Invasive Plant Management Plan for Plum Island in Horicon-Green Bay National Wildlife Refuge

Great Lakes Region

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On the cover:
Great Lakes Marsh, northwest Plum Island, Green Bay National Wildlife Refuge.
Photograph: Joshua Cohen, July 12, 2021

Summary

Invasive species management is a major priority of the National Wildlife Refuge (NWR) System of the United States Fish and Wildlife Service (USFWS). More than 2.5 million acres of NWR lands are infested with invasive species, of which about 10% have been treated. Recent success stories include Midway Atoll NWR eradicating 99% of invasive golden crownbeard (*Verbesina encelioides*) to the benefit of the endangered short-tailed albatross (*Phoebastria albatrus*) and other native seabirds and plants (USFWS 2013).

Invasive species management on any refuge requires baseline information about the invasive species present and conservation assets that they threaten. Invasive species management in refuges is prioritized and conducted on a sub-refuge area-invasive species basis. A plan for treatment must be developed which includes Specific, Measurable, Achievable, Results-oriented, and Time-bound objectives (SMART). This includes not only goals and instructions for treatment but for ongoing monitoring, data collection, and record-keeping. These objectives must be consistent with the principles of the multi-pronged approach of integrated pest management (IPM).

The Green Bay NWR consists of several islands of the Grand Traverse Islands chain in Lake Michigan, linking Wisconsin's Door Peninsula to Michigan's Garden Peninsula. The Refuge provides roosting habitat for the little brown bat, nesting and stopover habitat for many bird species such as the bald eagle, black-crowned night-heron, and Caspian tern, and supports a diversity of state and federally endangered plants such as dwarf lake iris, Laurentian fragile fern, and climbing fumitory (Salas et al. 2017, Bassett et al. 2022, Cohen et al. 2022).

In support of Green Bay NWR's Habitat Management Plan and Comprehensive Conservation Plan, this Invasive Plant Management Plan (IPMP) is meant to guide invasive plant species management and monitoring, using the principals of IPM, on Plum Island. Though the island has been significantly altered by anthropogenic disturbance, 2021 surveys found four quality natural communities and four state-listed plant species, including federally threatened dwarf lake iris (*Iris lacustris*). Historically, there were two additional listed plant species which may persist on the island in small quantities. These conservation assets are threatened by a diversity of invasive species, several of them quite aggressive, including multiflora rose (*Rosa multiflora*), reed canary grass (*Phalaris arundinacea*), narrow-leaved cat-tail (*Typha angustifolia*), bush honeysuckle (*Lonicera* sp.), and wild parsnip (*Pastinaca sativa*). The content and structure of this plan follow The Land Manager's Guide to Developing an Invasive Plant Management Plan (USFWS Cal-IPC 2018).

This IPMP provides field methods and data management procedures to facilitate monitoring surveys for conservation assets and invasive species, treatment objectives and actions, and treatment effectiveness monitoring. Data gathered by these methods should contribute to an adaptive management strategy based on this IPMP. Adapting management strategies based on new information will prompt the flexibility needed to combat the complex challenge of invasive plant management (Lowell et al. 2014).

Acknowledgments

We thank the authors of the framework used to guide this IPMP (USFWS Cal-IPC 2018). We are grateful to Michigan Natural Features Inventory (MNFI) staff who contributed to this project: Helen Enander for providing maps, Elizabeth Haber for feedback on this report, and Jesse Lincoln for his contributions to the project design, planning, and surveys on other islands. We thank USFWS Region 3 sponsors Richard King and Joshua Booker. We thank the staff at Green Bay NWR, particularly Bill Peterson and Sadie O'Dell. We are grateful to Matt Chansler and the Michigan State University Herbarium for assistance with plant identification and accepting voucher specimens. We thank Claire Peterson of the Michigan Invasive Species Information Network (MISIN) for providing records of invasive species observations.

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Chapter 1: Introduction

Plan Purpose and Need

Humans have been moving plants to new habitats for millennia. Shortly after Europeans began to colonize North America, many European plants began to naturalize on the continent such as dandelion (*Taraxacum officinale*), common plantain (*Plantago major*), and white clover (*Trifolium repens*; Mack 2003). Today, people continue to introduce non-native plants at a rapid rate through activities such as gardening, shipping, recreation, and travel (Reichard and White 2001, van Kleunen et al. 2018). Some introduced plants establish and naturalize in a relatively harmless fashion, while others become so problematic as to be called invasive.

Invasive species negatively affect biodiversity. In a global meta-analysis of animal and plant species, invasive species presence was associated with a 21% decrease in species richness (Crystal-Ornelas and Lockwood 2020). Approximately 42% of federally threatened and endangered species are vulnerable primarily due to invasive species (Pimentel et al. 2005). An abundant invasive species can even drive a related native species to extinction through hybridization and introgression (Levin et al. 1996).

Invasive plants can cause ecological harm to other species. Invasive plants such as spotted knapweed (*Centaurea stoebe* ssp. *micranthos*) release allelopathic chemicals that directly suppress the growth of native plants (Thorpe et al. 2009). Other invasive plants, such as garlic mustard (*Alliaria petiolata*), chemically suppress mycorrhizae which form mutualisms with native plants (Stinson et al. 2006). Invasive species can also affect animal communities by altering relative species abundances and decreasing habitat heterogeneity (Ceradini and Chalfoun 2017).

Invasive species can alter entire ecosystems by changing the amount of available nutrients such as nitrogen and carbon. A global meta-analysis found that invaded ecosystems had 40% and 133% higher levels of aboveground nitrogen and carbon, respectively (Liao et al. 2007). Cumulative impacts of invasive species cause an estimated $120 billion in environmental damage annually in the United States (Pimentel et al. 2005, Lockwood et al. 2013).

The impact of invasive species was recognized by the US federal government in President Obama's Executive Order 13751: Safeguarding the Nation from the Impacts of Invasive Species and in the Department of the Interior's Invasive Species Strategic Plan for the years 2021 – 2025 (USDI 2021). These documents call to prevent the introduction of new invasive species and to manage established invasive species. This is also consistent with the conservation, management, and restoration components of the mission of the National Wildlife Refuge (NWR) System.

With time and resources being scarce, a comprehensive, selective, and adaptive approach is needed to combat invasive plant species. Integrated pest management (IPM) uses multiple approaches to eliminate, manage, or prevent plant invasion (USFWS Cal-IPC 2018). It recognizes that emerging invasions can be reversed through early detection and rapid response (EDRR) and future invasions prevented through monitoring. For species that are not eradicable, it adopts a management strategy that depends on the availability of resources, the extent to which

the target species is detrimental, and the value of the resources of concern that the target species threatens. Strategies may include reducing cover of the target species, containing it to its current range, preventing its spread into high-quality natural communities, or electing not to manage for an invasive species. IPM has been successfully employed, for example, to reduce invasive reed (*Phragmites australis* ssp. *australis*) to less than ¼ of its peak cover on Beaver Island in Lake Michigan (Higman et al. 2019).

Islands are more susceptible to the impacts of invasive species than mainland areas (Lonsdale 1999), and the negative relationship between invasion and species richness is especially high on islands (Pysek et al. 2011). However, islands are often small/isolated enough that eradication can be successful if troublesome species are detected early in the invasion process (USDI 2021).

Islands in freshwater bodies are globally rare. The Great Lakes has the largest collection of freshwater islands in the world, with 32,000 islands (Henson et al. 2010). These islands are home to precious cultural resources, regionally endemic species such as dwarf lake iris, and rare natural communities such as limestone cobble shore (Cohen et al. 2015). They also provide habitat for colonial nesting birds, stopover land for migratory bird species, and spawning ground for fish in offshore shoals (Henson et al. 2010).

Here, we present an IPMP for Plum Island, an approximately 300-acre island in Lake Michigan located 1.4 miles (2.4 km) northeast of the Door Peninsula and 1.6 miles (2.6 km) southwest of Washington Island in the State of Wisconsin, for Horicon-Green Bay NWR Complex staff. The island is part of the Green Bay NWR. We share results of recent botanical and ecological surveys, a prioritization of invasive species and areas for treatment, a watch list of potential future invaders, management objectives and strategies, and recommendations for ongoing monitoring and evaluation.

This IPMP provides field methods and data management procedures to facilitate monitoring surveys for conservation assets and invasive species, treatment objectives and actions, and treatment effectiveness monitoring. Data gathered by these methods should contribute to an adaptive management strategy based on this IPMP. Adapting management strategies based on new information will prompt the flexibility needed to combat the complex challenge of invasive plant management (Lowell et al. 2014).

Spatial Scope and Setting

Plum Island (45°18′N, 86°58′W in Door County, Wisconsin, USA) is part of the Grand Traverse Islands, which run between Wisconsin's Door Peninsula and Michigan's Garden Peninsula (Figure 1). The chain is part of the Niagara Escarpment, a rock formation extending in an arc from Wisconsin to New York that is made of limestone and dolomite formed from calcium carbonate deposited by coral reefs in the Silurian Age. Dolomite is variant of limestone, but it consists of more magnesium calcium carbonate instead of calcite and aragonite, and it is more resistant to erosion (Albert et al. 1995). The Grand Traverse Islands are cherished for its diversity of animals, plants, and cultural artifacts such as shipwrecks, lighthouses, and ruins of Native American settlements. (Bacon 2016, Judziewicz 2001). The flora of the island chain has been in development since about 10,000 BP when post-glacial water levels in the Great Lakes receded enough for its land to be exposed (Forzley et al. 1993).

Plum Island is about 1.1 miles long by 0.9 miles wide. It covers around 267 to 316 acres (Judziewicz 2001, Salas et al. 2017). Its elevation is 13 m above sea level. Prior to European settlement, its vegetation was primarily mesic hardwoods, with a minor component of swamp conifers. Its most important pre-settlement tree species were sugar maple (*Acer saccharum*), basswood (*Tilia americana*), and balsam fir (*Abies balsamea*), with respective importance values of 70, 15, and 15 (Judziewicz 2001). Importance value is a metric based on frequency, abundance, and basal area, with higher numbers representing greater importance (Kershaw et al. 2017).

Since European settlement, the island has been subjected to severe anthropogenic disturbance. Lighthouses have been in operation since the mid-1800s, and several structures associated with navigation and rescue still stand. A network of roads and trails crisscrosses the island (Figure 2). Locals refer to a lagoon in the northwest corner as Carp Lake and likely fish there. Heavy selective logging occurred in the 1980s. White-tailed deer and pigs were later introduced and hunted (Judziewicz 2001).

The island has been part of the NWR system since 2007. It is currently open to the public for day use, and a dock in the northeast provides easy access from nearby Washington Island and the Door Peninsula. A charter company operates a cruise that regularly stops at the island (Lenz et al. 2013).

Over the 20th century, the island was the object of several botanical expeditions. The first occurred under the auspices of the Milwaukee Public Museum in 1905. Subsequent expeditions were made/headed by: William E. Tans of the Wisconsin Department of Natural Resources in 1974, S.P. Voice of the USFWS in 1982, a joint party of the Cranbrook Institute of Science and Oakland University in 1989 – 1990, and Emmett J. Judziewicz of the WDNR in 1998 – 1999. Botanists on these expeditions collected 259 plant species, recorded several rare plants and natural communities, and documented how the flora has changed over time in response to anthropogenic disturbance. Rare plants included federally and Wisconsin threatened dwarf lake iris, Wisconsin threatened dune goldenrod (*Solidago simplex* var. *gillmanii*) and western fescue (*Festuca occidentalis*), and Wisconsin special concern climbing fumitory (*Adlumia fungosa*) and white camas (*Anticlea elegans*).

As recently as 1974, the island was reported to host old-growth sugar maple – basswood forest. This would fit within the mesic northern forest/northern mesic forest according to Michigan and Wisconsin natural heritage methodology. The forest supported a dense understory of Canada yew (*Taxus canadensis*), able to thrive in the absence of white-tailed deer (*Odocoileus virginianus*). Subsequent logging and deer introduction wreaked havoc on the native vegetation. Judziewicz (2001) reported a scant bloom of spring ephemerals. The exception was along a narrow strip of forest flanking the trans-island trail that was spared from selective logging. Yew was absent by the time of his 1998 and 1999 visits. Invasive and ruderal native species had come to dominate parts of the understory.

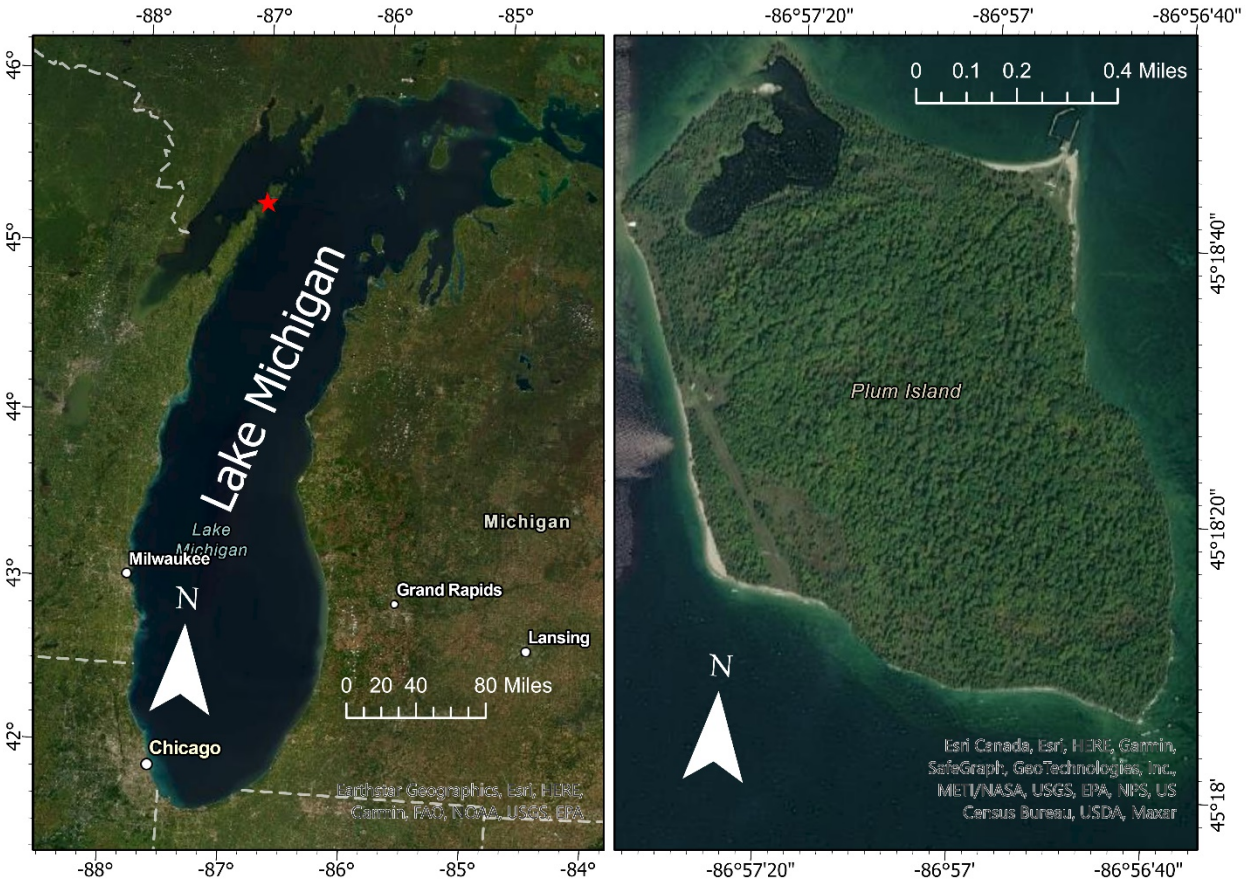

Figure 1. Plum Island (right) is located in northern Lake Michigan, USA (left). The red star in the left pane represents Plum Island.

Figure 2. Roads, trails, and structures of Plum Island. Map from Washington Island Chamber of Commerce, https://washingtonisland.com/plum-island/.

Conservation Assets

The 2021 ecological surveys revealed that quality natural communities persist along the shoreline and in parts of the interior of the island (Table 1; Figure 3, Figure 4). Quality mesic northern forest occupies 62.6 acres (25.3 ha), Great Lakes marsh 17.6 acres (7.1 ha), limestone lakeshore cliff 5.7 acres (2.3 ha), and limestone cobble shore 1.1 acres. Each of these was classified as an element occurrence (EO) according to methodology of the Natural Heritage Program network NatureServe of which MNFI is a part. An area qualifies as an EO if it is a

quality representation of a non-anthropogenic natural community. Much of the forested interior of the island was not of EO quality and was classified as disturbed boreal forest or disturbed mesic northern forest (Figure 4).

Five listed plant species were previously known from the island. Dwarf lake iris, white camas, and climbing fumitory were rediscovered (Table 1; Figure 4, Figure 5). Extensive surveys for dune goldenrod and western fescue were unsuccessful. An additional listed plant, Laurentian fragile fern (*Cystopteris laurentiana*), was newly discovered.

Troublesome invasive species occur within all of the natural communities described, as well as near the rare plants (Figure 6, Figure 7). Anthropogenic areas, the mesic northern forest EO, and the disturbed boreal and mesic northern forest were particularly plagued by numerous abundant invasive species. Strategies to control these invasives are discussed in Chapters 3 and 4.

We also watched several hundred little brown bats emerge from the lighthouse keeper's building (Figure 2) on the evening of July 13, 2021.

Table 1. Element occurrences (EOs) for rare native species and natural communities. Natural community classifications for both Michigan and Wisconsin are listed in the Element column. EO ID is a unique identifier assigned to each EO in Wisconsin Natural Heritage Database. New EO have EO ID to be determined (TBD). NatureServe Natural Heritage EO ranks are briefly described as follows: A = excellent viability, B = good viability, C = fair viability, D = poor viability, E = verified extent, F = failed to find. Combination of letter ranks represent intermediate ranking. State and global status ranks for natural communities are explained in Table 2. NA = not applicable, TBD = to be determined.

Element	Common name	EO ID	EO Rank	Last Observed	State Status	Global Status
Adlumia fungosa	Climbing fumitory	7972	C	2021	Special concern	G4
Anticlea elegans	White camas	TBD	TBD	2021	Special concern	G5
Cystopteris laurentiana	Laurentian fragile fern	TBD	TBD	2021	Special concern	G3
Festuca occidentalis	Western fescue	21210	F	1982	Threatened	G5
Haliaeetus leucocephalus	Bald eagle	UNK	UNK	2021	Unlisted	G5
Iris lacustris	Dwarf lake iris	7737	D	2021	Threatened (both federal and state)	G3
Myotis lucifugus	Little brown bat	UNK	UNK	2021	Threatened (also under federal review)	G3
Solidago simplex var. *gilmanii*	Gillman's goldenrod	15715	F	1999	Threatened	G5T3?
Great Lakes marsh / emergent marsh	NA	24367	C	2021	S4	G4
Limestone cobble shore / Great Lakes alkaline rockshore	NA	24370	C	2021	S2	G3
Limestone lakeshore cliff / moist cliff	NA	24368	C	2021	S4	GNR
Mesic northern forest	NA	24369	D	2021	S4	G4

Table 2. Explanation of state and global status ranks for natural communities (verbatim from NatureServe Biotics): https://help.natureserve.org/biotics/content/record_management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm

Status	Description	Explanation
S1	Critically Imperiled	At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
S2	Imperiled	At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
S3	Vulnerable	At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
S4	Apparently secure	At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
S5	Secure	At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.
G1	Critically Imperiled	At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
G2	Imperiled	At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3	Vulnerable	At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4	Apparently secure	At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5	Secure	At very low risk or extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
GNR	Unranked	Global rank not yet assessed.
GU	Unrankable	Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: Whenever possible (when the range of uncertainty is three consecutive ranks or less), a range rank (e.g., G2G3) should be used to delineate the limits (range) of uncertainty.
?	Inexact numeric rank	Denotes inexact numeric rank; this should not be used with any of the Variant Global Conservation Status Ranks or GX or GH.

Figure 3. Natural communities on Plum Island. Clockwise from upper left: Great Lakes marsh / emergent marsh, limestone cobble shore / Great Lakes alkaline rockshore, mesic northern forest, and limestone lakeshore cliff / moist cliff. Photographs by Joshua Cohen, July 12 – 13, 2021.

