN HARDWOOD SWAMP

Overview: Southern hardwood swamp is a minerotrophic forested wetland occurring in southern Lower Michigan on mineral or occasionally organic soils dominated by a mixture of lowland hardwoods. Conifers are absent or local. The community occupies shallow depressions and high-order stream drainages on a variety of landforms. Southern hardwood swamp occurs in poorly drained depressions on glacial lakeplain, outwash plains and channels, end moraines, till plains, and perched dunes. Soils are typically loam or silt loam, sometimes sandy loam or clay loam, of neutral to mildly alkaline pH (sandy substrates are more acidic), and sometimes covered by a thin layer of muck. An underlying impermeable clay lens is often present and allows for prolonged pooling of water. Water levels fluctuate seasonally, with standing water typically occurring throughout winter and spring. Due to anaerobic conditions associated with prolonged inundation and a high water table, trees are shallowly rooted and prone to frequent blowdown. The canopy is typically dominated by silver maple (*Acer saccharinum*), red maple (*A. rubrum*), green ash (*Fraxinus pennsylvanica*), and black ash (*Fraxinus nigra*) (Kost et al. 2007).
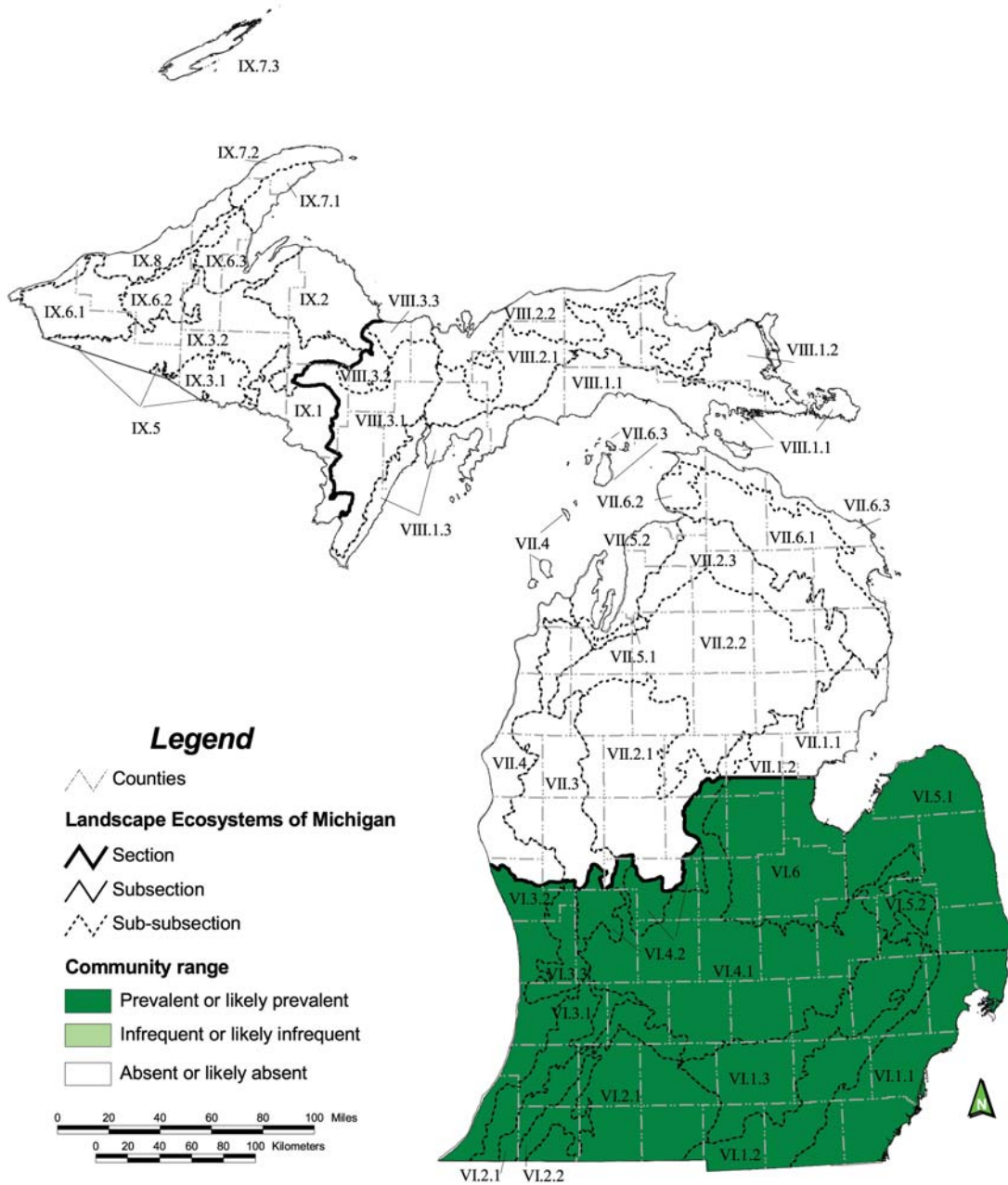
Figure 16. Distribution of southern hardwood swamp in Michigan.