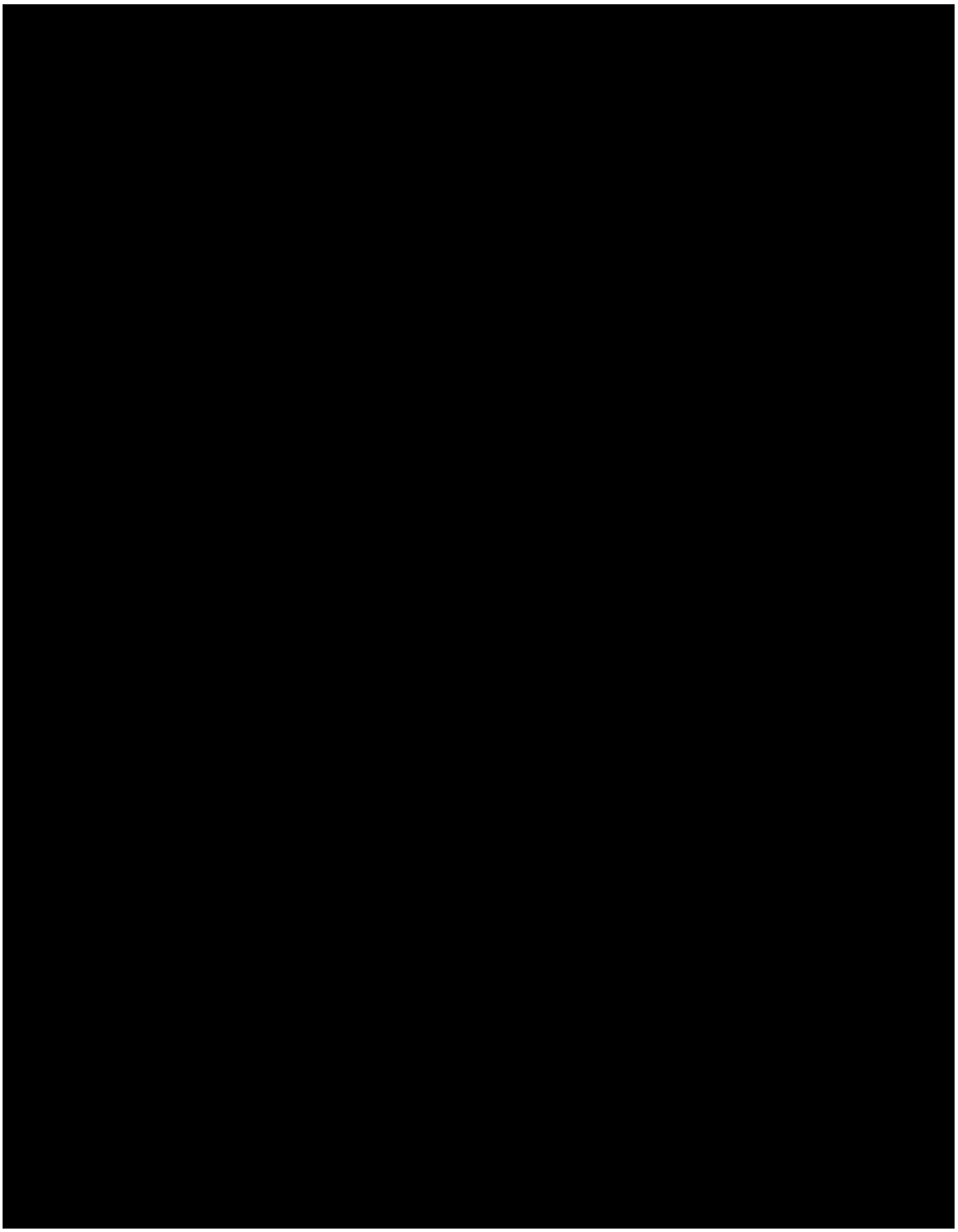

Figure 4. Rare-plant element occurrences (EOs) observed on Plum Island in 2021. The inset is a zoomed-in view of the red rectangle on the larger map.

Figure 5. Rare plant species observed on Plum Island in 2021. Clockwise from top: white camas (*Anticlea elegans*; photo: Tyler Bassett, July 13), climbing fumitory (*Adlumia fungosa*; Bassett, July 14), and dwarf lake iris (*Iris lacustris*; Joshua Cohen, July 12).

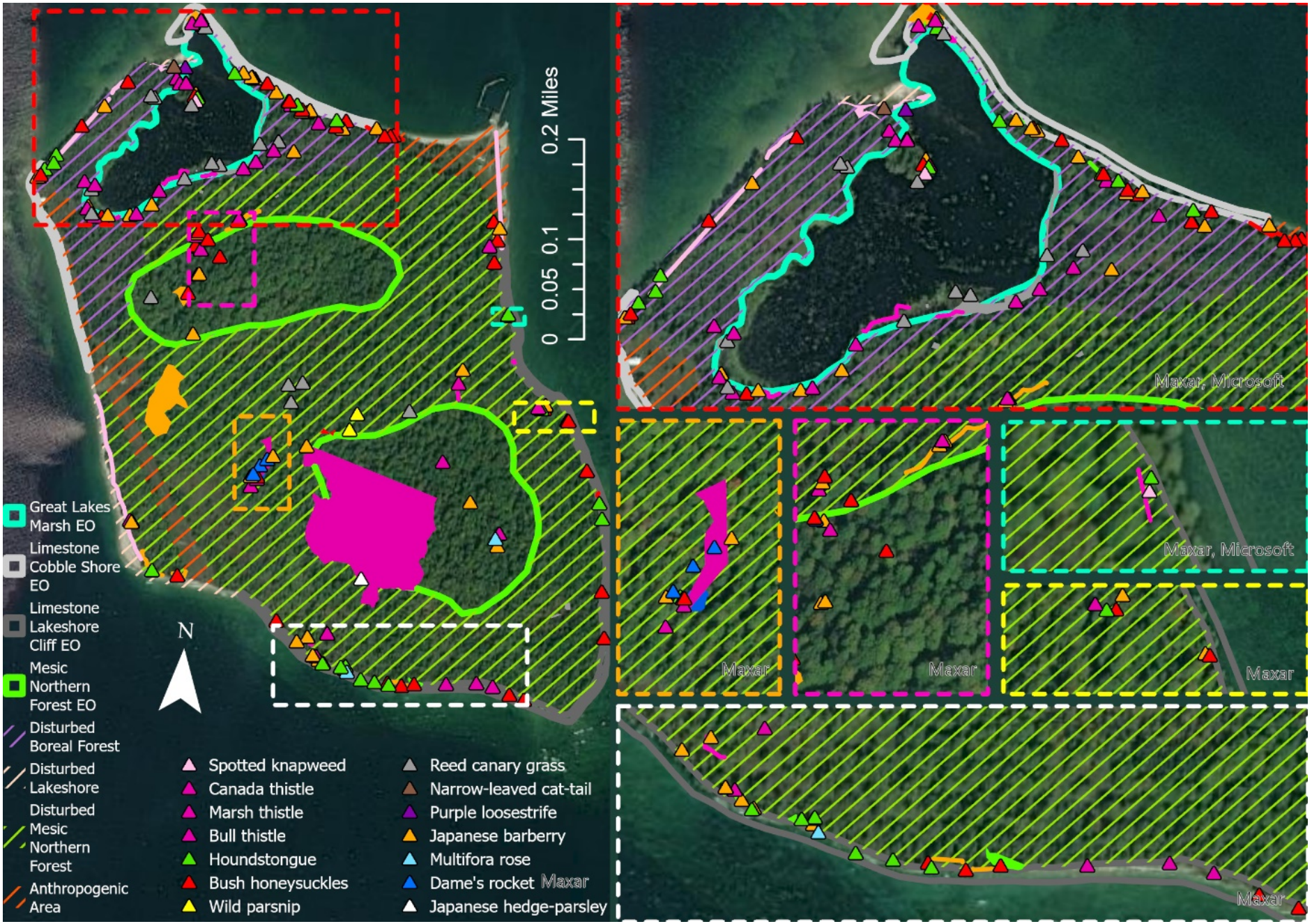

Figure 6. Invasive plants, natural communities, and disturbed habitats documented on Plum Island in 2021. The insets on the right side are zoomed-in views of the like-colored rectangles on the larger map. Note that many species were more widespread than the map indicates because highly disturbed areas were not prioritized for mapping (see Species and Area Descriptions below).

Figure 7. Invasive species on Plum Island. Clockwise from upper left: wild parsnip (*Pastinaca sativa*) with its yellow flowers in full bloom, profusion of Japanese barberry (*Berberis thunbergii*) in forest understory, ruderal opening with the white flowers of common valerian (*Valeriana officinalis*) visible on the ground especially on the right, two stems of marsh thistle (*Cirsium palustre*) poking out of the ferns, their pink-purple flowers visible. Photos by Joshua Cohen, July 12–14, 2021.

Conservation Goals

This plan supports the following Refuge System goals cited in the comprehensive conservation plan (Lenz et al. 2013):

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.

This plan also supports the following objectives specific to Green Bay NWR from the Habitat Management Plan (Salas et al. 2017):

- Maintain quality of limestone cobble shore / Great Lakes alkaline rockshore EO
- Maintain quality of mesic northern forest EO

We also advocate for maintaining the quality of the two additional natural community EOs on Plum Island (Table 1; Figure 3, Figure 4):

- Great Lakes marsh / emergent marsh
- Limestone lakeshore cliff / moist cliff

Specific, Measurable, Achievable, Results-oriented, and Time-bound (SMART) objectives are laid out in Chapter 4.

History of Invasive Plant Management

According to the GIS layer Islands_Invasive_Species.gdb provided by the USFWS, a large area near the dock and life-saving station in the northeast of Plum Island was treated for spotted knapweed in 2010. In 2015, that same area plus the Isle View Patrol Rd. and parts of the shoreline between the fog signal building and the range lights were treated for spotted knapweed. In 2015, invasive reed was treated in the Great Lakes marsh and part of the shoreline to the north of the marsh. Around this time, a single point was taken for a garlic mustard observation, in disturbed mesic northern forest just north of the southerly mesic northern forest EO polygon. Garlic mustard and invasive reed were not encountered in 2021.

On August 19, 2021, workers from the Door County Invasive Species Team of the Door County Soil and Water Conservation Department treated reed canary grass with glyphosate (trade name Rodeo, manufactured by Monsanto). They applied the solution to the foliage with a backpack sprayer (Figure 8).

Regulatory Context

Refuge staff and partners contracted for treatment should be familiar with relevant local, state, and federal regulations pertaining to the management action they are perusing.

Herbicides should be used with caution in consideration of nearby plants, wetlands, wind conditions, forecasted rain, and human health. All herbicide labels should be thoroughly understood, and the specific herbicide should be permitted in the state for the use desired. When working near wetlands/water, permits obtained from a Wisconsin Department of Natural Resources service center may be required. Refuge authorities also require pesticide use proposals through their Pesticide Use Proposal System before any chemical treatments. Herbicide applicators should have the appropriate certification. Detailed best management practices are in Cal-IPC (2015). More details can be found in *Regional Protocol Framework for Rare and Invasive Plant Monitoring on Great Lakes Islands* (2021c) and *Draft Site-specific Protocol for Vegetation Surveys on Great Lakes Islands, Green Bay and Gravel Island National Wildlife Refuges* (2021a).

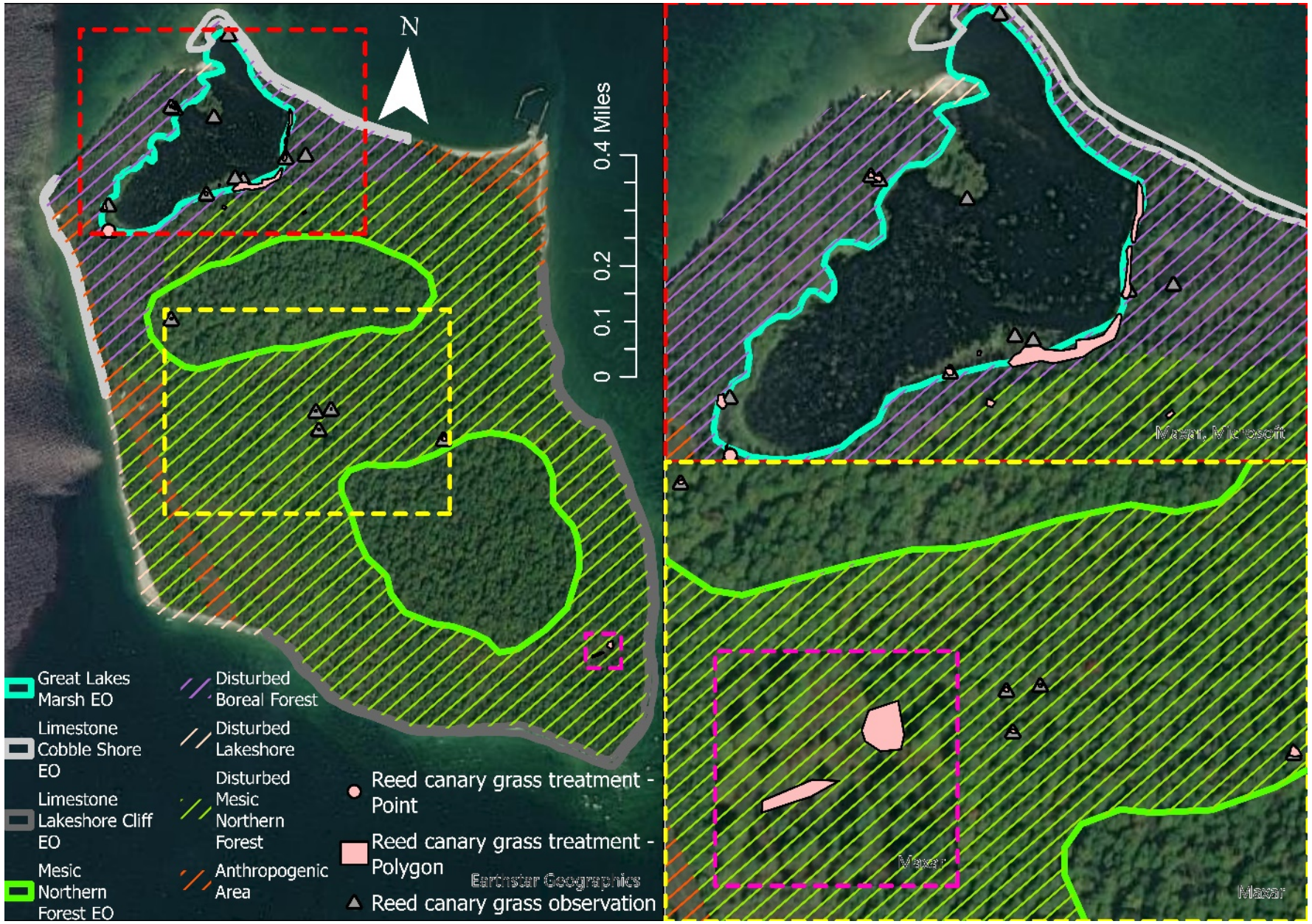

Figure 8. Treatment of invasive plants on Plum Island in 2021. Reed canary grass was treated with glyphosate on August 19, 2021, by the Door County Invasive Species Team. The insets on the right are finer resolution views of the like-colored rectangles on the larger map. Note that several species were also treated over 2010 – 2017 (described above).

Chapter 2: Methods

This chapter identifies the who, what, why, and how in the development of this IPMP for Plum Island, Green Bay NWR. The IPMP was developed using the best available information and processes. This chapter describes processes that were used to gather information and make decisions about areas, species, strategies, and activities to focus on and employ.

Project Team

The Project Team was comprised of members working on developing the IPMP [Scott Warner, Rachel Hackett (MNFI)], USFWS staff members who were decision makers [Richard King, Joshua Booker, Bill Peterson], and USFWS staff members who will be implementing the plan [Bill Peterson, Sadie O'Dell, Francis Gercz, Joel Vos, Jon Krapfl].

Internal and External Communication, Outreach, and Engagement

The IPMP team met and communicated throughout the planning, fieldwork, and reporting processes via virtual meetings, emails, electronic chat, MS Teams, and in-person meetings. Varying levels of involvement were required at different stages. External communication was maintained between other MNFI staff members who conducted the most recent surveys on Plum Island (Tyler Bassett, Josh Cohen, Scott Warner).Communication was also fostered with the local area conservationist Samantha Koyen, Door County Soil & Water Conservation Department (SWCD). Door County SWCD is a project partner who will conduct invasive plant treatment in the State of Wisconsin islands in the Grand Traverse Islands of the Green Bay NWR.

Information Gathering

Information was gathered from Horicon Complex NWR Staff, the Michigan Natural Heritage Database, botanical and ecological surveys conducted in 2021 (Bassett et al. 2022, Cohen et al. 2022), and online digital data sources [e.g., ArcGIS Online (AGOL) Great Lakes – Invasives and Photopoints, iNaturalist, Midwest Invasive Species Information Network (MISIN)]. The nomenclature of plant species follows Integrated Taxonomic Information System (ITIS, https://www.itis.gov).

Element Occurrence Records

The Wisconsin Natural Heritage Database contains EOs of rare and listed species and natural communities. MNFI made a request for records located on federal lands on Detroit Island from the Wisconsin Natural Heritage Program, a program of Wisconsin Department of Natural Resources. These records were used to plan survey visits to the island during appropriate detection periods (Table 1). A more detailed description of the use of this information to inform vegetative and ecological surveys on Plum Island can be found in *Regional Protocol Framework for Rare and Invasive Plant Monitoring on Great Lakes Islands* (2021c) and *Draft Site-specific Protocol for Vegetation Surveys on Great Lakes Islands, Green Bay and Gravel Island National Wildlife Refuges* (2021a).

When a rare species was encountered while doing field surveys, information about the observation was documented as requested by the Wisconsin Natural Heritage Program. An annual report of all rare and listed species observations, failed to find surveys, and new occurrences was submitted to Wisconsin Natural Heritage Program for review and incorporation

into the Wisconsin Natural Heritage Database (Bassett 2022). US Fish and Wildlife Service was supplied a copy of this report via Microsoft Teams.

Vegetation surveys

Vegetation surveys were conducted to inform both the management of invasive species threats and the prioritization of high-quality species and communities for protection or management. Plum Island was surveyed July 12 – 14, 2021. Protocols described in *Regional Protocol Framework for Rare and Invasive Plant Monitoring on Great Lakes Islands* (2021c) and *Draft Site-specific Protocol for Vegetation Surveys on Great Lakes Islands, Green Bay and Gravel Island National Wildlife Refuges* (2021a) and summarized here were followed in 2021.

Surveyors planned meander survey routes to adequately cover each natural community on the island. Meanders were designed to include known records of rare and listed plant species and possible micro-habitats or areas of non-homogenous habitat detectable from an inspection of aerial imagery, topographical maps, and prior observations. Possible micro-habitats encountered while in the field were also explored. The perimeter of the island and invasive species pathways such as docks and known anthropogenic disturbances (e.g., ruins, trails) were also included in vegetation surveys.

GPS data was collected in the field to map locations of rare species, rare and/or high-quality natural communities, and invasive species. Non-native species that were locally naturalized and relatively innocuous (e.g., dandelion, hawkweed [*Hieracium* sp.]) were not mapped but were included on species lists in the communities they invaded.

ArcGIS Online USFWS invasive species related data collection and management

Information gathered on invasive plant species populations during the 2021 surveys was synthesized and transcribed into the USFWS's AGOL feature layers for Region 3 plant and weed observations based on the type of geometry most suited to represent the population (i.e., point, line, polygon; Esri 2022b). Description of the data included in the feature layers can be found in Appendix 1.

Most of the data were collected and recorded in the field via ArcGIS Collector in an AGOL Web Map called Great Lakes – Invasives and Photopoints generated by USFWS data manager for the project (Esri 2020, Esri 2022b). Some data were transcribed out of the field using the same ArcGIS Collector app and Web Map. Detailed instructions for adding features to the Web Map are included in Appendix 2.

Features to document invasive species treatment and monitor its efficacy are also within the USFWS AGOL Great Lakes – Invasives and Photopoints Web Map. There are multiple feature layers to house the different management treatment types (e.g., chemical, mechanical). Like with invasive species populations, invasive species treatment areas should be mapped in the appropriate management feature layer in the program ArcGIS Collector: for example, pesticide applications should be documented with the Region [#] Management Actions Chemical Plant Feature.

Documentation and monitoring of treatment efficacy should be conducted with Photo Survey Points as described in *Regional Protocol Framework for Rare and Invasive Plant Monitoring on Great Lakes Islands* (2021c) and *Draft Site-specific Protocol for Vegetation Surveys on Great Lakes Islands, Green Bay and Gravel Island National Wildlife Refuges* (2021a) and summarized here: Photo points should be strategically placed in mapped invasive species communities to capture a visual representation of the cover and density of the target species. The number of photo points needed will vary, but a minimum of three points for each treatment area is expected. These points will be visited on multiple occasions: at least once prior to treatment (i.e., pre-treatment) and one or more visits post-treatment depending on treatment method(s) and logistical constraints. Detailed instructions on adding features to the Web Map are included in Appendix 2.

Prioritization of Species and Management Areas

Natural community areas and invasive species were ranked using the Invasive Plant Inventory and Early Detection Prioritization Tool (IPIEDPT) for comparison within the island. This tool was developed by the USFWS Inventory and Monitoring Initiative (Region 8) and Utah State University (USFWS 2016) and designed to highlight invasive plant monitoring priorities and watch list species.

For treatment prioritization across Green Bay NWR islands of Detroit, Plum, Poverty, and St. Martin, the IPIEDPT tool was not used. The tool's emphasis on invasive species monitoring was evident: areas that had little to no invasive species present were ranked in the highest tier (Appendix 3, Table 1-1). In its stead, we present the "Stewardship Prioritization" matrix generated for the natural community report for Green Bay NWR (Cohen et al. 2022).

Invasive species prioritization

To prioritize invasive plant species using the IPIEDPT, we needed to develop lists of invasive species present in each area and likely invaders from surrounding areas. Invasive species observed during the 2021 surveys were used to populate the list. To increase the practical application of the list, the likely invader list was expanded to include invasive species observed on nearby islands as gathered from 2021 surveys (Bassett et al. 2022; Cohen et al. 2022).

Using the IPIEDPT, species were scored using categorical ranks adhering to rubrics developed by IPIEDPT (USFWS 2016). The ranked factors fell into four categories, with one category having multiple factors:

- Invasiveness ranking (weighted 0.2)
- Invasive species status and habitat suitability (weighted 0.4)
    - Species proximity
    - Current species abundance
    - Habitat suitability
- Ecological impacts (weighted 0.3)
- Legal mandates – Noxious or other regulatory designation (weighted 0.1)

For invasiveness ranking, the NatureServe ranking system was used if available. If the IPIEDPT did not have a NatureServe invasiveness ranking for a species, primary research, expert opinion, and invasiveness ranking of that species from previous MNFI projects were used (Cohen et al.

2019). Species proximity and current abundance were derived from data gathered during the 2021 surveys (Cohen et al. 2022). Habitat suitability rank was determined using local field guides and expert opinion. Ecological impact rank was determined using expert opinion and invasiveness ranking of that species from previous MNFI projects (Cohen et al. 2019). Legal mandates were reviewed as listed on the US Department of Agriculture's (USDA's) PLANTS Database (https://plants.sc.egov.usda.gov/home/),

As the species of bush honeysuckle (*Lonicera* sp.) observed in the Green Bay NWR all have the same NatureServe rankings and are not managed differently, they are pooled together for the purpose of the IPIEDPT. Only *L.* × *bella* was observed on Plum Island in 2021. Future invasions of other invasive bush honeysuckles would be prioritized equivalently.

Prioritization across Detroit, Plum, Poverty, and St. Martin Islands

Although some of the input between the IPIEDPT area prioritization tool and MNFI's Stewardship Prioritization were the same, the Stewardship Prioritization scores differ in that more emphasis was placed on the natural communities in a global and state context, value was placed on the quality of the natural community, and individual invasive species presence, spread, and density were taken into consideration. For the Stewardship Prioritization, there were three indices educated by numerous factors:

- Ecological integrity index
    - EO rank
- Rarity index
    - Global rank of natural community
    - State rank of natural community
- Invasive index
    - Invasive threat severity
        - Site-specific information on infestations
        - Habit and history of invasive plant species in a natural community type
    - Treatment feasibility

The natural communities ranked as higher quality habitat had a higher ecological integrity index. The rarity index was the mean of the global and state rankings of the natural community types, with rarer communities having higher scores. The invasive index was the mean of the invasive threat severity and treatment feasibility. Experts ranked the invasive threat severity based on the 1) site-specific information gathered during the 2021 surveys on the species, spread, density, and location of invasive species infestations in the area and 2) knowledge of the impacts of present invasive species in that natural community type. A natural community with increased degradation due to invasive species infestations would have a higher score. The treatment feasibility index was a rank score assigned based on treatment ease and success of the invasive species present in the natural community. The sum of the three indices produced the stewardship prioritization score.

Area prioritization within Plum Island

Natural communities on the island were categorized using the scheme in *A Field Guide to the Natural Communities of Michigan* (Cohen et al. 2015), which concentrates on the dominant

species composition, soils, hydrology, and geography of the community, and corresponding classification was identified within the Wisconsin system (WDNR 2015). Information gathered during the 2021 ecology surveys was used to differentiate natural community areas and identify areas of high quality and good representation of those communities on the state level (USFWS 2021b, Cohen et al. 2022). Each natural community EO was included in the IPIEDPT. Disturbed boreal forest was also included. The highly disturbed sections of shoreline and other anthropogenic areas were not included in the IPIEDPT. Disturbed mesic northern forest was pooled with the mesic northern forest EO (Figure 4).

Using the IPIEDPT, areas were scored using categorical ranks adhering to rubrics developed by IPIEDPT (USFWS 2016). The ranked factors fell into three categories, each with multiple factors:

- Area description (weighted 0.4)
    - Ecological integrity
    - Innate resistance to invasion
    - Importance to Federal or State-listed species
    - Importance to other priority natural resources of conservation
- Invasion risk (weighted 0.3)
    - Relative to terrestrial pathways
    - Relative to aquatic pathways
    - Relative to transport vectors
    - Relative to anthropogenic disturbances
- Invasive plant status (weighted 0.3)
    - Relative to most recent inventory and monitoring event
    - Relative to overall infestation level
    - Number of invasive plant species present in area

The scores of each category were averaged (mean), weighed, then the three category scores were summed to derive the total score for the area. IPIEDPT default weights were used for each category.

For area description factors, categorical rankings were determined using 2021 ecological survey data and notes, NatureServe-MNFI resilience rankings of the natural community, NatureServe-MNFI biodiversity rankings of the natural community, NatureServe-MNFI state rarity score of natural community in Michigan, and expert opinion (Cohen et al. 2019, Cohen et al. 2022). For invasion risk factors, categorical rankings were determined using 2021 ecological survey data and notes; geospatial variables of proximity to shoreline and presence of trails, roads, human structures; evidence of past logging; and expert opinion (Cohen et al. 2022). For invasive plant status factors, categorical rankings were determined using the invasives species population data described in Chapter 2: Methods – Information Gathering. All areas had been comprehensively monitored within the last five years. Opinions on the highest value natural areas during the 2021 surveys were shared in virtual meetings among MNFI, USFWS, Horicon NWR Complex, and Door County SWCD, and applied as expert opinion where applicable.

Link area-species

Using the IPIEDPT, the link between each area and invasive species was also classified using the species presence, status and distribution, and habitat suitability in that area. These rankings were derived from data gathered from the 2021 surveys and expert opinion (Cohen et al. 2022). All three factors were equally weighed and added to the overall species score.

Identifying Management Strategies

Management strategies were identified from IPM and adaptive management literature and protocols. Strategies are broad and may be changed or adapted as new information is learned (Table 3). Multiple strategies may be suggested for the same management area per invasives species or the same invasive species over different management areas.

Table 3. Management terminology used to describe management strategies.

Strategy	Description
Early Detection/Rapid Response (EDRR)	Surveillance technique to monitor and treat emerging pest infestations.
Monitoring	On-going surveillance and documentation of infested or non-infested areas for pest populations at a regular frequency.
Eradication	Population is small and isolated enough that complete eradication of all plants and reproductive propagules is possible with little chance of re-introduction.
Elimination/Zero Density	Population is of high enough priority or small enough size to eliminate from a designated area, but re-introduction is likely from surrounding areas or vectors.
Outlier Control	When populations are present as large infestations, the first priority is to eliminate small outlier populations away from the larger infestation.
Perimeter Control	When populations are present as large infestations, once outlier populations have been eliminated, management focus switches to control around the perimeter of the larger infestation moving from the fringes towards the center.
Sustained Control	The species is so widespread that elimination is unlikely due to population size and pressure of continual reintroduction from neighboring areas. Control areas would most likely focus on specific high priority areas impacted from the species with a long-term commitment expected.

Chapter 3: Invasive Plant Priority Species and Areas

Observed and potential invasive species on Plum Island were divided into three categories: Priority 1, Priority 2, and Priority 3 (Table 4). Priority 1 species were observed on the island and pose a significant threat to natural communities and rare species (Figure 6). Management is likely to result in significant positive outcomes. Ten species were classified as Priority 1 (Table 5). Four species were placed in the Priority 1 category despite IPIEDPT scores closer in value to Priority 3 species: erect hedge-parsley (*Torilis japonica*), multiflora rose, dame's rocket (*Hesperis matronalis*), and wild parsnip. MNFI believes these species pose a significant risk to the island ecosystem and should be treated while their infestation is relatively small.

Priority 2 species are species that were not observed on Plum Island in 2021 but have been seen in nearby regions and would pose a significant threat if found on Plum Island. Twenty-three species were classified as Priority 2 (Table 6). EDRR is the recommended strategy for species in this category.

Priority 3 species were considered naturalized on Plum Island and nearby islands (Table 5; Figure 6). These species are difficult to detect in their first year, and they produce copious wind- or animal-dispersed seed. Their capacity to outcompete native plants in natural communities is limited. Four species were classified as Priority 3. Most strategies would be difficult to achieve for these species given the remote island setting. No management is recommended except for sustained control in the vicinity of select conservation assets.

Table 4. Description of prioritization categories given to observed and potential invasive plant species on Plum Island.

Category	Description
Priority 1	Present and prioritized: The species was observed in 2021, poses significant threats to natural communities and rare species, and is potentially eradicable or controllable.
Priority 2	Watch list: The species has been observed in at least one nearby county and would pose a significant threat to natural communities and rare species if found on Plum Island.
Priority 3	Present but not prioritized: The species is often considered invasive and was observed in 2021 but has thoroughly naturalized on Plum and nearby islands and poses a relatively low threat to rare species and high-quality communities.

Table 5. Categorization of invasive species observed in 2021 according to their invasibility and manageability. Non-native species that have been widely and long-naturalized in the region such as dandelion (Taraxacum officinale) were not considered. Priority 1 and Priority 3 are defined in Table 4. The breakdown of IPIEDPT Total Score can be found in Appendix 3.

Scientific Name	Common Name	Priority Level	IPIEDPT Total Score
Berberis thunbergii	Japanese barberry	Priority 1	9.00
Centaurea stoebe ssp. *micranthos*	Spotted knapweed	Priority 1	9.00
Hesperis matronalis	Dame's rocket	Priority 1	7.70
Lonicera spp.	Bush honeysuckles	Priority 1	8.47
Lythrum salicaria	Purple loosestrife	Priority 1	9.10
Pastinaca sativa	Wild parsnip	Priority 1	7.30
Phalaris arundinacea	Reed canary grass	Priority 1	9.07
Rosa multiflora	Multiflora rose	Priority 1	7.30
Torilis japonica	Erect hedge-parsley	Priority 1	5.90
Typha angustifolia	Narrow-leaved cat-tail	Priority 1	9.00
Cirsium arvense	Canada thistle	Priority 3	7.57
Cirsium palustre[1]	European marsh thistle	Priority 3	6.77
Cirsium vulgare	Bull thistle	Priority 3	6.77
Cynoglossum officinale	Houndstongue	Priority 3	6.77

A brief discussion of the management and ecology of each Priority 1 species follows. The Priority 2 species watch list is also presented. Priority 1 species were mapped when observed (Figure 6).

[1]Mapped as Cirsium sp., along with emerging basal rosettes unidentifiable to species.

Species Descriptions and Priorities

Priority 1: Present Aggressive Species

JAPANESE BARBERRY (*BERBERIS THUNBERGII*)
Japanese barberry is a popular cultivated shrub. It is prized for hedges and the fall/winter color provided by its red berries. It was first collected as a wild plant in Wisconsin in 1936 (Wisconsin State Herbarium 2022). It is now present throughout the state where it thrives in disturbed habitats, as well as more natural settings where its invasive tendencies displace native vegetation (Wisconsin State Herbarium 2022, Reznicek et al. 2011).

Species description: Japanese barberry has simple, alternate elliptic-to-obovate leaves with smooth margins. It is a spiny, often low-growing shrub, but vigorous individuals can reach a height of about 6 ft (2 m). The small cream-colored flowers bloom in May and mature into small egg-shaped red berries by late summer. Berries not dispersed by birds may persist on the plant into the winter. Japanese barberry can reproduce not only by seed but by creeping roots and branches; the branches root when they touch the ground (Czarapata 2005).

Habitat: Forests, swamps, fields, and dunes (Reznicek et al. 2011).

Current status in landscape: Japanese barberry is abundant across much of Plum Island. It was mapped in or at the border of every community EO and in every disturbed habitat type (Figure 6). Its prevalence is even greater than indicated in Figure 6 because the heavy invasive species cover in the disturbed habitats made comprehensive mapping infeasible.

Management: Like many invasive species, Japanese barberry leafs out earlier than native plants, making spring a good season for detection. The plant can be pulled or dug out, but all roots must be removed. In disturbed open habitats, such as trails and areas surrounding structures, mowing may be effective after large plants are removed. Plants can be cut at the base in winter or spring. Triclopyr formulated for use with penetrating oil can be used on cut stumps and as a basal bark treatment. Glyphosate applied to cut stumps may also work. Resprouts should be treated with glyphosate (Czarapata 2005).

SPOTTED KNAPWEED (*CENTAUREA STOEBE* SSP. *MICRANTHOS*)

Spotted knapweed was not collected in Wisconsin until 1915, yet it has since become a terrible invasive plant in open upland habitats throughout Michigan and Wisconsin (Reznicek et al. 2011, Wisconsin State Herbarium 2022), including relatively undisturbed natural areas (Czarapata 2005). In North America, this Eurasian allelopathic biennial first became a serious pest in the rangelands of the West. In Montana, USA., its annual economic impact has been estimated at a cost of $42 million a year (Czarapata 2005).

Species description: Spotted knapweed is a forb with basal rosette and flowering stage. Although considered a biennial, the basal rosette stage may last one to four years. It can be distinguished from other similar species by the combination of its deeply pinnatifid or bipinnatifid divided stem leaves and the blackened, fringed tips on the end of the green modified leaves (i.e., phyllaries) that form a cup (i.e., involucre) under the less than 3 cm broad flowerhead. Each mature plant flowers for several days as early as late June and as late as September, which makes this the easiest time window for detection. A seasoned naturalist can identify basal rosettes during most of the summer growing season. Seeds are dispersed by wind twenty days after the end of flowering. Spotted knapweed is viable in the seedbank for nine years (Czarapata 2005).

Habitat: Disturbed, open, upland sites (Reznicek et al. 2011).

Current status in landscape: Extensive areas were treated for spotted knapweed in 2010 and 2015, yet the species remains a large component of disturbed shoreline areas. A 1,000 ft^2 (93 m^2) patch was also mapped in the Great Lakes marsh, at the panhandle of land jutting into the open marsh in the northwest of the mapped EO. The 1,200 ft (350 m) line mapped to the south of the dock in the northeast just extends into the limestone lakeshore cliff EO. Two plants were also found in disturbed mesic northern forest at the edge of the limestone lakeshore cliff EO and pulled (Figure 6). The species is even more prevalent along disturbed shores and in adjacent trails/open areas than indicated in Figure 6 because disturbed areas with high invasive species cover were not mapped in a comprehensive fashion.

Management: Digging or hand-pulling can be successful when the ground is moist. Some people experience skin reactions when handling this plant, so gloves should be worn. It is essential to remove the entire root system and to remove the excised plant from the site. The soil should be loosened before pulling to prevent root breakage, as even a small root fragment left in the soil can resprout to form a new plant. Uprooting often exposes seed that will later germinate. Annual control measures will likely be necessary for several years. Spotted knapweed is viable in the seedbank for nine years (Czarapata 2005).

Chemical treatment near conservation assets may be inappropriate. An area 10 –15 ft (3 – 4.5 m) beyond the invasion zone must be treated to control roots and seeds. This would not be justified in the intact natural communities or near listed plants. Several insects have showed promise as biological control agents in the Midwest (Czarapata 2005). Care must be taken when weighing a decision for biological control, as introducing a new species into an island ecosystem can have unintended consequences (e.g., Ortega et al. 2004).

DAME'S ROCKET (*HESPERIS MATRONALIS*)

Dame's rocket, with its showy flowers, is a popular garden plant first collected in Wisconsin in 1913 and now spread throughout Michigan and Wisconsin (Reznicek et al. 2011, Wisconsin State Herbarium 2022). It thrives especially in disturbed open forests, but its ability to become a pest in relatively high-quality forests qualifies it as a significant invasive species.

Species description: Like other members of the cabbage family, dame's rocket has four-petaled flowers. Patches often contain a mix of white-, pink-, and purple-flowered plants, which has made the species a favorite component of "wildflower" mixes. These fragrant flowers bloom from mid-May through July and mature into long, narrow seed pods. This herb reaches a height of 2 – 3 ft (0.7 – 1 m) tall. It has simple alternate lance-shaped leaves with toothed margins. Reproduction is exclusively by seed (Czarapata 2005). Its winter basal rosette is green and used to identify it in late fall or early spring.

Habitat: Roadsides, thickets, river borders, and moist and mesic forests (Reznicek et al. 2011).

Current status in landscape: Three patches were mapped in the disturbed mesic northern forest totaling an area of 12 ft^2 (1.1 m^2) (Figure 6).

Management: Dame's rocket should be pulled or dug early in spring when soil is moist. If pulling is delayed until flowering season, remove plants from the site, as seed can mature on pulled plants. Glyphosate or triclopyr can be applied to foliage on warm days in late fall or early spring when native plants are dormant. At this time, practitioners will need to identify the winter-green basal rosette (Czarapata 2005). Because of the seedbank, follow-up treatment will likely be needed for several years (Czarapata 2005).

BUSH HONEYSUCKLES (*LONICERA* SPP.)

Invasive bush honeysuckles are allelopathic shrubs (Bauer et al. 2012) that have been established in Wisconsin since at least the 1880s. They have become terrible pests, readily spreading via avian fruit dispersal, and establishing not only in disturbed areas but also high-quality natural communities in which they can form dense thickets to the exclusion of native vegetation (Reznicek et al. 2011). Spring ephemerals are particularly affected by the shade these invasive species cast when they leaf-out earlier than native vegetation (Czarapata 2005).

Species description: Bush honeysuckles are woody, deciduous shrubs that can reach 15 ft (4.5 m) tall. Their leaves are opposite, oval, without small hairs on the outer edge (i.e., margin) of the leaf. Flowers are white to pink and bloom along the leaf axils. Fruits are red to orange berries that contain many seeds.

Bush honeysuckles can be distinguished from similar, native honeysuckles by their hollow pith in branches 2 years or older; native honeysuckles have a solid pith (Reznicek et al. 2011). Non-native honeysuckles also leaf-out before almost all native species and retain their leaves longer, extending their reliable detection period from April or May to November (Borland et al. 2015).

Habitat: Roadsides, thickets, banks, shores, and forests (Reznicek et al. 2011).

Current status in landscape: Bush honeysuckle is abundant on Plum Island in disturbed habitats, as well as along the lakeshore EOs and the mesic northern forest EO. It was also present along the edge of the Great Lakes Marsh EO. It was mapped thoroughly along the lakeshore. In the inland forest, it was mapped intermittently because much of the forested areas had such high invasive species cover that comprehensive mapping was infeasible. Occurrences were mapped as *Lonicera* sp. because our several invasive species from that genus have similar ecology and require similar management. On Plum Island, the occurrences represent hybrid honeysuckle *L.* × *bella*.

Management: Effective treatments include hand-pulling (remove all roots), foliar spray, stump-cutting plus herbicide, and basal bark treatment (spray bottom 18 in (46 cm) of stems; Borland et al. 2015). Pulled plants or cut stems can re-root if discarded on the soil, so proper disposal of plant fragments should be ensured. Treatment must be continued for 3 – 5 years until the seedbank is depleted (Czarapata 2005).

PURPLE LOOSESTRIFE (*LYTHRUM SALICARIA*)

Purple loosestrife is a Eurasian species, with attractive displays of pink flowers, that began to be cultivated in North America in the early 19th century. In Wisconsin, the species has been established as a wild plant since at least 1919. Since then, it has spread throughout both Wisconsin and Michigan and become a terrible wetland pest (Reznicek et al. 2011, Wisconsin State Herbarium 2022). It is a restricted weed in both states.