19. Haven Hill (Southern Hardwood Swamp)
Natural Community Type: Southern Hardwood Swamp
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 115 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 8806

Threats: Invasive plants are beginning to alter the species composition, vegetative structure, successional trajectory, and hydrology of the swamp. In localized patches, invasives dominate the ground layer and understory layer and include reed (*Phragmites australis*) and narrow-leaved cat-tail (*Typha angustifolia*). Glossy buckthorn (*Rhamnus frangula*), purple loosestrife (*Lythrum salicaria*), autumn olive (*Elaeagnus umbellata*), and Japanese barberry (*Berberis thunbergii*) occur scattered throughout the site. Dutch elm disease and emerald ash borer (*Agrilus planipennis*) have caused the death of canopy elm and ash, creating areas of open canopy that are favorable to these invasive plants. The hydrology in portions of the site has been altered by the invasive plant populations. High levels of deer densities have resulted in high deer browse pressure on the understory and ground cover species.

Management Recommendations: Control of invasive plant populations will require a major long-term effort to reduce the local dominance of reed and narrow-leaved cat-tail. In addition, populations of glossy buckthorn, autumn olive, and Japanese barberry should be controlled within the site and in surrounding wetlands. Reducing local deer densities will help decrease browse pressure. Monitoring should be implemented for efforts to control non-native plant populations and to gauge the impact of deer herbivory.

Photo 22. Haven Hill southern hardwood swamp. Photo by Joshua G. Cohen.

20. Tobico Swamp - Tobico State Game Area
Natural Community Type: Southern Hardwood Swamp
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 35 acres
Location: Bay City State Recreation Area
Element Occurrence Identification Number: 4116

Threats: Deer herbivory and invasive plants threaten to alter the species composition and vegetative structure of the swamp. Invasives prevalent throughout the swamp include Morrow honeysuckle (*Lonicera morrowii*) and bittersweet nightshade (*Solanum dulcamara*). Narrow-leaved cat-tail (*Typha angustifolia*) and glossy buckthorn (*Rhamnus frangula*) occur scattered throughout the site. High levels of deer densities have resulted in high deer browse pressure on the understory and ground cover species.

Management Recommendations: The primary management recommendations are to reduce deer browse pressure and control invasive species. Cutting and herbiciding of glossy buckthorn and honeysuckles are recommended. Reducing local deer densities and increasing the amount of late-successional habitat in the adjacent landscape will help decrease deer browse pressure. Monitoring should be implemented for efforts to control non-native plant populations and to gauge the impact of deer herbivory.

Photo 23. Tobico Swamp southern hardwood swamp. Photo by Joshua G. Cohen.