Species description: Purple loosestrife is a large herb to sub-woody plant reaching heights of 3 – 7 ft (1 – 2 m) or more. It is a variable species. Its leaves can be opposite, alternate, or whorled. Its flowers can be five- or six-petaled. The leaves are smooth-margined, lance-shaped, and without petioles (i.e., leaf stems). The flowers bloom from early July to September. Seeds can mature as early as late July. A single stem can produce 100,000 – 300,000 seeds a year, contributing to an enormous seedbank that can remain viable for 20 years. The plant can also reproduce via rhizomes (Czarapata 2005).

Habitat: Marshes, shores, borders of rivers, ditches (Reznicek et al. 2011).

Current status in landscape: A single, 1 ft^2 (0.1 m^2) patch was located, along the margin of the Great Lakes marsh (Figure 6).

Management: With their copious seed, aggressive vegetative spread, and regional abundance, prevention and containment are critical elements of purple loosestrife management. Plants within populations begin flowering asynchronously. Ideally, a site will be patrolled three times throughout the flowering season, the best time to detect this plant. Satellite patches that have spread beyond the central infestation should be prioritized first. Boots and equipment should be cleaned before leaving an infested area. Seed production begins shortly after flowering, so management techniques should not be delayed beyond the onset of flowering. Pulled plants will continue the process of seed production and can re-root. Small plants can be hand-pulled. Older plants will require a shovel to remove all roots while attempting to minimize soil disturbance. Mowing is not recommended.

Flowering portions of stems can be removed followed by hand-spraying cut stems with glyphosate formulated for use over water in July or August. Alternatively, triclopyr can be used to minimize effects on monocots. The “bloody glove” application technique can be used instead of hand-spraying. Broadcast spray of glyphosate will kill too many nontarget species.

Biological control may be the best option. There are several fecund, selective species from purple loosestrife’s home range, including beetles of the genus *Galerucella* (Czarapata 2005). Care must be taken when weighing a decision for biological control, as introducing a new species into an island ecosystem can have unintended consequences (e.g., Ortega et al. 2004).

WILD PARSNIP (*PASTINACA SATIVA*)

Wild parsnip is a biennial that was first collected in Wisconsin in 1884; since then, it has established throughout both Wisconsin and Michigan (Reznicek et al. 2011, Wisconsin State Herbarium 2022). It is found mostly on shores, roadsides, and anthropogenic openings but it also invades thickets and open forests (Reznicek et al. 2011). Wild parsnip spreads in slow waves at first and then begins to spread rapidly. Extreme caution should be used when treating this plant. All aboveground plant parts contain sap that can cause intense burns, rashes, and blistering on skin when exposed to sunlight (Czarapata 2005).

Species description: Wild parsnip is a biennial forb with a basal rosette and flowering stage. It has coarsely toothed compound leaves that clasp around a grooved stem. The flowers are small, yellow, and arranged in flat umbels 2 – 6 in (5 – 15 cm) broad. The seeds can remain viable for four years (Czarapata 2005). Seeds are flattened, ridged, and oval. Seeds attach easily to passing animals, but can also be moved by wind and water, as well as by roadside mowing equipment. Seeds can remain viable in the soil for up to four years. The easiest detection period is from June to mid-July when the showy yellow flowers are in bloom (Czarapata 2005).

Habitat: Roadsides, fields, clearings, shores, thickets, and open forests (Reznicek et al. 2011).

Current status in landscape: Two patches of wild parsnip were discovered in disturbed mesic northern forest at the edge of the mesic northern forest EO (Figure 6, Figure 7).

Management: Plants can be uprooted when the soil is moist. Alternatively, the root should be cut 1 – 2 in (2.5 – 5 cm) below ground level to prevent resprouting. Removal is best done before seed has begun to set. If not, seed heads must be bagged and destroyed in a secure location (Czarapata 2005).

Larger populations can be cut at ground level with a power brush-cutter. Chemical treatment is also effective: Glyphosate or metsulfuron-methyl plus a surfactant, or triclopyr formulated for use with water and 2,4-D amine are commonly used as foliar sprays (Czarapata 2005). Follow-up monitoring and treatment will be necessary. The seeds can remain viable for four years (Czarapata 2005).

REED CANARY GRASS (*PHALARIS ARUNDINACEA*)

Reed canary grass is a native element of our flora, yet invasive strains have been introduced from Europe. The native and invasive strains are morphologically indistinct. The latter has become a serious pest in wetland habitats, forming dense monocultures (Reznicek et al. 2011).

Species description: Reed canary grass is a perennial grass that reaches 2 – 7 ft tall (0.5 – 2 m). Its leaves are 0.25 – 0.75 in (0.6 – 2 cm) wide and up to 10 inches (25.5 cm) long. It blooms from May – mid-June and its flowers change color from green to purple to beige over time. Seeds ripen in late June. Reed canary grass can be difficult to distinguish from other grasses for those unfamiliar with local wetland grasses, especially blue-joint (*Calamagrostis canadensis*). Reed canary grass is easiest to detect from May through July when it has flowers and fruits. Reed canary grass reproduces by seed and vegetatively through rhizomes.

Habitat: Marshes, wet shores, borders of streams and ponds, ditches, and sparse forests (Reznicek et al. 2011).

Current status in landscape: Reed canary grass was occasional in disturbed mesic northern forest and the mesic northern forest EO. It was frequent in the Great Lakes marsh and the surrounding disturbed boreal forest, where it co-occurred with state/federally threatened dwarf lake iris. After MNFI mapped these occurrences, the Door County Invasive Species Team treated the occurrences, and several new patches that they detected, with glyphosate (Figure 8).

Management: Reed canary grass can be difficult to eradicate because of its prodigious seedbank and thick fibrous root mass by which it spreads. Small patches can be dug up or covered with plastic for one growing season, followed by planting the bare patch with native species (Czarapata 2005). Chemical treatments have been successful in controlling large patches in late summer or fall (Borland et al. 2015). It can also be treated in the spring, as this species' leaf-out is earlier than many other species and can be managed when many native plants are still dormant (Czarapata 2005). Monitoring and follow-up treatment is required for 5 – 10 years (Borland et al. 2015).

MULTIFLORA ROSE (*ROSA MULTIFLORA*)

Multiflora rose was formerly recommended in cultivation for living fences, erosion control, and wildlife fodder (Czarapata 2005). It has been known as a wild plant in Wisconsin since 1957. Since then, it has become widespread in Wisconsin and Michigan, primarily in disturbed places, but also invading forests and shores of relatively high quality (Reznicek et al. 2011, Wisconsin State Herbarium 2022), and it is a restricted species in Wisconsin.

Species description: Multiflora rose is a shrub with long, arching, thorny canes. It spreads to form dense thickets and reaches a height up to 15 ft (5 m). The leaves are alternate and pinnately compound, with 5 – 11 small oval leaflets and distinctive feathery stipules at the base of the petioles (leaf stems). The abundant white flowers appear in May or June. The small red fruits form in August. They are dispersed by many mammals and birds. Those not dispersed remain in winter and make for easy detection of the plant outside of the growing season. An individual plant can produce 500,000 seeds a year, which remain viable in the soil for 10 – 20 years. The plant also reproduces vegetatively. Its stems root at nodes, and new shoots can root at their tips. (Czarapata 2005).

Habitat: Roadsides, forests, fields, thickets, primarily in dry places but occasionally in moist ground (Reznicek et al. 2011)**.**

Current status in landscape: Multiflora rose appears to be early on the invasion curve on Plum Island (Harvey and Mazzotti 2014). One 3 ft^2 (0.3 m^2) patch was mapped in the mesic northern forest EO. One 2 ft^2 (0.2 m^2) patch was mapped along the limestone lakeshore cliff / moist cliff (Figure 6).

Management: Small plants can be dug with a shovel or pulled with the help of a leverage tool such as the Weed Wrench. All roots must be removed. Cut-surface treatment using glyphosate, basal bark treatment with triclopyr formulated for use with penetrating oil, foliar treatment with woody-plant-specific fosamine in water, foliar treatment with glysophate, and foliar treatment with broadleaf-specific metsulfuron-methyl plus a surfactant are effective chemical controls. Should chemical/mechanical methods fail to halt the emerging spread, the virus-like rose rosette disease can be introduced by grafting infected stems onto target plants (Czarapata 2005).

ERECT HEDGE-PARSLEY (*TORILIS JAPONICA*)

Erect hedge-parsley is a relatively newly established plant in Wisconsin first collected there in 1976 but now fairly widespread in southern and eastern Wisconsin, as well as in the Lower Peninsula of Michigan plus one Upper Peninsula county (Rezincek et al. 2011, Wisconsin State Herbarium 2022). It thrives best in disturbed habitats but also has the capacity to invade relatively undisturbed forests.

Species description: Like other members of the carrot family (e.g., dill, parsnip, Queen Anne's lace), erect hedge-parsley has distinctive finely divided compound leaves and umbrella-like arrangements of white flowers. It is a rather dainty herb, with small flowers, narrow leaf segments, and a height of just 12 – 20 in (30 – 50 cm). It blooms in July and August before producing its bristly fruit, easily dispersed by fur and clothing (Czarapata 2005).

Habitat: Roadsides, trails, clearings, and both upland and swampy forests (Reznicek et al. 2011).

Current status in landscape: A single patch was discovered, in a highly invaded section of mesic northern forest, at the edge of the mesic northern forest EO. While often considered a plant of moderate invasibility, it is categorized as Priority 1 because of the early status of invasion on Plum Island.

Management: Hand pull prior to flowering (Czarapata 2005).

NARROW-LEAVED CAT-TAIL (*TYPHA ANGUSTIFOLIA*)

Narrow-leaved cat-tail is a perennial and obligate wetland plant. It has been known from Wisconsin since at least 1915 and is now thoroughly naturalized across the state, as well as Michigan. Many wetlands of the Midwest are dominated by invasive cat-tails (Reznicek et al. 2011; Wisconsin State Herbarium 2022).

Description: The long leaves of narrow-leaved cat-tail are approximately 0.25 – 0.75 in wide (0.6 – 2 cm). It flowers from June – July, and flowers are borne in a velvety brown reproductive structure called a spike with a gap of at least 1 in (2.5 cm) separating the female flowers on the bottom from the male flowers on top. The seeds of narrow-leaved cat-tail can remain viable for 100 years (Borland et al. 2015). Narrow-leaved cat-tail spreads via seeds and rhizomes.

Wisconsin has one other species of cat-tail, broad-leaved cat-tail (*T. latifolia*). The most distinguishing feature between the two species is in the gap between female and male flowers; in native broad-leaved cat-tail, it is absent or is less than 1 inch (2 cm). The species are difficult to distinguish outside of the flowering season. Substantial overlap in the width of leaves [0.5 – 1 in (1.25 – 2.5 cm) in broad-leaved cat-tail] and the fruiting structure make intermediate individuals of both species indeterminable based on size alone.

Hybridization between the two species produces hybrid cat-tail (*T.* × *glauca*) and further vexes identification (Reznicek et al. 2011). Both narrow-leaved and hybrid cat-tail have invasive tendencies, particularly the latter (Czarapata 2005). Misidentifications are frequent even among trained naturalists. Hybrid cat-tail is mostly sterile but also spreads via rhizomes (Czarapata 2005). We recommend considering both narrow-leaved and hybrid cat-tail a severe threat to wetland communities.

Habitat: Almost any wet habitat (Reznicek et al. 2011).

Current status in landscape: A single patch of narrow-leaved cat-tail was discovered on Plum Island. It covered 10 ft^2 (0.9 m^2) at the edge of disturbed boreal forest and disturbed lakeshore, near the Great Lakes marsh / emergent marsh EO (Figure 6).

Management: The most effective treatments for this species have been glyphosate applied in mid- to late-summer with a wick, boom, or hand-spray applicator, followed by cutting and removing dead stems a week later. Annual follow-up treatments will be necessary for a few years as the root system continues to produce new shoots. The 100-year viability of seeds and ongoing possibility of new emigrants necessitates vigilant annual monitoring (Czarapata 2005).

Priority 2: Watch List

The focus for the Plum Island invasive species watch list is on moderately to highly invasive species that are known from nearby islands and the mainland in Delta County, Michigan, Door County, Wisconsin, and other counties in the immediate vicinity (Table 6). The following species should be watched for with particular vigilance, as they are either previously known from Plum Island or known from nearby islands in the Green Bay NWR: invasive reed, garlic mustard, autumn olive (*Elaeagnus umbellata*), white sweet-clover (*Melilotus albus*), and leafy spurge (*Euphorbia esula*). The watch list was not limited by the regional Great Lakes islands watch list in the *Regional Protocol Framework for Rare and Invasive Plant Monitoring on Great Lakes Islands* (USFWS 2021c). Species occurrences were compiled from the following databases: Michigan Flora Online, Online Virtual Flora of Wisconsin, Michigan Invasive Species Information Network, and iNaturalist. Invasive species observed on islands in Green Bay NWR were included in the IPIEDPT.

Table 6. Watch list of invasive species that have been observed near Plum Island, Door County, Wisconsin, USA. Abbreviations: iNat = iNaturalist, Co. = County, I. = Island, MISIN = Midwest Invasive Species Information Network, MNFI = Michigan Natural Features Inventory, WIS = Wisconsin State Herbarium. Counties: Brown Co., WI; Delta Co., MI; Door Co., WI.

Scientific name	**Common name**	**Source and year of most recent observation**	**Location**
Acer platanoides	Norway maple	iNat 2020 (inaturalist.org/observations/53771341)	Door Co.
Ailanthus altissima	Tree of heaven	WIS 1977 (Catalog #: v0329267WIS)	Door Co.
Alliaria petiolata	Garlic mustard	Bassett et al. 2022, Cohen et al. 2022	Detroit I., Door Co.
Celastrus orbiculatus	Oriental bittersweet	MISIN 2020	Delta Co.
Dipsacus fullonum	Wild teasel	WIS 2000 (Catalog #: UWGB35359)	Brown Co.
Dipsacus laciniatus	Cut-leaf teasel	iNat 2020 (https://www.inaturalist.org/observations/54274873)	Door Co.
Elaeagnus umbellata	Autumn olive	Bassett et al. 2022, Cohen et al. 2022	St. Martin I., Delta Co.
Epilobium hirsutum	Great hairy willow-herb	iNat 2021 (https://www.inaturalist.org/observations/90580693)	Door Co.
Euphorbia esula	Leafy spurge	Bassett et al. 2022, Cohen et al. 2022	St. Martin I. and Rocky I., Delta Co.
Fallopia japonica	Japanese knotweed	iNat 2021 (https://www.inaturalist.org/observations/94607207)	Delta Co.
Frangula alnus	Glossy buckthorn	iNat 2021 (https://www.inaturalist.org/observations/97788402)	Delta Co.
Iris pseudoacorus	Yellow iris	iNat 2021 (https://www.inaturalist.org/observations/83344012)	Delta Co.
Lysimachia nummularia	Moneywort	iNat 2021 (https://www.inaturalist.org/observations/97786520)	Delta Co.
Melilotus albus	White sweet-clover	Bassett et al. 2022, Cohen et al. 2022	Hog I., Poverty I., Door Co.; Rocky I., Delta Co.
Melilotus officinalis	Yellow sweet-clover	iNat 2021 (https://www.inaturalist.org/observations/85598750)	Door Co.
Morus alba	White mulberry	iNat 2020 (https://www.inaturalist.org/observations/48336723)	Door Co.
Myriophyllum spicatum	Eurasian water-milfoil	MISIN 2019	Delta Co.

Scientific name	Common name	Source and year of most recent observation	Location
Pinus sylvestris	Scotch pine	iNat 2021 (https://www.inaturalist.org/observations/95590492)	Door Co.
Phragmites australis ssp. *australis*	Invasive reed	MNFI 2021	Poverty I., St. Martin I.
Populus alba	White poplar	Bassett et al. 2022, Cohen et al. 2022	St. Martin I., Delta Co.
Rhamnus cathartica	Common buckthorn	iNat 2021 (https://www.inaturalist.org/observations/98069022)	Door Co.
Robinia pseudoacacia	Black locust	iNat 2020 (https://www.inaturalist.org/observations/62369578)	Door Co.
Vinca minor	Lesser periwinkle	iNat 2021 (https://www.inaturalist.org/observations/94772911)	Door Co.
Vincetoxicum nigrum	Black swallow-wort	iNat 2017 (https://www.inaturalist.org/observations/8092705)	Door Co.

Area Priorities among Detroit, Plum, Poverty, and St. Martin Islands

Among all natural communities documented on Detroit, Plum, Poverty, and St. Martin Islands, four occur on Plum (Cohen et al. 2022). Of the EOs among the four islands, Plum had 1 community ranking in the medium stewardship tier, and 3 ranked in the low stewardship tier (Table 7).

High tier EOs were on Poverty and Detroit Islands. The EOs of the high tier were ranked higher quality (i.e., ecological integrity index) and had greater threat from invasive species based on the habit of the species in that natural community and treatment feasibility at their 2021 infestation severity than those EOs of medium and low tiers (i.e., invasive index). Poverty Island boreal forest (EO ID 7488) was considered particularly vulnerable to invasive species considering the fire in 2016 increasing the opportunity for invasive establishment including the present invasive reed (*Phragmites australis* ssp. *australis*) in disturbed areas (Cohen et al. 2022).

Plum Island's Great Lakes marsh / emergent marsh was ranked in the medium tier (Table 7). The state rarity of Great Lakes marsh / emergent marsh (i.e., State Rank Score) and its invasion severity and treatment feasibility are what ranked it greater than other natural community EOs on Plum Island. Several invasive species have been treated and their population decreased in the EO in the last 20 years (e.g., purple loosestrife). The listed species dwarf lake iris, climbing fumitory, and white camas occur at or near the border of Great Lakes marsh / emergent marsh. More detailed information on this natural community can be found in the Area Description on page 33.

Three Plum Island natural community EOs were in the low stewardship tier: limestone cobble shore / Great Lakes alkaline rockshore, limestone lakeshore cliff / moist cliff, and mesic northern forest. The low feasibility of treatment of the invasive species present in those communities was the largest contributor to their low stewardship tier status. For mesic northern forest, low ecological integrity was a significant contributor. For limestone cobble shore, being relatively uninvaded in the shore proper was a contributor, though numerous invasives were present at the inland margin (Figure 6).

Table 7. MNFI stewardship prioritization scores for natural community EOs across Detroit, Plum, Poverty, and St. Martin Islands in Green Bay NWR. Higher scores indicate a higher stewardship priority. "EO ID" refers to a unique identifier in a State Natural Heritage Database. The Stewardship Prioritization Score is the sum of the three bolded indices (i.e., Ecological Integrity Index, Rarity Index, Invasive Index) to which the other scores contribute. Element occurrences are sorted by their MNFI stewardship prioritization scores and assigned a high (red), medium (yellow), or low (blue) stewardship priority. Anthropogenic areas were not ranked using the MNFI Stewardship prioritization score. Plum Island natural community EOs are bolded. The MNFI Stewardship Prioritization is abridged from Cohen et al. 2022.

Island	Area	EO ID	**Ecological Integrity Index**	Global Rank Score	State Rank Score	**Rarity Index**	Invasive Threat Severity Score	Treatment Feasibility	**Invasive Index**	**Stewardship Prioritization Score**
Poverty	Boreal forest	7488	4	3	3	3	3	4	3.5	**10.5**
Poverty	Limestone bedrock lakeshore	4159	4.5	3	4	3.5	2	3	2.5	**10.5**
Detroit	Limestone bedrock lakeshore	24374	4	3	4	3.5	2	3	2.5	**10**
Poverty	Limestone lakeshore cliff	1437	5	1.5	4	2.75	2	2.5	2.25	**10**
St. Martin	Limestone lakeshore cliff	24348	5	1.5	4	2.75	2	3	2.5	**10**
Detroit	Limestone cobble shore	24375	3.5	3	4	3.5	2	3	2.5	**9.5**
St. Martin	Limestone cliff	24350	4	1.5	4	2.75	2	3	2.5	**9.25**
St. Martin	Limestone cobble shore	24353	4	3.5	3	3.25	1	3	2	**9.25**
Plum	**Great Lakes marsh / emergent marsh**	**24367**	**3**	**2**	**4**	**3**	**3**	**3**	**3**	**9**
St. Martin	Mesic northern forest	24349	3.5	2	3	2.5	3	3	3	**9**
St. Martin	Boreal forest north	24351	4	3	3	3	1	2	1.5	**8.5**
St. Martin	Boreal forest south	24351	4	3	3	3	1	2	1.5	**8.5**
Plum	**Limestone cobble shore / Great Lakes alkaline rockshore**	**24370**	**3**	**3**	**4**	**3.5**	**2**	**2**	**2**	**8.5**
Detroit	Limestone lakeshore cliff	24372	3.5	3	2	2.5	2	3	2.5	**8.5**
Plum	**Limestone lakeshore cliff / moist cliff**	**24368**	**3**	**3**	**2**	**2.5**	**4**	**2**	**3**	**8.5**
St. Martin	Northern hardwood swamp	24352	3	2	3	2.5	3	3	3	**8.5**
Plum	**Mesic northern forest**	**24369**	**2**	**2**	**3**	**2.5**	**5**	**2**	**3.5**	**8**
Detroit	Limestone cliff	24373	3.5	1.5	1	1.25	2	3	2.5	**7.25**
Detroit	Sand and gravel beach	24387	3.5	3	4	3.5	0	---	0	**7**

Area Descriptions and Priorities

Without taking into account which invasive species were present in each area, IPIEDPT scored the four natural community EO areas above the disturbed boreal forest (Table 8). This aligns mostly with the expert opinion of MNFI. Each area is described briefly. Management recommendations are discussed in Chapter 4.