SOUTHERN WET MEADOW

Overview: Southern wet meadow is an open, groundwater-influenced (minerotrophic), sedge-dominated wetland that occurs in central and southern Lower Michigan. Southern wet meadow occurs on glacial lakebeds, lakeplains, and in depressions on glacial outwash and moraines. The community frequently occurs along the margins of lakes and streams, where seasonal flooding or beaver-induced flooding is common. Soils are typically neutral to strongly alkaline organic soils (i.e., sapric to hemic peat), but saturated mineral soil may also support the community. Open conditions are maintained by seasonal flooding, beaver-induced flooding, and fire. Sedges in the genus *Carex*, in particular tussock sedge (*Carex stricta*), dominate the community (Kost et al. 2007).
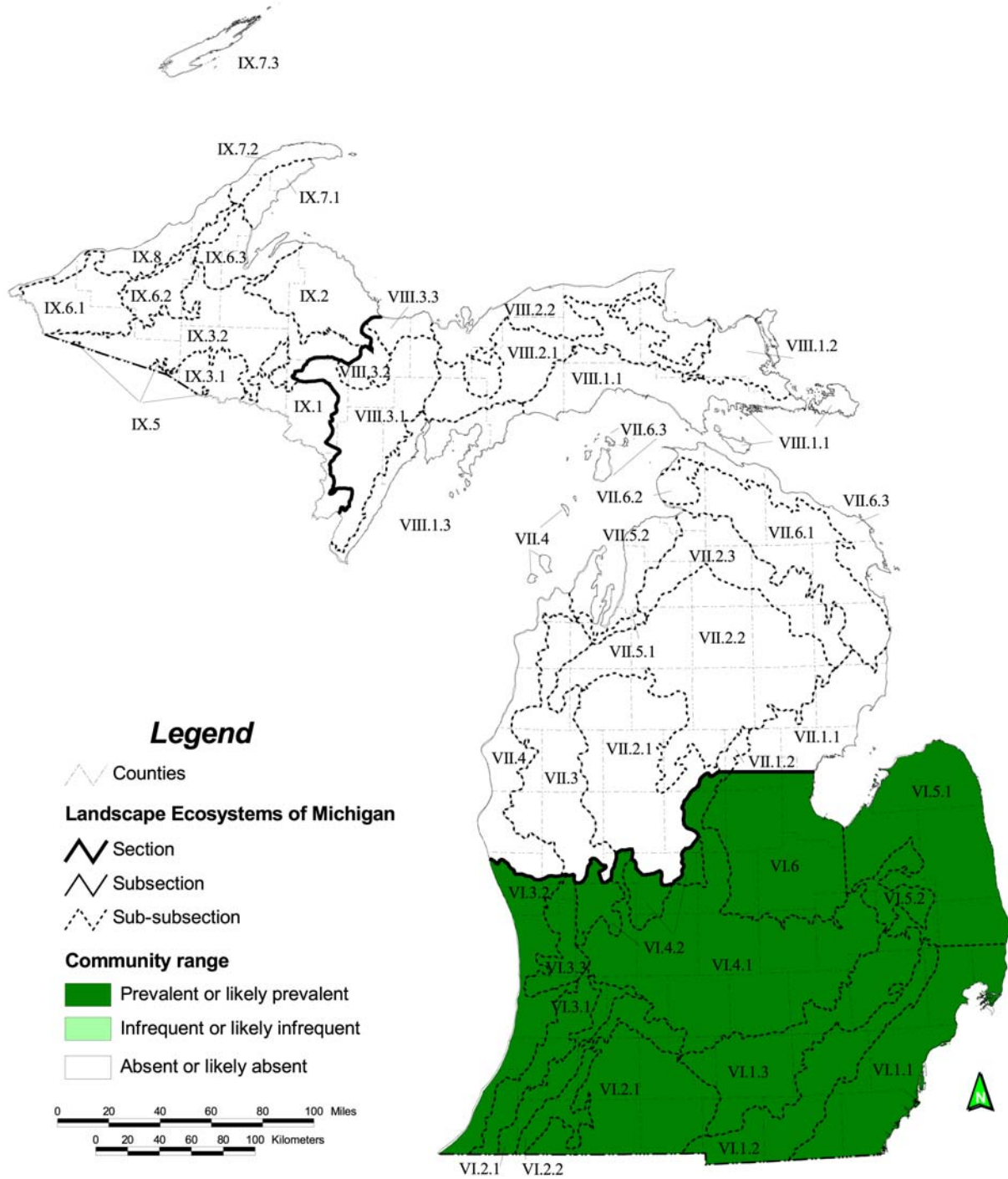
Figure 17. Distribution of southern wet meadow in Michigan.