Table 8. IPIEDPT area prioritization scores for Plum Island. Higher scores indicate a higher management priority.

Area	Description Score	Risk Score	Status Score	Total Score
Great Lakes marsh / emergent marsh	2.8	1.8	0.5	5.1
Mesic northern forest	2.3	1.5	0.3	4.1
Limestone cobble shore / Great Lakes alkaline rockshore	1.3	1.8	0.9	4.0
Limestone lakeshore cliff / moist cliff	1.4	1.8	0.5	3.7
Boreal forest	1.1	1.5	0.3	2.9

Disturbed Boreal Forest

Boreal forest is a conifer or conifer-hardwood forest that is widespread in northern latitudes throughout the world. In Wisconsin, it is confined to the northernmost tier of counties, including Door County (WDNR 2015). In Michigan, it is confined to the Upper Peninsula and far-northern Lower Peninsula (Cohen et al. 2015). Dominant tree species include balsam fir, white spruce, and white cedar. Paper birch, trembling aspen, balsam poplar, white pine, and hemlock are also often important. The relative canopy composition shifts according to site moisture and time since disturbance (e.g., fire, windthrow, insect epidemic). For example, recent disturbance favors birch and aspen, while long stable periods favor balsam fir, white spruce, and white cedar (Cohen et al. 2015). A swath of forest in the north of Plum Island most closely resembles a boreal forest community, but the degree of anthropogenic disturbance has altered its state (Figure 9). Invasive species are abundant here. Most of the forest is in a successional period, but even as it proceeds to a forest with more mature canopy and long-lived canopy species, it may not resemble a defined natural community as existed prior to European colonization and mass logging efforts. The ground cover and topography has been altered by previous logging events.

Figure 9. Boreal forest on Plum Island. The understory pictured here is relatively uninvaded, but much of the ground layer of the boreal forest overall was dominated by Japanese barberry (*Berberis thunbergii*). Photo: Joshua Cohen, July 12, 2021.

Sensitive resources: [redacted] This community is adjacent to the Great Lakes marsh / emergent marsh and limestone cobble shore / Great Lakes alkaline rockshore EOs (Figure 4).

Important abiotic/biotic factors: This community was not surveyed in great detail because it does not qualify as a natural community EO.

Identified vectors and pathways: Plum Island is open to the public during daylight hours and served by a cruise line. Trails/roads run through/near the community. Much of the community occurs along Lake Michigan, and the propagules of invasive plants can be expected to wash up on shore. Anglers likely visit the Great Lakes marsh / emergent marsh, known locally as Carp Lake.

Invasive plant status: Invasive species are ubiquitous in this area, to such an extent that invasive species were not thoroughly mapped. The abundance of invasive species is a large reason the area was not considered of high enough quality to be granted EO status, Priority 1 species bush honeysuckle and Japanese barberry were particularly abundant. Reed canary grass was common just beyond the boreal forest in the Great Lakes marsh (Bassett et al. 2022; Figure 6). Nine other exotic species were recorded. These were not mapped except for thistles (*Cirsium sp.*) and houndstongue (*Cynoglossum officinale*).

The most likely new invaders of this area include eight Priority 1 species and two Priority 2 species that scored greater than 20 due to suitable habitat and/or proximity in adjacent areas/nearby islands (Table 9):

- Erect hedge-parsley
- Dame's rocket
- Purple loosestrife
- Garlic mustard
- Spotted knapweed
- Multiflora rose
- Wild parsnip
- Autumn olive
- Reed canary grass
- Narrow-leaved cat-tail

Table 9. IPIEDPT area-species link scores for the disturbed boreal forest. Species with a non-zero "Status Score" were observed in the area during the 2021 surveys (Bassett et al. 2022, Cohen et al. 2022). Priority 1 species that had present status in area are bolded. As bush honeysuckle (*Lonicera* sp.) observed on the island all have the same NatureServe rankings, they are pooled together in the table. Appendix 3, Table 3-3 lists all area-species links by species, and it lists additional common names.

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Helleborine	*Epipactis helleborine*	10	7	10	27	4.97	31.97
Common gypsy-weed	*Veronica officinalis*	10	7	10	27	4.9	31.9
Houndstongue	*Cynoglossum officinale*	10	5	10	25	6.77	31.77
Tall buttercup	*Ranunculus acris*	10	7	10	27	4.1	31.1
Japanese barberry	***Berberis thunbergii***	**10**	**1**	**10**	**21**	**9**	**30**
Bush honeysuckle	***Lonicera* sp.**	**10**	**1**	**10**	**21**	**8.47**	**29.47**
Common St. John's wort	*Hypericum perforatum*	10	10	5	25	4.37	29.37
Bladder campion	*Silene vulgaris*	10	10	5	25	4.1	29.1
Garden valerian, common valerian	*Valeriana officinalis*	10	1	10	21	7.3	28.3
Bull thistle	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Dame's rocket	*Hesperis matronalis*	10	0	10	20	7.7	27.7
Canada thistle	*Cirsium arvense*	10	0	10	20	7.57	27.57
Multiflora rose	*Rosa multiflora*	10	0	10	20	7.3	27.3
Wild parsnip	*Pastinaca sativa*	10	0	10	20	7.3	27.3
Marsh thistle	*Cirsium palustre*	10	0	10	20	6.77	26.77
Erect hedge parsley	*Torilis japonica*	10	0	10	20	5.9	25.9
Common hempnettle	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Lesser burdock	*Arctium minus*	10	0	10	20	5.1	25.1
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	0	10	20	4.9	24.9
Thyme-leaf speedwell	*Veronica serpyllifolia*	10	0	10	20	4.5	24.5
Meadow fescue	*Schedonorus pratensis*	10	0	10	20	4.5	24.5
Soapwort, bouncing bet	*Saponaria officinalis*	10	0	10	20	4.5	24.5
Garlic mustard	*Alliaria petiolata*	5	0	10	15	9.4	24.4
Flannel plant, common mullein	*Verbascum thapsus*	10	0	10	20	4.37	24.37
Butter and eggs	*Linaria vulgaris*	10	5	5	20	4.37	24.37
Bitter dock, broadleaf dock	*Rumex obtusifolius*	10	0	10	20	4.1	24.1
Canada bluegrass	*Poa compressa*	10	0	10	20	4.1	24.1
Reed canary grass	*Phalaris arundinacea*	10	0	5	15	9.07	24.07
Common mouse-ear chickweed	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Dandelion	*Taraxacum officinale*	10	0	10	20	3.57	23.57

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Kentucky bluegrass	*Poa pratensis*	10	0	10	20	3.43	23.43
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
European cranberry-bush	*Viburnum opulus*	10	0	5	15	5.1	20.1
Purple loosestrife	*Lythrum salicaria*	10	0	1	11	9.1	20.1
Queen Anne's lace	*Daucus carota*	10	0	5	15	5.1	20.1
Narrow-leaf cat-tail	*Typha angustifolia*	10	0	1	11	9	20
Spotted knapweed	*Centaurea stoebe* ssp. *micranthos*	10	0	1	11	9	20
Common timothy	*Phleum pratense*	10	0	5	15	4.9	19.9
Wormseed wallflower	*Erysimum cheiranthoides*	10	0	5	15	4.9	19.9
Redtop	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Red clover	*Trifolium pratense*	5	0	10	15	4.5	19.5
Orange hawkweed	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Jack-go-to-bed-at-noon	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
White campion	*Silene latifolia*	5	0	10	15	4.1	19.1
Spotted ladysthumb, ladysthumb	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Motherwort	*Leonurus cardiaca*	10	0	5	15	4.1	19.1
Yellow hawkweed	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Scotch mist	*Galium sylvaticum*	5	0	10	15	4.1	19.1
Orchard grass	*Dactylis glomerata*	10	0	5	15	4.1	19.1
Ox-eye daisy	*Leucanthemum vulgare*	10	0	5	15	3.97	18.97
Black bindweed, wild buckwheat	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Wood bluegrass	*Poa nemoralis*	10	0	5	15	3.57	18.57
Cat-nip	*Nepeta cataria*	10	0	5	15	3.57	18.57
Leafy spurge	*Euphorbia esula*	5	0	5	10	8.1	18.1
White poplar	*Populus alba*	5	0	5	10	6.5	16.5
White sweet-clover	*Melilotus albus*	5	0	5	10	6.3	16.3
Quackgrass	*Elymus repens*	5	0	5	10	5.7	15.7
Goldmoss stonecrop	*Sedum acre*	10	0	1	11	4.37	15.37
Common reed	*Phragmites australis*	5	0	1	6	9.1	15.1
Black medick	*Medicago lupulina*	5	0	5	10	4.5	14.5
Proso millet	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Strawberry clover	*Trifolium fragiferum*	5	0	5	10	3.57	13.57
Annual bluegrass	*Poa annua*	5	0	5	10	3.57	13.57
Smallflower hairy willow herb	*Epilobium parviflorum*	5	0	1	6	5.3	11.3
Norway spruce	*Picea abies*	5	0	1	6	4.1	10.1

Disturbed Mesic Northern Forest

This forest most closely resembles a mesic northern forest community, but the degree of anthropogenic disturbance has altered its state so it is difficult to recognize (Figure 10). Most of the forest is in a successional period, but even as it proceeds to a forest with more mature canopy and long-lived canopy species, it may not resemble a defined natural community as existed prior to European colonization and mass logging efforts. The ground cover and topography has been altered by previous logging events.

Figure 10. Disturbed mesic northern forest on Plum Island. Photo: Joshua Cohen, July 13, 2021.

Sensitive resources: [redacted] The disturbed mesic northern forest is adjacent to the limestone lakeshore cliff and mesic northern forest EOs.

Important abiotic/biotic factors: This community was not surveyed in great detail because it does not qualify as a natural community EO.

Identified vectors and pathways: Plum Island is open to the public during daylight hours and served by a cruise line. Trails/roads run through and near the community. Much of the

community occurs in close proximity to Lake Michigan, and the propagules of invasive plants can be expected to wash up on shore.

Invasive plant status: Invasive species are ubiquitous in the disturbed mesic northern forest, to such an extent that invasive species were not thoroughly mapped. The abundance of invasive species is a large reason the area was not considered of high enough quality to be granted EO status. A comprehensive species list was not kept, and this community was combined with the mesic northern forest EO in the IPIEDPT. Its species composition is similar to that of the mesic northern forest EO (Table 13), but with a higher abundance of invasive species (Bassett et al. 2022).

Priority 1 species bush honeysuckle and Japanese barberry were particularly abundant. Reed canary grass was common along the border of Great Lakes marsh and occasional elsewhere (Figure 6). Fifteen other exotic species were present. These were not mapped except for thistles and houndstongue.

The most likely new invaders of this area are the same as for the mesic northern forest EO and include two other Priority 1 species and two Priority 2 species that scored greater than 20 due to suitable habitat and/or proximity in adjacent areas/nearby islands (Table 13):

- Autumn olive
- Purple loosestrife
- Narrow-leaved cat-tail
- Garlic mustard

Great Lakes Marsh / emergent Marsh (EO ID 24367)

Great Lakes marsh is an herbaceous wetland community (Figure 11). In Wisconsin, it is classified as emergent marsh, with a statewide distribution (WDNR 2015). In Michigan, Great Lakes marsh occurs or likely occurs in every coastal county, along the Great Lakes and their major connecting rivers. Vegetation varies with substrate and water level, but this community tends to have three distinct zones: submergent marsh, emergent marsh, and sedge meadow. The habitat provided by this community is important to many wildlife species, such as migrating and breeding waterfowl and shorebirds. Short-term, seasonal, and interannual water-level variation can rapidly change the vegetation. The sedge meadow zone is typically dominated by grasses and shrubs, with woody encroachment during prolonged low-water level events. The emergent marsh zone is dominated by bulrushes (*Scirpus* spp., *Schoenoplectus* spp.), spike-rushes (*Eleocharis* spp.), rushes (*Juncus* spp.), cat-tails and submergent and floating plants. The submergent zone has deep water with mostly submergent and floating plants (Figure 11; Cohen et al. 2015).

Figure 11. Great Lakes marsh / emergent marsh on Plum Island. Photo: Joshua Cohen, July 13, 2021.

Sensitive resources: [redacted] This community occurs adjacent to the limestone cobble shore EO.

Important biotic factors: Most of the community is surrounded by disturbed boreal forest in which invasive species are extremely prevalent. The marsh is distinctly divided into three zones: sedge meadow, emergent marsh, and submergent marsh. Blue-joint and sedge (*Carex stricta*) dominate the meadow; some trees and shrubs are present, but most have been flood-killed by recent highwater years (2016 – 2020; Cohen et al. 2022).

Important abiotic factors: The marsh covers 17.5 acres (7.1 ha) in the northwest of the island. Water in the submergent marsh zone is 1.7 – 3.3 ft (0.5 – 1 m) deep. Soils are shallow, alkaline, and organic. The community is frequently disturbed by storm waves and water-level fluctuations (Cohen et al. 2022).

Identified vectors and pathways: Plum Island is open to the public during daylight hours and served by a cruise line. Trails/roads run near the marsh. The marsh occurs along Lake Michigan, and the propagules of invasive plants can be expected to wash up on shore. Anglers likely visit the Great Lakes marsh, known locally as Carp Lake.

Invasive plant status: Six Priority 1 invasive species were present, including a large patch of spotted knapweed and several patches each of Japanese barberry and reed canary grass. Purple loosestrife, bush honeysuckle, and narrow-leaved cat-tail were present in smaller amounts, the latter just beyond the mapped Great Lakes marsh (Bassett et al. 2022; Figure 6). Reed canary grass was treated after the MNFI survey by the Door County Invasive Species Team with glyphosate (Figure 8). Four other exotic species were present. Only thistles and houndstongue were mapped.

The most likely new invaders of this area include one other Priority 1 species and two Priority 2 species that scored greater than 20 due to suitable habitat and/or proximity in adjacent areas/nearby islands (Table 10):

- Invasive reed
- Wild parsnip
- Autumn olive

Table 10. IPIEDPT area-species link scores for the Great Lakes marsh area. Species with a non-zero "Status Score" were observed in the area during the 2021 surveys (Bassett et al. 2022, Cohen et al. 2022). Priority 1 species that had present status in area were bolded. As bush honeysuckle (*Lonicera* sp.) observed on the island all have the same NatureServe rankings, they are pooled together in the table. Appendix 3, Table 3-3 lists all area-species links by species, and it lists additional common names.

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Purple loosestrife	***Lythrum salicaria***	**10**	**10**	**10**	**30**	**9.1**	**39.1**
Narrow-leaf cat-tail[2]	***Typha angustifolia***	**10**	**10**	**10**	**30**	**9**	**39**
Houndstongue	*Cynoglossum officinale*	10	10	10	30	6.77	36.77
Bull thistle	*Cirsium vulgare*	10	10	10	30	6.77	36.77
Wormseed wallflower	*Erysimum cheiranthoides*	10	7	10	27	4.9	31.9
Reed canary grass	***Phalaris arundinacea***	**10**	**1**	**10**	**21**	**9.07**	**30.07**
Bush honeysuckle	***Lonicera* sp.**	**10**	**1**	**10**	**21**	**8.47**	**29.47**
Spotted knapweed	***Centaurea stoebe* ssp. *micranthos***	**10**	**5**	**5**	**20**	**9**	**29**
Japanese barberry	***Berberis thunbergii***	**10**	**5**	**5**	**20**	**9**	**29**
Marsh thistle	*Cirsium palustre*	10	1	10	21	6.77	27.77
Wild parsnip	*Pastinaca sativa*	10	0	10	20	7.3	27.3
Common hempnettle	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Lesser burdock	*Arctium minus*	10	0	10	20	5.1	25.1
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	0	10	20	4.9	24.9
Goldmoss stonecrop	*Sedum acre*	10	0	10	20	4.37	24.37
Common reed	*Phragmites australis*	5	0	10	15	9.1	24.1
Common mouse-ear chickweed	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Canada thistle	*Cirsium arvense*	10	0	5	15	7.57	22.57
Garden valerian, common valerian	*Valeriana officinalis*	10	0	5	15	7.3	22.3
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Smallflower hairy willow herb	*Epilobium parviflorum*	5	0	10	15	5.3	20.3
Queen Anne's lace	*Daucus carota*	10	0	5	15	5.1	20.1
Common timothy	*Phleum pratense*	10	0	5	15	4.9	19.9
Redtop	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Meadow fescue	*Schedonorus pratensis*	10	0	5	15	4.5	19.5
Soapwort, bouncing bet	*Saponaria officinalis*	10	0	5	15	4.5	19.5
Orange hawkweed	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Flannel plant, common mullein	*Verbascum thapsus*	10	0	5	15	4.37	19.37

[2]Found just beyond the edge of the community (Figure 6).

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Bladder campion	*Silene vulgaris*	10	0	5	15	4.1	19.1
Bitter dock, broadleaf dock	*Rumex obtusifolius*	10	0	5	15	4.1	19.1
Tall buttercup	*Ranunculus acris*	10	0	5	15	4.1	19.1
Spotted ladysthumb, ladysthumb	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Orchard grass	*Dactylis glomerata*	10	0	5	15	4.1	19.1
Dame's rocket	*Hesperis matronalis*	10	0	1	11	7.7	18.7
Black bindweed, wild buckwheat	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Multiflora rose	*Rosa multiflora*	10	0	1	11	7.3	18.3
Erect hedge parsley	*Torilis japonica*	10	0	1	11	5.9	16.9
Helleborine	*Epipactis helleborine*	10	0	1	11	4.97	15.97
Common gypsy-weed	*Veronica officinalis*	10	0	1	11	4.9	15.9
Quackgrass	*Elymus repens*	5	0	5	10	5.7	15.7
Thyme-leaf speedwell	*Veronica serpyllifolia*	10	0	1	11	4.5	15.5
Butter and eggs	*Linaria vulgaris*	10	0	1	11	4.37	15.37
Common St. John's wort	*Hypericum perforatum*	10	0	1	11	4.37	15.37
European cranberry-bush	*Viburnum opulus*	5	0	5	10	5.1	15.1
Canada bluegrass	*Poa compressa*	10	0	1	11	4.1	15.1
Motherwort	*Leonurus cardiaca*	10	0	1	11	4.1	15.1
Yellow hawkweed	*Hieracium caespitosum*	10	0	1	11	4.1	15.1
Ox-eye daisy	*Leucanthemum vulgare*	10	0	1	11	3.97	14.97
Dandelion	*Taraxacum officinale*	10	0	1	11	3.57	14.57
Wood bluegrass	*Poa nemoralis*	10	0	1	11	3.57	14.57
Cat-nip	*Nepeta cataria*	10	0	1	11	3.57	14.57
Red clover	*Trifolium pratense*	5	0	5	10	4.5	14.5
Kentucky bluegrass	*Poa pratensis*	10	0	1	11	3.43	14.43
Garlic mustard	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Jack-go-to-bed-at-noon	*Tragopogon pratensis*	5	0	5	10	4.3	14.3
White campion	*Silene latifolia*	5	0	5	10	4.1	14.1
Leafy spurge	*Euphorbia esula*	5	0	1	6	8.1	14.1
Proso millet	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Strawberry clover	*Trifolium fragiferum*	10	0	0	10	3.57	13.57
Annual bluegrass	*Poa annua*	5	0	5	10	3.57	13.57
White poplar	*Populus alba*	5	0	1	6	6.5	12.5
White sweet-clover	*Melilotus albus*	5	0	1	6	6.3	12.3
Black medick	*Medicago lupulina*	5	0	1	6	4.5	10.5
Norway spruce	*Picea abies*	5	0	1	6	4.1	10.1
Scotch mist	*Galium sylvaticum*	5	0	1	6	4.1	10.1

Limestone Cobble Shore / Great Lakes Alkaline Rockshore (EO ID 24370)

Limestone cobble shore, or Great Lakes alkaline rockshore according to Wisconsin Natural Heritage methodology, is a state-imperiled community that in Wisconsin occurs only in Door County (WDNR 2015). 'Cobble' refers to the size of the limestone rocks, which are larger than gravel but smaller than boulders (Figure 12). Limestone cobble shore communities occur on islands and on the mainland along the Niagara Escarpment. Vegetation is sparse and varies with water levels. It consists of herbs and scattered shrubs along the open shore and is often backed by a thicket of trees and shrubs such as northern white cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), white spruce (*Picea glauca*), soapberry (*Shepherdia canadensis*), tag alder (*Alnus incana*), and shrubby cinquefoil (*Dasiphora fruticosa*; Cohen et al. 2015). Threats to limestone cobble shore include unauthorized off-road vehicle recreation and invasive plant species (Kost et al. 2007, Cohen et al. 2020).

Figure 12. Limestone cobble shore / Great Lakes alkaline rockshore on Plum Island. Photo: Joshua Cohen, July 12, 2021.

Sensitive resources: [redacted]

[redacted]. This community occurs adjacent to the Great Lakes marsh / emergent marsh EO.

Important biotic factors: Vegetation along the cobble shore is absent to sparse, this likely exacerbated by recent highwater years. The vegetation present is limited to the inland margin and cracks between cobbles. A scattering of trees and shrubs, including white cedar, paper birch, trembling aspen, and choke cherry (*Prunus pensylvanica*), occurs on the inland margin, along with recently flood-killed trees. The shore proper contains a scattering of native herbs such as silverweed (*Argentina anserina*), harebell (*Campanula rotundifolia*), starry false Solomon-seal (*Maianthemum stellatum*), and swamp milkweed (*Asclepias incarnata*), as well as scattered invasive species, discussed below. A large group of pelicans was observed, along with one dead pelican that likely died of botulism (Cohen et al. 2022).

Important abiotic factors: The cobble shore covers 2.7 acres (1.1 ha) along parts of the northern and western shores. The extent of the community fluctuates with water levels; it is currently relatively narrow, ranging from 10 – 20 ft (3 – 6 m) wide. Soils between and beneath the cobbles are wet, gravelly, alkaline sands mixed with organics; they are subject to frequent disturbance by storm activity and water-level fluctuations. Small inclusions of sand and gravel beach intergrade with the cobble shore along the north coast (Cohen et al. 2022).

Identified vectors and pathways: Plum Island is open to the public during daylight hours and served by a cruise line. Trails/roads run near the cobble shore. The cobble shore occurs along Lake Michigan, and the propagules of invasive plants can be expected to wash up on shore. Anglers likely visit the adjacent Great Lakes marsh / emergent marsh EO, known locally as Carp Lake.

Invasive plant status: The Priority 1 species spotted knapweed, bush honeysuckle, and Japanese barberry were observed along or near the limestone cobble shore. The surveyors recorded spotted knapweed in a limited quantity but technical difficulties precluded in-field mapping. Bush honeysuckle was mapped extensively along the edge of the cobble shore on the north shore of the island. Japanese barberry was mapped extensively just beyond the edge of the cobble shore (Bassett et al. 2022; Figure 6). Thirteen other exotic species were present. Only thistles and houndstongue were mapped.

The most likely new invaders of this area include six Priority 1 species and three Priority 2 species that scored greater than 20 due to suitable habitat and/or proximity in adjacent areas/nearby islands (Table 11).

- Autumn olive
- Erect hedge-parsley
- Purple loosestrife
- White sweet-clover
- Multiflora rose
- Wild parsnip
- Invasive reed
- Reed canary grass
- Narrow-leaved cat-tail

Table 11. IPIEDPT area-species link scores for the limestone cobble shore area. Species with a non-zero "Status Score" were observed in the area during the 2021 surveys (Bassett et al. 2022, Cohen et al. 2022). Priority 1 species that had present status in the area were bolded. Appendix 3, Table 3-3 lists all area-species links by species, and it lists additional common names.

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Spotted knapweed	***Centaurea stoebe* ssp. *micranthos***	**10**	**5**	**10**	**25**	**9**	**34**
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Common timothy	*Phleum pratense*	10	7	10	27	4.9	31.9
Wormseed wallflower	*Erysimum cheiranthoides*	10	7	10	27	4.9	31.9
Houndstongue	*Cynoglossum officinale*	10	5	10	25	6.77	31.77
Soapwort, bouncing bet	*Saponaria officinalis*	10	7	10	27	4.5	31.5
Flannel plant, common mullein	*Verbascum thapsus*	10	7	10	27	4.37	31.37
Bladder campion	*Silene vulgaris*	10	7	10	27	4.1	31.1
Spotted ladysthumb, ladysthumb	*Persicaria maculosa*	10	7	10	27	4.1	31.1
Ox-eye daisy	*Leucanthemum vulgare*	10	7	10	27	3.97	30.97
Bush honeysuckle	***Lonicera* sp.**	**10**	**1**	**10**	**21**	**8.47**	**29.47**
Purple loosestrife	*Lythrum salicaria*	10	0	10	20	9.1	29.1
Narrow-leaf cat-tail	*Typha angustifolia*	10	0	10	20	9	29
Japanese barberry[3]	***Berberis thunbergii***	**10**	**5**	**5**	**20**	**9**	**29**
Canada thistle	*Cirsium arvense*	10	0	10	20	7.57	27.57
Garden valerian, common valerian	*Valeriana officinalis*	10	0	10	20	7.3	27.3
Wild parsnip	*Pastinaca sativa*	10	0	10	20	7.3	27.3
Bull thistle	*Cirsium vulgare*	10	0	10	20	6.77	26.77
Marsh thistle	*Cirsium palustre*	10	0	10	20	6.77	26.77
Common St. John's wort	*Hypericum perforatum*	10	7	5	22	4.37	26.37
Canada bluegrass	*Poa compressa*	10	7	5	22	4.1	26.1
Black bindweed, wild buckwheat	*Fallopia convolvulus*	10	7	5	22	3.7	25.7
Butter and eggs	*Linaria vulgaris*	10	1	10	21	4.37	25.37
Common hempnettle	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Lesser burdock	*Arctium minus*	10	0	10	20	5.1	25.1
Thyme-leaf speedwell	*Veronica serpyllifolia*	10	0	10	20	4.5	24.5
Meadow fescue	*Schedonorus pratensis*	10	0	10	20	4.5	24.5
Goldmoss stonecrop	*Sedum acre*	10	0	10	20	4.37	24.37
Tall buttercup	*Ranunculus acris*	10	0	10	20	4.1	24.1

[3]Found just beyond the edge of the community (Figure 6).

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Common reed	*Phragmites australis*	5	0	10	15	9.1	24.1
Reed canary grass	*Phalaris arundinacea*	10	0	5	15	9.07	24.07
Common mouse-ear chickweed	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Dandelion	*Taraxacum officinale*	10	0	10	20	3.57	23.57
Cat-nip	*Nepeta cataria*	10	0	10	20	3.57	23.57
Kentucky bluegrass	*Poa pratensis*	10	0	10	20	3.43	23.43
Multiflora rose	*Rosa multiflora*	10	0	5	15	7.3	22.3
White sweet-clover	*Melilotus albus*	5	0	10	15	6.3	21.3
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Erect hedge parsley	*Torilis japonica*	10	0	5	15	5.9	20.9
Quackgrass	*Elymus repens*	5	0	10	15	5.7	20.7
Smallflower hairy willow herb	*Epilobium parviflorum*	5	0	10	15	5.3	20.3
Queen Anne's lace	*Daucus carota*	10	0	5	15	5.1	20.1
Common gypsy-weed	*Veronica officinalis*	10	0	5	15	4.9	19.9
Redtop	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Red clover	*Trifolium pratense*	5	0	10	15	4.5	19.5
Black medick	*Medicago lupulina*	5	0	10	15	4.5	19.5
Orange hawkweed	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Jack-go-to-bed-at-noon	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
White campion	*Silene latifolia*	5	0	10	15	4.1	19.1
Bitter dock, broadleaf dock	*Rumex obtusifolius*	10	0	5	15	4.1	19.1
Motherwort	*Leonurus cardiaca*	10	0	5	15	4.1	19.1
Yellow hawkweed	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Orchard grass	*Dactylis glomerata*	10	0	5	15	4.1	19.1
Dame's rocket	*Hesperis matronalis*	10	0	1	11	7.7	18.7
Wood bluegrass	*Poa nemoralis*	10	0	5	15	3.57	18.57
Annual bluegrass	*Poa annua*	5	0	10	15	3.57	18.57
Leafy spurge	*Euphorbia esula*	5	0	5	10	8.1	18.1
Helleborine	*Epipactis helleborine*	10	0	1	11	4.97	15.97
European cranberry-bush	*Viburnum opulus*	5	0	5	10	5.1	15.1
Garlic mustard	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Proso millet	*Panicum miliaceum*	5	0	5	10	3.9	13.9
White poplar	*Populus alba*	5	0	1	6	6.5	12.5
Norway spruce	*Picea abies*	5	0	1	6	4.1	10.1
Scotch mist	*Galium sylvaticum*	5	0	1	6	4.1	10.1
Strawberry clover	*Trifolium fragiferum*	5	0	1	6	3.57	9.57

Limestone Lakeshore Cliff / moist Cliff (EO ID 24368)

According to Michigan Natural Heritage methodology, limestone lakeshore cliff is made up of vertical exposures of limestone along the Great Lakes (Cohen et al. 2015). In Wisconsin, this community is placed in the moist cliff category, which contains both lakeside and inland cliffs, and occurs throughout most of the state (WDNR 2015). The sparse soil of lakeside cliffs is exposed to desiccating wind, ice, and sun. Substrate is periodically lost when weathering sloughs off bedrock. These stressful and unstable conditions support a sparse vascular plant assemblage, though the ridge top may be forested with species such as red oak (*Quercus rubra*), sugar maple, white cedar, balsam fir, and paper birch (Figure 13). In Wisconsin, moist cliff is apparently secure (WDNR 2015), but this community is critically imperiled in Michigan (Cohen et al. 2015). Threats to limestone lakeshore cliffs include shoreline development, logging of adjacent uplands and associated soil erosion, excessive foot traffic along upper edge, rock climbing, and invasive plants (Kost et al. 2007, Cohen et al. 2020).

Figure 13. Limestone lakeshore cliff / moist cliff on Plum Island. Photo: Joshua Cohen, July 12, 2021.

Sensitive resources: [redacted]

Important biotic factors: Vegetation is absent to sparse, generally restricted to lips, cracks, ledges, and along the base. Where present, it includes herbs such as wild columbine (*Aquilegia canadensis*), harebell, yarrow (*Achillea millefolium*), beggar's lice (*Hackelia virginiana*), large-leaved aster (*Eurybia macrophylla*), and mosses; shrubs such as choke cherry, round-leaved dogwood (*Cornus rugosa*), red elder (*Sambucus racemosa*), and beaked hazelnut (*Corylus cornuta*); and often-stunted trees such as white cedar, paper birch, trembling aspen, and green ash (*Fraxinus pennsylvanica*). Three white cedars were cored and their ages estimated to be approximately 170 years or more; another was estimated to be over 205 (Cohen et al. 2022). Even-older trees may be present, as some white cedar of the Niagara Escarpment have been documented to live for up to 1900 years (Kelly and Larson 2007). Exotic species are locally common as discussed below. A bald eagle, western fox snake, and hummingbird were observed. The inland edge of the cliff system is bordered by disturbed mesic northern forest (Cohen et al. 2022).

Important abiotic factors: The limestone lakeshore cliff EO occupies 5.7 acres (2.3 ha) along a 0.5 mi (0.8 km) stretch of the eastern and southern shores. It intergrades with small inclusions of limestone bedrock lakeshore. The cliffs are relatively short at 3 – 12 ft (1 – 4 m) tall. Soils, where present, are alkaline, fine-textured, organic, and shallow. Thin soils, wind, cold winter temperatures, and summer droughts contribute to harsh growing conditions (Cohen et al. 2022).

Identified vectors and pathways: Plum Island is open to the public during daylight hours and served by a cruise line. Trails/roads run near the cliffs. The cliffs occur along Lake Michigan, and the propagules of invasive plants can be expected to wash up on shore.

Invasive plant status: Priority 1 spotted knapweed was present along the edge of the limestone lakeshore cliff / moist cliff. A long line of spotted knapweed, mapped along the disturbed northeast lakeshore, just extends into the limestone lakeshore cliff / moist cliff. Two plants were also found in disturbed mesic northern forest at the edge of the limestone lakeshore cliff / moist cliff EO and pulled. A multiflora rose patch of 2 ft^2 was present on the south shore. Bush honeysuckle was frequent (Bassett et al. 2022; Figure 6). Twelve other exotic species were present. These were not mapped except for thistles and houndstongue.

The most likely new invaders of this area include six Priority 1 species and three Priority 2 species that scored greater than 20 due to suitable habitat and/or proximity in adjacent areas/nearby islands (Table 12):

- Invasive reed
- Narrow-leaved cat-tail
- Reed canary grass
- Erect hedge-parsley
- Japanese barberry
- Wild parsnip
- Purple loosestrife
- Autumn olive
- White sweet-clover

Table 12. IPIEDPT area-species link scores for the limestone lakeshore cliff area. Species with a non-zero "Status Score" were observed in the area during the 2021 surveys (Bassett et al. 2022, Cohen et al. 2022). Priority 1 species that had present status in the area were bolded. As bush honeysuckle (*Lonicera* sp.) observed on the island all have the same NatureServe rankings, they are pooled together in the table. Appendix 3, Table 3-3 lists all area-species links by species, and it lists additional common names.

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Spotted knapweed	***Centaurea stoebe* ssp. *micranthos***	**10**	**10**	**10**	**30**	**9**	**39**
Bull thistle	*Cirsium vulgare*	10	10	10	30	6.77	36.77
Multiflora rose	***Rosa multiflora***	**10**	**10**	**5**	**25**	**7.3**	**32.3**
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Common timothy	*Phleum pratense*	10	7	10	27	4.9	31.9
Thyme-leaf speedwell	*Veronica serpyllifolia*	10	7	10	27	4.5	31.5
Meadow fescue	*Schedonorus pratensis*	10	7	10	27	4.5	31.5
Flannel plant, common mullein	*Verbascum thapsus*	10	7	10	27	4.37	31.37
Goldmoss stonecrop	*Sedum acre*	10	7	10	27	4.37	31.37
Tall buttercup	*Ranunculus acris*	10	7	10	27	4.1	31.1
Ox-eye daisy	*Leucanthemum vulgare*	10	7	10	27	3.97	30.97
Common mouse-ear chickweed	*Cerastium fontanum* ssp. *vulgare*	10	7	10	27	3.9	30.9
Dandelion	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Wood bluegrass	*Poa nemoralis*	10	7	10	27	3.57	30.57
Kentucky bluegrass	*Poa pratensis*	10	7	10	27	3.43	30.43
Lesser burdock	*Arctium minus*	10	5	10	25	5.1	30.1
Bush honeysuckle	***Lonicera* sp.**	**10**	**1**	**10**	**21**	**8.47**	**29.47**
Purple loosestrife	*Lythrum salicaria*	10	0	10	20	9.1	29.1
Narrow-leaf cat-tail	*Typha angustifolia*	10	0	10	20	9	29
Houndstongue	*Cynoglossum officinale*	10	1	10	21	6.77	27.77
Canada thistle	*Cirsium arvense*	10	0	10	20	7.57	27.57
Garden valerian, common valerian	*Valeriana officinalis*	10	0	10	20	7.3	27.3
Wild parsnip	*Pastinaca sativa*	10	0	10	20	7.3	27.3
European cranberry-bush	*Viburnum opulus*	10	7	5	22	5.1	27.1
Queen Anne's lace	*Daucus carota*	10	7	5	22	5.1	27.1
Marsh thistle	*Cirsium palustre*	10	0	10	20	6.77	26.77
Canada bluegrass	*Poa compressa*	10	7	5	22	4.1	26.1
Motherwort	*Leonurus cardiaca*	10	7	5	22	4.1	26.1
Yellow hawkweed	*Hieracium caespitosum*	10	7	5	22	4.1	26.1
Orchard grass	*Dactylis glomerata*	10	7	5	22	4.1	26.1
Helleborine	*Epipactis helleborine*	10	10	1	21	4.97	25.97

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Butter and eggs	*Linaria vulgaris*	10	1	10	21	4.37	25.37
Common hempnettle	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Wormseed wallflower	*Erysimum cheiranthoides*	10	0	10	20	4.9	24.9
Soapwort, bouncing bet	*Saponaria officinalis*	10	0	10	20	4.5	24.5
Bladder campion	*Silene vulgaris*	10	0	10	20	4.1	24.1
Common reed	*Phragmites australis*	5	0	10	15	9.1	24.1
Spotted ladysthumb, ladysthumb	*Persicaria maculosa*	10	0	10	20	4.1	24.1
Reed canary grass	*Phalaris arundinacea*	10	0	5	15	9.07	24.07
White sweet-clover	*Melilotus albus*	5	0	10	15	6.3	21.3
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Erect hedge parsley	*Torilis japonica*	10	0	5	15	5.9	20.9
Quackgrass	*Elymus repens*	5	0	10	15	5.7	20.7
Smallflower hairy willow herb	*Epilobium parviflorum*	5	0	10	15	5.3	20.3
Japanese barberry	*Berberis thunbergii*	10	0	1	11	9	20
Common gypsy-weed	*Veronica officinalis*	10	0	5	15	4.9	19.9
Redtop	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Red clover	*Trifolium pratense*	5	0	10	15	4.5	19.5
Black medick	*Medicago lupulina*	5	0	10	15	4.5	19.5
Orange hawkweed	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Common St. John's wort	*Hypericum perforatum*	10	0	5	15	4.37	19.37
Jack-go-to-bed-at-noon	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
White campion	*Silene latifolia*	5	0	10	15	4.1	19.1
Bitter dock, broadleaf dock	*Rumex obtusifolius*	10	0	5	15	4.1	19.1
Dame's rocket	*Hesperis matronalis*	10	0	1	11	7.7	18.7
Black bindweed, wild buckwheat	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Annual bluegrass	*Poa annua*	5	0	10	15	3.57	18.57
Leafy spurge	*Euphorbia esula*	5	0	5	10	8.1	18.1
Garlic mustard	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Proso millet	*Panicum miliaceum*	5	0	5	10	3.9	13.9
White poplar	*Populus alba*	5	0	1	6	6.5	12.5
Norway spruce	*Picea abies*	5	0	1	6	4.1	10.1
Scotch mist	*Galium sylvaticum*	5	0	1	6	4.1	10.1
Strawberry clover	*Trifolium fragiferum*	5	0	1	6	3.57	9.57
Cat-nip	*Nepeta cataria*	0	0	0	0	3.57	3.57

Mesic Northern Forest (EO ID 24369)

Mesic northern forest is a hardwood or hardwood-conifer forest dominated by trees such as sugar maple and American beech (*Fagus grandifolia*) with frequent yellow birch (*Betula alleghaniensis*), basswood, red oak, hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and in wetter areas, northern white-cedar (Figure 14; Cohen et al. 2015). Natural disturbances in mesic northern forests include frequent but small-scale windthrow events. There is little evidence that fires were prominent or frequent. Mesic forests once covered most of the mesic uplands in the Great Lakes region, but most have been thoroughly logged at least once in the last 200 years (Cohen et al. 2020). More novel threats to remnant and second-growth mesic forests include non-native insects or a combination of insect-fungus invasions: emerald ash borer, hemlock wooly adelgid (*Adelges tsugae*), beech bark disease, and bumper years of the caterpillar spongy moth (*Lymantria dispar dispar*, formerly known as gypsy moth). These disturbances create larger and more frequent canopy gaps changing the microhabitats underneath.

Figure 14. Mesic northern forest element occurrence on Plum Island. Photo: Joshua Cohen, July 12, 2021.