21. Teeple Lake (Southern Wet Meadow)
Natural Community Type: Southern Wet Meadow
Rank: G4? S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 40 acres
Location: Highland State Recreation Area
Element Occurrence Identification Number: 7705

Threats: The hydrology of the wetland has likely been altered by the old road that passes through the center of the site. Western and southern portions of the element occurrence are dominated by reed canary grass (*Phalaris arundinacea*) with localized patches of purple loosestrife (*Lythrum salicaria*). These areas may have experienced greater past hydrological disturbance and perhaps grazing as well. The entire wetland is fire suppressed as manifest by the thick litter layer and the encroachment of shrubs and trees. Localized infestations of invasives threaten to alter the species composition and vegetative structure. Multiflora rose (*Rosa multiflora*) occurs as a local dominant along the wetland and upland margin. Glossy buckthorn (*Rhamnus frangula*) occurs scattered throughout at low densities and a small clump of narrow-leaved cat-tail (*Typha angustifolia*) occurs in the southern portion of the meadow.

Management Recommendations: The primary management recommendation is to reintroduce fire as a fundamental disturbance factor maintaining open conditions. The southern wet meadow should be burned in concert with the surrounding wetlands. 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., trails, roads, and adjacent wetlands) should be used. New fire breaks could allow for additional invasive species encroachment. Areas with narrow-leaved cat-tail should not be burned since this species can spread dramatically following fire. Instead, the few patches of narrow-leaved cat-tail should be spot treated. Cutting and herbiciding of glossy buckthorn and multiflora rose are warranted. Populations of purple loosestrife throughout the Teeple Lake wetland should be controlled through biocontrol (i.e., leaf-feeding beetles, *Galerucella* spp.). Monitoring should be implemented to assess efforts to control non-native plant populations and evaluate the success of fire management.

Photo 23. Teeple Lake southern wet meadow. Photo by Joshua G. Cohen.

DISCUSSION

This report provides site-based assessments of 21 natural community element occurrences on PRD lands. 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. Over the next several years, MNFI will continue to survey the remaining natural community element occurrences within the State Parks and Recreation Areas. 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 24. Thompson's Harbor coastal fen. Photo by Joshua G. Cohen.

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Photo 25. Marsh blazing star (*Liatris spicata*) within the Algonac South Drain lakeplain wet-mesic prairie. Photo by Joshua G. Cohen.

Appendix 1. Ecology Community Field Survey Form

Ecological Community Field Survey Form

Michigan Natural Features Inventory

MICHIGAN STATE UNIVERSITY EXTENSION

SURVEY INFORMATION

Survey date: _____ Time: from _____ AM PM to _____ AM PM Sourcecode: _____

Surveyors (principal surveyor first, include first & last name):
_____

Weather conditions: _____

Revisit needed? ☐ Yes ☐ No Why? ☐ Complete community survey ☐ Rare species survey ☐ Invasive plant survey ☐ Monitoring

FILING

Survey site: _____ Site name: _____

IDENTIFICATION (Identify community if known positively, or provide closest alliance/association if not known)

Community Name: _____ Overall Rank: _____ EOID: _____ EO #: _____

If classification problems, explain:

```


```

Photo/slide taken? ☐ Yes ☐ No Where has photo been deposited? _____

If associated plot, list project name, and reference #:
_____

LOCATIONAL INFORMATION

Township/Range/Section: _____ County: _____

DIRECTIONS: Provide detailed directions to the observation (rather than the survey site). Include landmarks, roads, towns, distances, compass directions.

```


```

Landowner type: ☐ Public ☐ Private ☐ Other: _____

Landowner Contact Information: _____

Notes: _____

Was a GPS used? ☐ Yes ☐ No Type of unit: _____ Unit number: _____

Waypoint name/#: _____ File name: _____

Latitude: _____ Longitude: _____

Feature Information (mandatory): _____ Source feature: ☐ Single Source EO ☐ Multiple Source EO

SIZE - Measure of the area of the Element at the observed location.