Sensitive resources: [redacted]

Important biotic factors: The mesic northern forest EO is uneven-aged and has undergone selective logging. It is dominated by sugar maple with canopy associates including red oak, basswood, paper birch, white cedar, hemlock, and white pine. Canopy trees generally range from 14 – 24 in (35 – 60 cm) in diameter, with some of the largest trees reaching 36 in (90 cm). The subcanopy is comprised of sugar maple, ironwood (*Ostrya virginiana*), white cedar, and hemlock. Estimated tree ages derived from tree cores included four canopy trees at over 120 years and one at over 220 years. The ground cover is diverse and dense. Non-native earthworms were observed. Deer, deer trails, and heavy browse were observed throughout.

Important abiotic factors: The mesic northern forest EO covers 63 acres. Soils are shallow alkaline loams over limestone cobble and bedrock.

Identified vectors and pathways: Plum Island is open to the public during daylight hours and served by a cruise line. Trails/roads run through/near the community.

Invasive plant status: For the IPIEDPT, the disturbed mesic northern forest and mesic northern forest EO were pooled. This was because a comprehensive species list was not kept for the highly infested disturbed forest (i.e., only the most problematic species were selectively mapped). In the mesic northern forest at-large, the following Priority 1 invasive species were present in the form of up to three small patches: dame's rocket, wild parsnip, erect hedge-parsley, and multiflora rose. Priority 1 reed canary grass was occasional; later in 2021, the Door County Invasive Species Team treated that species with glyphosate. Priority 1 Japanese barberry and bush honeysuckle were abundant (Bassett et al. 2022). Fifteen other exotic species were present. These were not mapped except for thistles and houndstongue.

The most likely new invaders of this area include two other Priority 1 species and two Priority 2 species that scored greater than 20 due to suitable habitat and/or proximity in adjacent areas/nearby islands (Table 13):

- Autumn olive
- Purple loosestrife
- Spotted knapweed
- Narrow-leaved cat-tail
- Garlic mustard

Table 13. IPIEDPT area-species link scores for the mesic northern forest area. Species with a non-zero "Status Score" were observed in the area during the 2021 surveys (Bassett et al. 2022, Cohen et al. 2022). Priority 1 species that had present status in area were bolded. As bush honeysuckle (*Lonicera* sp.) observed on the island all have the same NatureServe rankings, they are pooled together in the table. Appendix 3, Table 3-3 lists all area-species links by species, and it lists additional common names.

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Multiflora rose	***Rosa multiflora***	**10**	**10**	**10**	**30**	**7.3**	**37.3**

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Wild parsnip[4]	***Pastinaca sativa***	**10**	**10**	**10**	**30**	**7.3**	**37.3**
Bull thistle	*Cirsium vulgare*	10	10	10	30	6.77	36.77
Erect hedge parsley[5]	***Torilis japonica***	**10**	**10**	**10**	**30**	**5.9**	**35.9**
Canada thistle	*Cirsium arvense*	10	7	10	27	7.57	34.57
Dame's rocket[5]	***Hesperis matronalis***	**10**	**5**	**10**	**25**	**7.7**	**32.7**
Common hempnettle	*Galeopsis tetrahit*	10	7	10	27	5.1	32.1
Helleborine	*Epipactis helleborine*	10	7	10	27	4.97	31.97
Common gypsy-weed	*Veronica officinalis*	10	7	10	27	4.9	31.9
Houndstongue	*Cynoglossum officinale*	10	5	10	25	6.77	31.77
Tall buttercup	*Ranunculus acris*	10	7	10	27	4.1	31.1
Reed canary grass	***Phalaris arundinacea***	**10**	**7**	**5**	**22**	**9.07**	**31.07**
Dandelion	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Kentucky bluegrass	*Poa pratensis*	10	7	10	27	3.43	30.43
Japanese barberry	***Berberis thunbergii***	**10**	**1**	**10**	**21**	**9**	**30**
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	5	10	25	4.9	29.9
Bush honeysuckle	***Lonicera* sp.**	**10**	**1**	**10**	**21**	**8.47**	**29.47**
Common St. John's wort	*Hypericum perforatum*	10	10	5	25	4.37	29.37
Narrow-leaf cat-tail	*Typha angustifolia*	10	0	10	20	9	29
Garden valerian, common valerian	*Valeriana officinalis*	10	1	10	21	7.3	28.3
Marsh thistle	*Cirsium palustre*	10	1	10	21	6.77	27.77
Orchard grass	*Dactylis glomerata*	10	7	5	22	4.1	26.1
Ox-eye daisy	*Leucanthemum vulgare*	10	7	5	22	3.97	25.97
Cat-nip	*Nepeta cataria*	10	7	5	22	3.57	25.57
Lesser burdock	*Arctium minus*	10	0	10	20	5.1	25.1
Thyme-leaf speedwell	*Veronica serpyllifolia*	10	0	10	20	4.5	24.5
Meadow fescue	*Schedonorus pratensis*	10	0	10	20	4.5	24.5
Soapwort, bouncing bet	*Saponaria officinalis*	10	0	10	20	4.5	24.5
Garlic mustard	*Alliaria petiolata*	5	0	10	15	9.4	24.4
Flannel plant, common mullein	*Verbascum thapsus*	10	0	10	20	4.37	24.37
Butter and eggs	*Linaria vulgaris*	10	5	5	20	4.37	24.37
Bitter dock, broadleaf dock	*Rumex obtusifolius*	10	0	10	20	4.1	24.1
Canada bluegrass	*Poa compressa*	10	0	10	20	4.1	24.1

[4]Not recorded in the mesic northern forest EO proper but found in adjacent disturbed mesic northern forest.

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Common mouse-ear chickweed	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Wood bluegrass	*Poa nemoralis*	10	0	10	20	3.57	23.57
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
European cranberry-bush	*Viburnum opulus*	10	0	5	15	5.1	20.1
Purple loosestrife	*Lythrum salicaria*	10	0	1	11	9.1	20.1
Queen Anne's lace	*Daucus carota*	10	0	5	15	5.1	20.1
Spotted knapweed	*Centaurea stoebe* ssp. *micranthos*	10	0	1	11	9	20
Common timothy	*Phleum pratense*	10	0	5	15	4.9	19.9
Wormseed wallflower	*Erysimum cheiranthoides*	10	0	5	15	4.9	19.9
Redtop	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Red clover	*Trifolium pratense*	5	0	10	15	4.5	19.5
Black medick	*Medicago lupulina*	5	0	10	15	4.5	19.5
Orange hawkweed	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Jack-go-to-bed-at-noon	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
Bladder campion	*Silene vulgaris*	5	0	10	15	4.1	19.1
White campion	*Silene latifolia*	5	0	10	15	4.1	19.1
Spotted ladysthumb, ladysthumb	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Motherwort	*Leonurus cardiaca*	10	0	5	15	4.1	19.1
Yellow hawkweed	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Scotch mist	*Galium sylvaticum*	5	0	10	15	4.1	19.1
Black bindweed, wild buckwheat	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Leafy spurge	*Euphorbia esula*	5	0	5	10	8.1	18.1
White poplar	*Populus alba*	5	0	5	10	6.5	16.5
White sweet-clover	*Melilotus albus*	5	0	5	10	6.3	16.3
Quackgrass	*Elymus repens*	5	0	5	10	5.7	15.7
Goldmoss stonecrop	*Sedum acre*	10	0	1	11	4.37	15.37
Common reed	*Phragmites australis*	5	0	1	6	9.1	15.1
Proso millet	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Strawberry clover	*Trifolium fragiferum*	5	0	5	10	3.57	13.57
Annual bluegrass	*Poa annua*	5	0	5	10	3.57	13.57
Smallflower hairy willow herb	*Epilobium parviflorum*	5	0	1	6	5.3	11.3
Norway spruce	*Picea abies*	5	0	1	6	4.1	10.1

Anthropogenic Areas and Disturbed Shoreline

Plum Island has a history of intense use following the arrival of European people. It contains several areas so anthropogenically disturbed they cannot be identified to a natural community. These areas are labeled in Figure 4 and Figure 6 as Anthropogenic Areas and Disturbed Shoreline. They are found along roads and in the vicinity of structures (Figure 2). These areas are often under intense management, for example mowing along roads/trails and the planting of a wildflower garden for pollinators in the vicinity of the lifesaving station. Management goals in these areas differ from those meant to preserve or restore natural communities. Goals can range from maintaining recreational value, creating safe space for visitors, preserving historical anthropogenic environment, to enhancing educational opportunities. In relation to preserving the natural communities on the island from invasive species, monitoring and treatment of Priority 1 invasive species may occur if it does not conflict with these areas overarching goals (e.g., chemical treatment may be a safety concern for visitors).

Sensitive resources: [redacted]

Identified vectors and pathways: Plum Island is open to the public during daylight hours and served by a cruise line. Boats, equipment, and people traveling along roads/trails can be expected to bring propagules of invasive species. Propagules of invasive species can be expected to wash up on shore. The dock in the northeast is part of an anthropogenic area; it is the most likely pathway for new invasive species.

Invasive plant status: Comprehensive plant species lists were not kept for anthropogenic areas or highly disturbed sections of shoreline. The Priority 1 species Japanese barberry, bush honeysuckle, and spotted knapweed were abundant in these areas (Bassett et al. 2022; Figure 6). Priority 1 multiflora rose, wild parsnip, erect hedge-parsley, dame's rocket, narrow-leaved cat-tail, and reed canary grass are likely invaders from other areas on Plum Island. Priority 2 garlic mustard, invasive reed, white sweet-clover, leafy spurge and autumn olive are likely invaders from elsewhere in the Grand Traverse Islands and the mainland (Bassett et al. 2022).

Chapter 4: Work Plan

This section will propose management objectives and compile and summarize management actions best suited for the island areas as related to the invasive species documented on the island as discussed in Chapter 3. Management objectives were written to be measurable, yet flexible to the needs and limitations of treatment on remote islands. Each management action will include a management strategy (Table 3), species targeted, location, and timing recommendations, and be related to a management objective

Invasive Plant Management Objectives

- Elimination of 4 of 10 Priority 1 species across Plum Island within ten years.
    - Erect hedge parsley, wild parsnip, dame's rocket, reed canary grass
- Elimination of 3 additional Priority 1 species across Plum Island within 20 years
    - Purple loosestrife, multiflora rose, narrow-leaved cat-tail
- Elimination of 1 of 10 Priority 1 species along the limestone lakeshore cliff / moist cliff within ten years
    - Spotted knapweed
- Outlier control to perimeter control of 1 of 10 Priority 1 species within the Great Lakes marsh / emergent marsh, northeast anthropogenic area, and northwest disturbed lakeshore
    - Spotted knapweed
- Eradication of 5 of 10 Priority 1 species within 25 years
    - Dame's rocket, purple loosestrife, wild parsnip, multiflora rose, erect hedge parsley
- Sustained control of 2 of 10 Priority 1 species within natural communities EOs (ongoing)
    - Japanese barberry, spotted knapweed
- Plan treatment of newly observed Priority 2 species or unprioritized invasive species within 2 years of observation
- Reduce 25% of each population of Priority 1 and 3 species within 330 ft (100 m) of the climbing fumitory, white camas, Laurentian fragile fern, and dwarf lake iris EOs within fifteen years

Management Strategies and Actions

Ongoing actions

- Regular *monitoring* of areas on and near the shore, along the road/trail system, and around structures for new occurrences of invasives plant species.
- Regular *monitoring* of known listed plant species climbing fumitory, white camas, dwarf lake iris, and Laurentian fragile fern.

Continue Nuisance Deer Control Hunting Program on Plum Island. Continue *monitoring* deer population and impact on vegetation. Adapt Nuisance Deer Control Hunting Program as new information is collected, such as increasing the maximum harvest number if needed to maintain management threshold.Actions to be initiated within five years

- *Elimination* of wild parsnip and erect hedge-parsley in the disturbed mesic northern forest. Declare *eradication* after monitoring efforts failing to find the species span five years.
- *Elimination* of spotted knapweed from the limestone lakeshore cliff / moist cliff. Declare *eradication* after monitoring efforts failing to find the species span ten years.

- *Elimination* of dame's rocket from the disturbed mesic northern forest. Declare *eradication* after monitoring efforts failing to find the species span ten years.
- *Elimination* of reed canary grass from the Great Lakes marsh / emergent marsh and mesic northern forest. Declare *eradication* after monitoring efforts failing to find the species span ten years.
- *Elimination* of purple loosestrife and narrow-leaved cat-tail from the Great Lakes marsh / emergent marsh area. Declare *eradication* after monitoring efforts failing to find the species span twenty years.
- *Elimination* of multiflora rose from the mesic northern forest and limestone lakeshore cliff / moist cliff. Declare *eradication* after monitoring efforts failing to find the species span twenty years.

Actions to be initiated within ten years

- *Outlier control* to *perimeter control* of spotted knapweed in Great Lakes marsh / emergent marsh and anthropogenic areas
- *Sustained control* of Japanese barberry and bush honeysuckle within all natural-community EOs
- *Sustained control* of Japanese barberry, bush honeysuckle, houndstongue, and thistle within 330 ft (100 m) of federally listed dwarf lake iris EO
- *Sustained control* of houndstongue, thistle, bush honeysuckle, reed canary grass, and Japanese barberry within 330 ft (100 m) of state listed climbing fumitory, white camas, and Laurentian fragile fern

Best Management Practices for Avoiding Non-Target Effects

Best management practices (BMPs) describe efforts to initiate before, during, and after treatment to minimize negative effects on conservation assets (Table 1; Figure 3, Figure 4, Figure 5) and other resources. BMPs differ relative to the area, invasive species, and conservation assets involved and their relation among each other. Preparation and knowledge are the best weapons in this effort. The recommended practices are:

1. Those treating invasive species and monitoring treatment efforts should have skills and resources to identify Priority 1, Priority 2, selectively targeted Priority 3, and rare species found on the island
2. When possible, mark and maintain a buffer area around conservation assets
3. When treatment is occurring near conservation assets, plan efforts prior to treatment to protect populations such as
    a. covering asset with barrier, like buckets or tarp, while treatment is occurring,
    b. bagging and preventing propagule spread of invasive species as soon as possible after treatment
    c. using treatment tools, methods, or additives that reduce fine-scale, non-target exposure and damage
    d. timing treatment to avoid non-target exposure to treatment

Chapter 5: Monitoring and Evaluation

Monitoring and Evaluation

Follow-up treatment is necessary for all Priority 1 species due to viability of reproductive propagules and other strategies (e.g., resprouting) after treatment. Initial and follow-up treatments for any species should be documented with the appropriate feature type in the layer R3 Management Actions in the USFWS AGOL Feature layers.

A species will be considered eliminated/zero density when it is first undetected in a follow-up survey. It will be considered eradicated when it is undetected for upwards of three years depending on the viability of that species' reproductive propagules (e.g., six years for invasive reed, four for wild parsnip). At this point the species will move from the Priority 1 treatment list to the Priority 2 watch list for the island. Areas on and near the shore, roads/trails, natural community EOs, and the vicinity of listed plants, particularly dwarf lake iris and Laurentian fragile fern EOs, should be monitored with regular frequency.

Progress in invasive species treatment will be monitored through USFWS AGOL Feature Layers, specifically the Plant Invasive Location, Plant [Treatment], and Photo Point Survey feature layers. These layers collect data relevant to monitoring, treatment, and treatment efficacy respectively. Methods are described in Chapter 2 and directions to contribute to these layers can be found in Appendix 2.

Adaptation

An adaptive management strategy is a framework for dealing with complex environmental management problems. Adaptive management strategies stress the importance of symbiotic planning, management actions, experimentation, knowledge acquisition, and learning in the face of uncertain outcomes and changes (Lowell et al. 2014). To make informed and applicable management decisions, these schedules, management objectives, and management actions should be reviewed after each treatment and monitoring event for adaptation needs based on new information derived from those events (Lowell et al. 2014; Figure 15).

Both a treatment and monitoring schedule should be planned and budgeted based on the management objectives and proposed actions. Treatment and monitoring can occur during the same visit if time and personnel are budgeted accordingly. In Figure 15, this IPMP is the "Plan" at the top of the Adaptive management cycle, a treatment is "Act", a monitoring event is "Monitor", and a revisit of the management objectives, actions, and schedules with information gathered from the "Act" and "Monitor" and from novel research, experiments, and technology is "Evaluate".

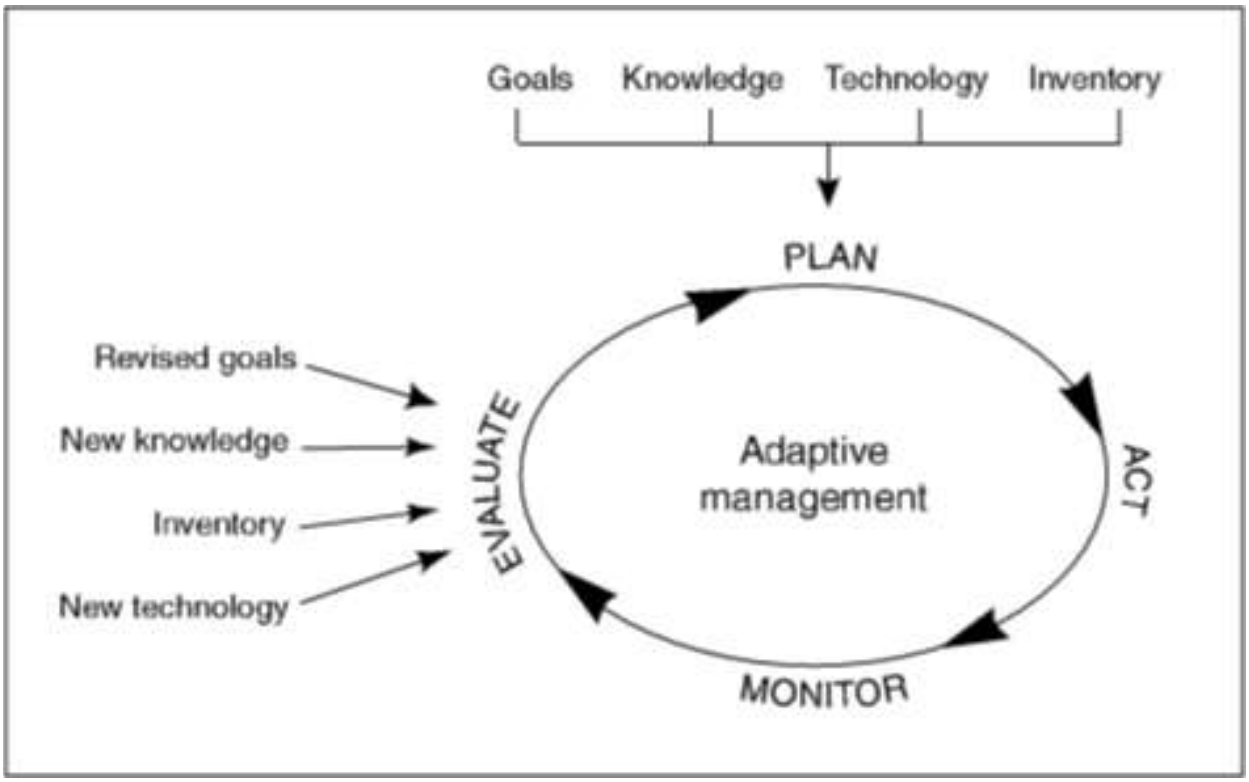

Figure 15. The adaptive management cycle. Figure reproduced from USDA USDI (1994) and Lowell et al. (2014).

Monitoring

Regular monitoring should occur to monitor treatment efficacy, detect new or newly spreading invasive species, and check the status of known rare species and communities. Monitoring effort may need to be adjusted among years due to resource and logistical constraints. Suggested monitoring tasks for each level of effort are described in Table 14. When any island visit is planned, the top three monitoring tasks should be conducted. The amount of time and personnel available for a visit can guide which additional monitoring tasks, if any, are to be conducted. Note: given the remoteness of the island, a team of at least two persons working together is recommended for safety.

Table 14. List of monitoring tasks categorized as belonging in a minimal, lower, medium, high, or highest monitoring effort. Monitoring tasks of highest priority are included in lower monitoring efforts. Priorities may change as a result of new information derived from monitoring and treatment efforts. An estimate of time for a team of two staff needed to survey is listed below each monitoring effort. Day(s) is abbreviated "d".