Observed area (unit): ☐ Acres ☐ Hectares Type of measurement: ☐ Precise ☐ Estimate

Basis for estimate: _____

SIZE RANK (comments): _____

CONFIDENCE EXTENT

Indicate whether there is confidence that the observed area represents the full extent of the community element at that location.
(Y = confidence that the full extent is known; N = confidence that the full extent is not known; ? = uncertainty whether full extent is known)

☐ Yes ☐ No ☐ ? _____

Appendix 1, continued. Ecology Community Field Survey Form.

LANDSCAPE CONTEXT - An integrated measure of the quality of biotic and abiotic factors, structures and processes surrounding the observed area, and the degree to which they may affect the continued existence of the Element at that location. Component of landscape context for communities are: 1) landscape structure and extent, 2) condition of the surrounding landscape (i.e., community development/maturity, species composition and biological structure, ecological processes, and abiotic physical/chemical factors.) Factors to consider include integrity/fragmentation, stability/old growth, richness/distribution of species, presence of invasive species, presence of invasive species, degree of disturbance, changes to ecological processes, stability of substrate, and water quality.

SURROUNDING LAND USE AND LAND COVER:

Percent natural cover: ☐ >90% ☐ >75% ☐ >50% ☐ >25% ☐ <25%   Road density: ☐ HIgh ☐ Medium ☐ Low

Check all that apply

Dominant land use:	Dominant land cover:
☐ Natural cover	☐ Upland forest
☐ Managed timber/forest	☐ Savanna/grassland
☐ Agriculture	☐ Forested wetland
☐ Mining	☐ Non-forested wetland
☐ Urban/suburban	☐ Agriculture
☐ Other: _____	☐ Urban
	☐ Other: _____

1. Comment on the relative integrity/fragmentation of the surrounding landscape

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2. List native plant communities in surrounding landscape

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3. Comment on invasive plants present in surrounding area and describe resulting impacts

```



```

List disturbances (either natural or caused by humans) and ecological processes (e.g., hydrologic and fire regimes) in surrounding area

☐ Logging	☐ Plant disease: _____	☐ Wild fire
☐ Grazing/browsing	☐ Insect damage: _____	☐ Prescribed fire
☐ Agriculture	☐ Exotic animal activity: _____	☐ Windthrow
☐ Soil erosion	☐ Herbivore impact (e.g., deer): _____	☐ Ice storm
☐ Mining	☐ Invasive plants: _____	☐ Ice scour
☐ Dumping		☐ Desiccation
☐ Trails/roads		☐ Flooding
☐ ORV/vehicular disturbance		☐ Beaver flooding
☐ Hydrologic alteration		☐ Beaver chewed trees
(drainage, ditches, blocked culverts, etc.)		☐ Other: _____
☐ Fire supression		
☐ Other: _____		

LANDSCAPE RANK (comments)**:**

```



```

Appendix 1, continued. Ecology Community Field Survey Form.

CONDITION: ABIOTIC DATA

Geology

Igneous Rocks
- [ ] **Granitic** (Granite, Schyolite, Syenite, Trachyte)
- [ ] **Dioritic** (Diorite, Dacite, Andesite)
- [ ] **Gabbroic** (Gabbro, Basalt, Pyroxenite, Peridotite, Diabase, Traprock)
- [ ] **Rhyolite**
- [ ] Other: _____

Metamorphic Rocks
- [ ] **Felsic Gneiss and Schist** (Granitic)
- [ ] **Mafic Gneiss and Schist**
- [ ] **Slate**
- [ ] **Quartzite**
- [ ] Other: _____

Sedimentary Rocks
- [ ] **Volcanic Conglomerates**
- [ ] **Breccias**
- [ ] **Sandstone**
- [ ] **Siltstone** (calcareous or noncalcareous)
- [ ] **Limestone and Dolomite**
- [ ] **Gypsum**
- [ ] **Shale**
- [ ] Other: _____

Landform

Glacial
- [ ] Lake plain
- [ ] End or lateral moraine
- [ ] Ground moraine (till plain)

Ice Contact Feature
- [ ] Drumlin
- [ ] Esker
- [ ] Kame
- [ ] Kettle
- [ ] Lake bed
- [ ] Outwash channel

Outwash
- [ ] Outwash channel
- [ ] Outwash plain
- [ ] Pitted outwash
- [ ] Other: _____

River/Lakeshore
- [ ] Shoreline
- [ ] Sand dune
- [ ] Barrier dune
- [ ] Spit
- [ ] Offshore bar
- [ ] Riverine estuary
- [ ] Delta
- [ ] Stream bed
- [ ] Stream terrace
- [ ] Alluvial fan
- [ ] Alluvial flat
- [ ] Alluvial terrace
- [ ] Dike
- [ ] Other: _____

Aeolian
- [ ] Dunes
- [ ] Aeolian sand flats
- [ ] Other: _____

Other
- [ ] Cliff
- [ ] Ledge
- [ ] Lakeshore bedrock outcrop
- [ ] Ridgetop bedrock outcrop
- [ ] Inland level-to-sloping bedrock outcrop
- [ ] Ravine
- [ ] Seep
- [ ] Slide
- [ ] Talus
- [ ] Other: _____

Organic Soil Deposits:

Core One: GPS Point
_____

	Depth	pH
[ ] Fibirc Peat:	_____	_____
[ ] Hemic Peat:	_____	_____
[ ] Sapric Peat (muck):	_____	_____
[ ] Marl (depth):	_____	_____
[ ] Other (describe):	_____	_____

Comments:

Core Two: GPS Point
_____

	Depth	pH
[ ] Fibirc Peat:	_____	_____
[ ] Hemic Peat:	_____	_____
[ ] Sapric Peat (muck):	_____	_____
[ ] Marl (depth):	_____	_____
[ ] Other (describe):	_____	_____

Comments:

Core Three: GPS Point
_____

	Depth	pH
[ ] Fibirc Peat:	_____	_____
[ ] Hemic Peat:	_____	_____
[ ] Sapric Peat (muck):	_____	_____
[ ] Marl (depth):	_____	_____
[ ] Other (describe):	_____	_____

Comments:

Appendix 1, continued. Ecology Community Field Survey Form.

Mineral Soil Depth (average): _____

pH: _____

Surface Soil Texture (Upper 10 cm of soil profile)

- ☐ Sand
- ☐ Loamy sand
- ☐ Sandy loam
- ☐ Loam
- ☐ Silt loam
- ☐ Sandy Clay loam
- ☐ Clay loam
- ☐ Silty clay loam
- ☐ Sandy clay
- ☐ Clay
- ☐ Silty clay
- ☐ Other: _____

Soil Series: _____

Comments:

[ ]

Wetland Mineral Soil Indicators:

- ☐ Gleyed soils (list soil texture and depth):

  _____

- ☐ Iron mottling (list soil texture and depth):

  _____

Depth to saturation: _____

Depth to water table: _____

Hydrologic Regime:

Wetlands:

- ☐ Intermittently flooded
- ☐ Permanently flooded
- ☐ Semipermanently flooded
- ☐ Temporarily flooded (e.g., floodplains)
- ☐ Seasonally flooded (e.g., seasonal ponds)
- ☐ Saturated (e.g., bogs, perennial seeps)
- ☐ Unknown

Non-Wetlands:

- ☐ Wet Mesic
- ☐ Mesic (moist)
- ☐ Dry-Mesic
- ☐ Xeric (dry)

Groundcover:
(with >5% cover, 20 m x 20 m area)

- _____ % Bedrock
- _____ % Wood (>1cm)
- _____ % Litter, duff
- _____ % Large rocks (cobbles, boulders >10 cm)
- _____ % Small rocks (gravel, 0.2 - 10 cm)
- _____ % Bare soil
- _____ % Water
- _____ % Other
- 100% (Total = 100%)

Light:

- ☐ Open
- ☐ Partial
- ☐ Filtered
- ☐ Shade

Cowardin System:

- ☐ Upland
- ☐ Riverine
- ☐ Lacustrine
- ☐ Palustrine

Slope:

Measured Slope: _____ °   _____ %

☐ Flat	0°	0%
☐ Gentle	0 - 5°	0 - 9%
☐ Moderate	6 - 14°	10 - 25%
☐ Somewhat steep	15 - 25°	26 - 49%
☐ Steep	26 - 45°	50 - 100%
☐ Very Steep	45 - 69°	101 - 275%
☐ Abrupt	70 - 100°	276 - 300%
☐ Overhanging/sheltered	> 100°	> 300%

Aspect (down slope):

Measured Aspect: _____ ° (N = 0°)

☐ Flat		
☐ Variable		
☐ N	338 - 22°	
☐ NE	23 - 67°	
☐ E	68 - 112°	
☐ SE	113 - 157°	
☐ S	158 - 202°	
☐ SW	203 - 247°	
☐ W	248 - 292°	
☐ NW	293 - 337°	

Topographic position:

- ☐ Ridge, summit, or crest
- ☐ High slope (upper slope, convex slope)
- ☐ Midslope (middle slope)
- ☐ Lowslope (lower slope, footslope)
- ☐ Toeslope (alluvial toeslope)
- ☐ Low level (terrace lakeplain, outwash plan, lake bed, etc)
- ☐ Channel
- ☐ Other: _____

Soil Type - Describe soil profile, pH, and method of assessment

[ ]

CONDITION: VEGETATIVE FIELD DATA FOR THE ELEMENT

DBH (indicate cm or inches) of several dominant tree species, include age in years of cored trees:

Species	DBH(AGE)	DBH(AGE)	DBH(AGE)	DBH(AGE)	DBH(AGE)	DBH(AGE)

Density:

	Tree canopy	Shrub layer	Herb layer
Closed			
Open			
Patchy			
Sparse			
Absent			

Appendix 1, continued. Ecology Community Field Survey Form.

Complete one or more of the quantitative vegetation data boxes below. If completing only box indicate whether data represents a synthesis of overall community or community is relatively homogeneous throughout.

QUANTITATIVE VEGETATION DATA FOR THE ELEMENT

Method used (e.g., ocular estimation, quantitative transect, fixed plot, prism plot): _____

Sample Point 1: _____   GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *
1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

Sample Point 2: _____   GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *
1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

Sample Point 3: _____   GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *
1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

Sample Point 4: _____   GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *
1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

Page 5 of 10

Appendix 1, continued. Ecology Community Field Survey Form.

CONDITION - An integrated measure of the quality of biotic and abiotic factors, structures and processes within the observed area, and the degree to which they may affect the continued existence of the Element a that location. Factors to consider include evidence of stability/presence of old growth, richness/distirbution of species, presence of invasive species, degree of disturbance, changes to ecological processes, stability of substrate and water quality.

1. Species composition:

2. Community structure:

3. Ecological processes:

Natural and Anthropogenic Disturbance: information on disturbances(s) (either natural or caused by humans)

☐ Logging
☐ Grazing/browsing
☐ Agriculture
☐ Soil erosion
☐ Mining
☐ Dumping
☐ Trails/roads
☐ ORV/vehicular disturbance
☐ Hydrologic alteration
   (drainage, ditches, blocked culverts, etc.)
☐ Fire supresion
☐ Other: _____

☐ Plant disease: _____
☐ Insect damage: _____
☐ Exotic animal activity: _____
☐ Herbivore impact (e.g., deer): _____
☐ Invasive plants: _____

☐ Wild fire
☐ Prescribed fire
☐ Windthrow
☐ Ice storm
☐ Ice scour
☐ Desiccation
☐ Flooding
☐ Beaver flooding
☐ Beaver chewed trees
☐ Other: _____

Comment on disturbance(s) and changes to ecological processes (e.g., hydrologic and fire regimes) <u>within</u> in observed area:

Comment on invasives present within the observed area and describe resulting impacts:

CONDITION RANK (comments):

Appendix 1, continued. Ecology Community Field Survey Form.

MANAGEMENT CONSIDERATIONS

Threats (e.g., fire suppression, invasive species, ORVs, hydrologic alteration, logging, high deer densities etc.)

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Management (stewardship and restoration), **Monitoring and Research Needs** for the Element at this location (e.g., burn periodically, open the canopy, control invasives, ban ORV's, remove drainage ditches, clear blocked culvert, break drain tile, reduce deer densities, study effects of herbivore impacts)

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Protection Needs for the Element at this location (e.g., protect the entire marsh, the slope and crest of slope)

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SUMMARY OF ELEMENT OCCURRENCE

General Description of the Element: Provide a brief "word picture" of the community focusing on abiotic and biotic factors. Describe the landforms, geological formations, soils/substrates, topography, slope, aspect, hydrology, aquatic features, vegetative layers, significant species etc.

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Description of the Vegetation: Describe variation within the observed area in terms of vegetation structure and environment. Describe dominant and characteristic species and any inclusion communities. If a mosaic, describe spatial distribution and associated community types.

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OVERALL RANK (comments):

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Appendix 1, continued. Ecology Community Field Survey Form.

SPECIES LIST

Group and record species for each relevant strata (e.g., Overstory, Sub-canopy, Tall Shrub, Low Shrub, Ground Cover).
For each species, include abundance rank: **D = dominant A = abundant C = common O = occasional U = uncommon R = scarce L = local (modifier)**

Appendix 1, continued. Ecology Community Field Survey Form.

Sketch the most descriptive cross-section through the natural community, depicting the topography, vegetative structure and composition:

Appendix 1, continued. Ecology Community Field Survey Form.

GPS WAYPOINTS AND DESCRIPTIONS

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____
8 _____
9 _____
10 _____
11 _____
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42 _____
43 _____
44 _____
45 _____
46 _____
47 _____
48 _____
49 _____
50 _____

Appendix 2. Threat Assessment Form.

Threat	Severity	Scope	Reversibility	Threat Score	Comments
Invasive Species					
Fire Suppression					
Deer Herbivory					
ORV Activity					
Hydrologic Alteration					
Infrastructure/ Trail Development					
Water Quality/ Contamination					
Invasive Plant #1:					
Invasive Plant #2:					
Invasive Plant #3:					
Invasive Plant #4:					
Invasive Plant #5:					

Rank each observed threat in terms of **Severity**, **Scope**, and **Reversibility** on a scale of 1 to 5.
Severity is the level of damage to the site and a score of 1 means the site is slightly
damaged and a score of 5 means the site has been extensively damaged.
Scope is the geographic extent of impact and a score of 1 means the threat
occupies a trace area within the site and a score of 5 means the threat is ubiquitous.
Reversibility is the probability of controlling the threat and reversing the damage and a score
of 1 means the threat can be easily controlled and a score of 5 means the threat is unlikely to be
controlled.
Threat Score is a sum of the rankings for **Severity**, **Scope**, and **Reversibility**.

Severity:

5: Without action, the community will likely be destroyed or eliminated (beyond restoration) within 10-15 years

4: Without action, the community will likely be seriously degraded (potentially lowered by 1 EO Rank) within 10-15 years

3: Without action, the community will likely be moderately degraded (potentially lowered by 1/2 EO Rank) within 10-15 years

2: Without action, the community will likely be slightly impaired by this threat within 10-15 years

1: Without action, the community may be slightly impaired by this threat within 15+ years

0: No threat

Scope:

5: Threat impacts the entire community EO (90%+)

4: Threat impacts large portions of the community EO (roughly 50-89%)

3: Threat impacts moderate portions of the community EO (roughly 15-49%)

2: Threat impacts localized portions of the community EO (roughly 5-14%, possibly in several scattered small patches)

1: Threat impacts only one small patch within or on the edge of the community EO, or is currently outside EO in the vicinity but likely to impact EO within the next 10 years

0: No threat

Reversibility:

5: Threat is not reversible (e.g., parking lot/paving)

4: Threat is reversible but not practically affordable without major investment of $ and time (potentially hundreds of thousands of dollars or full time staff effort)

3: Threat is reversible but moderately difficult and requires a fair investment of $ and/or time (potentially tens of thousands of dollars or 2+ weeks of staff time/year)

2: Threat is reversible at relatively low cost (potentially several days of staff time/year or up to a few thousand dollars)

1: Threat is easily reversible with only a few hours of effort (potentially annually) by a small group of people such as volunteers or state workers

0: No threat

Appendix 3. 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.