Monitoring Task	Monitoring Effort				
	Minimal (0.5 d)	Low (0.5-1 d)	Medium (1-2 d)	High (2-3 d)	Highest (4-5 d)
Treatment efficacy photo points	X	X	X	X	X
Invasive species survey on northern and western shoreline, including limestone cobble shore / Great Lakes alkaline rockshore EO, Great Lakes marsh / emergent marsh EO, northeast dock, and disturbed lakeshore	X	X	X	X	X
Rare species occurrences of dwarf lake iris	X	X	X	X	X
Invasive species survey on road/trails and around associated structures		X	X	X	X
Rare species occurrences of climbing fumitory, Laurentian fragile fern, and white camas		X	X	X	X
Invasive species on eastern and southern shore (i.e., limestone lakeshore cliff / moist cliff EO)			X	X	X
Invasive species survey in mesic northern forest EO			X	X	X
Invasive species survey in disturbed boreal and disturbed mesic northern forest forest				X	X
Rare species survey for new occurrences in limestone cobble shore / Great Lakes alkaline rockshore, limestone lakeshore cliff / moist cliff, Great Lakes marsh / emergent marsh				X	X
Invasive species survey in all island communities					X
Rare species survey for new occurrences in mesic northern forest EO					X
Rare species survey for new occurrences in disturbed boreal forest, disturbed mesic northern forest, disturbed lakeshore, and anthropogenic areas					X
Rare species survey in all island communities					X

A monitoring schedule including desired effort should be planned and budgeted (Table 15). This schedule should be flexible to adapt the IPMP based on evaluation of new data acquired after treatment and/or monitoring (Figure 15). Greater intensity monitoring efforts should be conducted when 1) resources allow, 2) the span between more intensive survey efforts is five years or more, and 3) after a new or spreading invasive species is observed during a monitoring or treatment event. Observation of a new or spreading invasive species will require modifications to management objectives/actions, monitoring prioritizations, and the effort schedule. Following a new observation, the monitoring effort should be revisited and more frequent surveys scheduled for the following years. If the new observation occurred during a treatment of minimal-, low-, or medium-level monitoring effort, a high-level or highest-level monitoring effort should be scheduled within the following two years. If the new observation occurred during a high- or highest-level monitoring effort, the monitoring effort for the following years can be less (Table 14).

Table 15. Several examples of scheduled monitoring efforts for 16 years. Base schedule A is minimal effort each year with medium effort once every 5 years and a high effort every 15 years. Base schedule B is low effort every three years with high effort after 3 low efforts. Base schedule C is monitoring every 5 years alternating between high and low efforts. The apostrophe (') represents an adaptation to a monitoring schedule based on the discovery of a new or spreading invasive species and which year it was found.

	Example Schedule of Monitoring Effort					
Year	A	A'	B	B'	C	C'
1	Minimal	Minimal	Low	Low	High	High
2	Minimal	Minimal				
3	Minimal	Minimal				
4	Minimal	Minimal	Low	Low '		
5	Medium	Medium		High		
6	Minimal	Minimal		Minimal	Low	Low
7	Minimal	Minimal '	Low	Low		
8	Minimal	High				
9	Minimal	Minimal				
10	Medium	Medium	High	Low		
11	Minimal	Minimal			High	High '
12	Minimal	Medium				Minimal
13	Minimal	Minimal	Low	Low		Minimal
14	Minimal	Minimal				
15	Highest	Medium				
16	Minimal	Minimal	Low	High	Low	High

Treatment

All treatments should undergo the treatment and permitting process and then be recorded in the appropriate USFWS AGOL Region 3 treatment feature layer (e.g., Plant Chemical Use). These layers are engineered to house relevant data and multiple treatments of the same area, if needed.

All treatment areas should undergo monitoring for treatment efficacy using the USFWS AGOL Photo Points Survey feature layer. Protocols described in *Regional Protocol Framework for Rare and Invasive Plant Monitoring on Great Lakes Islands* (2021c) and *Draft Site-specific Protocol for Vegetation Surveys on Great Lakes Islands, Green Bay and Gravel Island National Wildlife Refuges* (2021a) and summarized here should be followed:

The treatment area is photographed before and after treatment. The number, orientation, and spacing of photographs within the treatment area will vary, but the photographs should be collected at surveyor discretion with the goal of collecting enough photos to accurately capture a visual representation of the cover and density of target plants. The GPS locations of the pre-treatment photographs will be revisited post-treatment. Any new photographs taken at the photo point will be submitted via the USFWS AGOL Photo Point Survey feature layer as a related table to the pre-treatment photo. This will allow for easier monitoring of qualitative treatment efficacy.

Following treatment or monitoring years, the management objectives and actions should be revisited and reevaluated based on the new information gathered. The treatment or monitoring plan may need to be adapted. Adaptive management practices allow for more flexibility in decision making and account for uncertainty and variability in the plan (Lowell et al. 2014).

Data Management

Invasives species populations, treatments, and treatment efficacy data will be collected via USFWS AGOL Web Map like Great Lakes – Invasives and Photo Points as described in Chapter 2 (Esri 2022b). The accessibility and flexibility of AGOL tools allow for easy sharing among partners and almost instant synching of new or updated data. These data are managed by regional USFWS staff. For more information on layer metadata, see Appendix 1. For more information on using ArcGIS Collector to record data, see Appendix 2.

Chapter 6: References

Albert DA, Comer PJ, Corner RA, Cuthrell DL, Penskar MR, Rabe ML. 1995. Bedrock shoreline survey of the Niagaran escarpment in Michigan's Upper Peninsula: Mackinac County to Delta County. Report prepared by Michigan Natural Features Inventory for Michigan Department of Natural Resources.

Bacon J. 2016. The Grand Traverse Islands: Our Next National Lakeshore? Door County Maritime Speaker Series. http://www.dcmm.org/uncategorized/grand-traverse-islands-next-national-lakeshore/.

Bassett TJ, Warner SM, Cohen JG, Lincoln JM, Hackett RA. 2022. Rare and Invasive Plant Surveys of National Wildlife Refuge Islands - 2021 Horicon Complex. Michigan Natural Features Inventory, Report No. 2022-10, Lansing, MI.

Bauer KT, Shannon SM, Stoops RE, Reynolds HL. 2012. Context dependency of the allelopathic effects of *Lonicera maackii* on seed germination. *Plant Ecology*. 213: 1907 – 1916.

Borland K, Campbell S, Higman P, Peterson C, Schillo R. 2015. A Field Identification Guide to Invasive Plants in Michigan's Natural Communities. Michigan Natural Features Inventory, Lansing, MI.

Cal-IPC. 2015. Best Management Practices for Wildland Stewardship: Protecting Wildlife When Using Herbicides for Invasive Plant Management. Cal-IPC Publication 2015-1. California Invasive Plant Council, Berkeley, CA. Available: www.cal-ipc.org.

Ceradini JP and Chalfoun AD. 2017. Species' traits help predict small mammal responses to habitat homogenization by an invasive grass. *Ecological Applications.* 27: 1451 – 1465.

Cohen JG, Kost MA, Slaughter BS, Albert DA. 2015. *A Field Guide to the Natural Communities of Michigan*. Michigan Natural Features Inventory. Michigan State University Press, East Lansing, Michigan, USA.

Cohen JG, Kost MA, Slaughter BS, Albert DA, Lincoln JM, Kortenhoven AP, CM Wilton, Enander HD, Korroch KM. 2020. Michigan Natural Community Classification [web application]. Michigan Natural Features Inventory, Michigan State University Extension, Lansing, Michigan. Available https://mnfi.anr.msu.edu/communities/classification. (Accessed: March 1, 2022).

Cohen JG, Lincoln JA, Bassett TJ, Warner SM, Hackett RA. 2022. Natural Community Surveys of National Wildlife Refuge Islands – 2021 Horicon Complex. Michigan Natural Features Inventory, Report No. 2022-07, Lansing, MI.

Cohen JG, Wilton CM, Enander HD. 2019. Invasive Species Treatment Prioritization Model. Michigan Natural Fea-tures Inventory. Report Number 2019-27, Lansing, MI. 21 pp

Crystal-Ornelas R and Lockwood JL. 2020. Cumulative meta-analysis identifies declining but negative impacts of invasive species on richness after 20 yr. *Ecology*. 101: e3082.

Czarapata EJ. 2005. Invasive Plants of the Upper Midwest. The University of Wisconsin Press, Madison, WI.

Esri. 2020. Collector for ArcGIS v.20.2.2. Environmental Systems Research Institute, Inc. Redlands, CA, USA

Esri. 2022a. ArcGIS Field Maps v.22.0.1. Environmental Systems Research Institute, Inc. Redlands, CA, USA

Esri. 2022b. ArcGIS Online (AGOL). Environmental Systems Research Institute, Inc. Redlands, CA, USA.

Forzley KC, Grudzien TA, Wells JR. 1993. Comparative floristics of seven islands in northwestern Lake Michigan. *The Michigan Botanist* 32: 3–21.

Harvey RG, Mazzotti FJ. 2014. The invasion curve: a tool for understanding invasive species management in south Florida. *Institute of Food and Agricultural Sciences.* Publication Number WEC-347.
Henson BL, Kraus DT, McMurtry MJ, Ewert DN. 2010. Islands of Life: A Biodiversity and Conservation Atlas of the Great Lakes Islands. Nature Conservancy of Canada. 154 pp.
Higman PJ, Enander HD, Hyde DA, Badra PJ, Korroch KM. 2019. Examples of Case Studies for Invasive Species Action: Michigan's Great Lakes Islands. Report to the USFWS Great Lakes Coastal Program. MNFI Report No, 2019-19.
Judziewicz EJ. 2001. Flora and vegetation of the Grand Traverse Islands (Lake Michigan), Wisconsin and Michigan. *The Michigan Botanist*. 40: 81 – 208.
Kelly E, Larson DW. 2007. The last Stand: a journey through the ancient cliff-face forest of the Niagara Escarpment. Natural Heritage Imprint, Dundurn Press, Toronto, ON.
Kershaw JA Jr., Ducey MJ, Beers TW, Husch B. 2017. Forest Mensuration. 5th Ed. John Wiley & Sons, Ltd, West Sussex, UK.
Kost, MA, Albert DA, Cohen JG, Slaughter BS, Schillo RK, Weber CR, Chapman KA. 2007. Natural Communities of Michigan: Classification and Description. Michigan Natural Features Inventory, Report No. 2007-21, Lansing, MI.
Lenz S, Vaniman M, Kahl SF. 2013. Gravel Island, Green Bay, Harbor Island, Huron, and Michigan Islands National Wildlife Refuges Comprehensive Conservation Plan. 320 pp.
Levin DA, Francisco-Ortega J, Jansen RK. 1996. Hybridization and the extinction of rare plant species. *Conservation Biology.* 10: 10 – 16.
Liao C, Peng R, Luo Y, Zhou X, Wu X, Fang C, Chen J, Li B. 2007. Altered ecosystem carbon and nitrogen cycles by plant invasion: a meta-analysis. *New Phytologist*. 177: 706 – 714.
Lockwood JL, Hoopes MF, Marchetti MP. 2013. *Invasion Ecology*. Malden, MA, Blackwell Publishing.
Lonsdale WM. 1999. Global patterns of plant invasions and the concept of invasibility. *Ecology*. 80: 1522 – 1536.
Lowell D, Stankey GH, Williams BK. 2014. *Adaptive Management of Natural Resources: Concepts and Applications*. Nova Science Publishers, Inc.
Mack RN. 2003. Plant Naturalizations and invasions in the Eastern United States, 1634-1860. *Annals of the Missouri Botanical Garden.* 90: 77 – 90.
Ortega YK, Pearson DE, McKelvey KS. 2004. Effects of biological control agents and exotic plant invasion on deer mouse populations. *Ecological Applications*, 14(1): 241-253.
Pimentel D, Zuniga R, Morrison D. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52: 273 – 288.
Pysek P, Jarosik V, Hulme PE, Pergl J, Hejda M, Schaffner U, Vila M. 2011. *Global Change Biology*. 18: 1725 – 1737.
Reichard SH, P White. 2001. Horticulture as a pathway to invasive plant introductions in the United States. *BioScience*. 51: 103 – 113.
Reznicek AA, Voss EG, Walters BS. 2011 *MICHIGAN FLORA ONLINE*. University of Michigan. Web. https://michiganflora.net. Accessed 07 February 2022.
Salas D, Taylor W, Lenz S, O'Dell S, Krapfl J, Bolin D, Hoffman D. 2017. Habitat Management Plan for Green Bay and Gravel Island National Wildlife Refuges. 186 pp.

Stinson KA, Campbell SA, Powell JR, Wolfe BE, Callaway RM, Thelen GC, Hallett SG, Prati D, Klironomos JN. 2006. Invasive plant suppresses the growth of native tree seedlings by disrupting belowground mutualisms. *PLOS Biology*. 4: 727 – 31.

Thorpe AS, Thelen GC, Diaconu A, Callaway RM. 2009. Root exudate is allelopathic in invaded community but not in native community: field evidence for the novel weapons hypothesis. *Journal of Ecology.* 97: 641 – 45.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management [USDA USDI]. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [Place of publication unknown.] 74 pp. [Plus attachment A: standards and guidelines].

U.S. Department of the Interior [USDI]. 2021. U.S. Department of the Interior Invasive Species Strategic Plan, Fiscal Years 2021-2025. Washington, D.C., 54 pp.

U.S. Fish and Wildlife Service [USFWS]. 2013. National Invasive Species Program Update FY 2012. Department of Interior, Washington, D.C. Available: http://www.fws.gov/invasives/pdfs/InvasiveSpeciesProgramFactSheet_2012.pdf (28 February 2022).

U.S. Fish and Wildlife Service [USFWS]. 2016. The Invasive Plant Inventory and Early Detection Prioritization Tool. National Wildlife Refuge System, Pacific Southwest Region, Inventory and Monitoring Initiative, Sacramento, CA.

U.S. Fish and Wildlife Service [USFWS]. 2020. Final Report: Bald Eagle Population Size: 2020 Update. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. U.S.A.

U.S. Fish and Wildlife Service [USFWS]. 2021a. Draft Site-specific Protocol for Vegetation Surveys on Great Lakes Islands, Green Bay and Gravel Island National Wildlife Refuges.

U.S. Fish and Wildlife Service [USFWS]. 2021b. Regional Protocol Framework for the Inventory and Monitoring of Natural Communities and Forests on Great Lakes Islands Version 0.1. Department of Interior Great Lakes Region, U.S. Fish and Wildlife Service Regional Office, Bloomington, MN.

U.S. Fish and Wildlife Service [USFWS]. 2021c. Regional Protocol Framework for Rare and Invasive Plant Monitoring on Great Lakes Islands. Version 0.1. Department of Interior Great Lakes Region, U.S. Fish and Wildlife Service Regional Office, Bloomington, MN.

U.S. Fish and Wildlife Service and California Invasive Plant Council [USFWS Cal-IPC]. 2018. Land Manager's Guide to Developing an Invasive Plant Management Plan. Cal-IPC Publication 2018-01. National Wildlife Refuge System, Pacific Southwest Region, Inventory and Monitoring Initiative, Sacramento, CA. California Invasive Plant Council, Berkeley, CA.

Van Kleunen M, Bossdorf O, Dawson W. 2018. The Ecology and Evolution of Alien Plants. *Annual Review of Ecoogy,. Evolution, and Systematics.* 49: 25 – 47.

Wisconsin Department of Natural Resources [WDNR]. 2015. The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131 2015, Madison.

Wisconsin State Herbarium, University of Wisconsin-Madison. 2022. Online Virtual Flora of Wisconsin. Web. https://wisflora.herbarium.wisc.edu/index.php. Accessed 14 March 2022.

Appendix 1. Meta data for data collection forms

Digital data forms were used to collect and compile data where appropriate for field surveys conducted to collect critical background information for the IPMP. To collect information for rare species occurrences (i.e., element occurrences), surveyors used MNFI's public "MNFI Rare Species Form" via Survey123 Field App (Table 1-1). Entries were quality controlled by MNFI staff prior to addition to Michigan's Natural Heritage database.

To collect information for invasive species occurrences for 2021 surveys, surveyors used a map generated and deposited in USFWS AGOL group called "Great Lakes – Invasives and Photopoints" via ArcGIS Collector App (ESRI 2020). This map contained several Feature Layers that could have entries added. Each Feature Layer in "Great Lakes – Invasives and Photopoints" is described below in tables 1-1 to 1-5.

For all tables, "Display name" is the name used in surveys and most correspondence. All data layers will auto-generate many fields including username, created date, last edited date, and unique global ID.

Table 1-1. Description of metadata collected for MNFI Rare Species Form via Survey123. This form contains only one layer. Data collected automatically by device that is hidden from the surveyor was not included in the metadata table (e.g., GPS location)

Display Name	Definitions and Values	Example	Required
Survey Date & Time	Date and time in local time zone. Generated by device	5/8/2016, 8:01 am	X
Observer/s	Full name(s) of observers	Rachel Hackett	X
Affiliation	Group which the observer ascribes to	MNFI	
Email	Observer email address to which to address follow-up questions	hackett5@msu.edu	X
Survey Type	Select best description of what type of survey, if any was conducted to find organism.	Camera Trap	
General Location	Name of location, park, closest waterway, street name, etc. to describe locality of observation	Mayberry State Park	X
Latitude read-only	Display of latitude collected by device	45.3789542	
Longitude read-only	Display of longitude collected by device	86.5468732	
Manual Distance	If GPS was read from a separate device, enter a numerical estimate of accuracy of coordinates.	25	
Manual Distance Unit	Units of the above accuracy estimate	Meters	
Add Photo	Add up to 4 photographs taken by device		
Audio Recording	Make an audio recording to support identification		
Search Type	Select how to search for the species observed: by element or by taxonomy	Element	X
Species Type	Select whether the species observed is an Animal or Plant	Plant	X
Search by	Select whether to search for species by Scientific Name, Common Name, Genus, Family, or Order	Scientific name	X
Higher Class Unit	If Search Type of 'Taxonomy' was selected, select genus, family, or order of organism	Pinguicula	
Species	If Search Type of 'Element' was selected, select the species name of the organism	Butterwort	X

Display Name	Definitions and Values	Example	Required
Location Use Class	For animal species, select whether there is evidence of breeding (e.g., breeding plumage, songs)	Not applicable	
Scientific Name	Display of scientific name based on species selected	Pinguicula vulgaris	
Common Name	Display of common name based on species selected	Butterwort	
Subnational Rank	Display of State/subnational rank of species based on NatureServe ranking calculator	S3	
EO Track Status	Display of what is ranked about species	Track all extant and selected historical EOs	
Number of adults/individuals observed	For animal species, enter number of adults observed	2	
Number of juveniles observed	For animal species, enter the number of juveniles observed	0	
Estimate or actual count?	For animal species, indicate whether the count of adults and juveniles is an estimate or exact count	Actual	
Evidence Type	For animal species, select from list what is the basis of the observation	Photographed	
Notes	For animal species, list anything more of note about the observation (e.g., size, sex, behavior, identification notes)	It sounded like a Cooper's Hawk, but looked small. Caught a sparrow.	
Number of individuals observed	For plant species, enter the number of individuals observed	20	
Estimate or actual count?	For plant species, indicate whether the count of individuals is an estimate or exact count	Estimate	
Abundance	For plant species, indicate the qualitative abundance of the species in the area using the DAFOR scale	Occasional	
Percent of plants in flower	For plant species, estimate the percentage of plants in flower	10	
Percent of plants in fruit	For plant species, estimate the percentage of plants in fruit	0	
Apparent vigor	For plant species, rate the health of the plant or population	Good	
Notes	For plant species, list anything more of note about the observation (e.g., size, distribution pattern, unique features, identification notes)	Clumped near Sphagnum mounds. Leaf herbivory	
Associated Species	For plant species, list any other plant species that grow with the observed species in the habitat	Sphagnum moss, Cladium mariscoides, Juncus, Thuja occidentalis, Arctostraphylos uva-ursi, Triantha glutinosa, Utricularia cornuta.	
Habitat Description	Description of area in which the organism was observed	Found in coastal fen near pooling water.	
Disturbance	Description or list of possible disturbance to the population (e.g., invasive species, pollution, hydrology)	Unmarked trail splits population. Frangula alnus encroaching in area	
Overall site quality	Rating of overall quality of the site	Good	

Table 1-2. Description of layers and metadata collected for USFWS Photo Point Survey AGOL feature layer. The Photo_Point layer describes the location of the photo point. The Obs_Event is a table related to Photo_Point layer that describes each observation event where photos are taken at the photo point. One photo point can have many observation events. Data collected automatically by the device that is hidden from the surveyor was not included in the metadata table (e.g., GPS location). This layer is often used to document invasive treatment efficacy over time.

Layer	Display Name	Definitions and Values	Example	Required
Photo_Point	Photo_ID	Unique label to indicate refuge, island, and target species of the photo taken	GBY Plum P HAU_3	X
Photo_Point	Photo_Direction	Azimuth	140	X
Photo_Point	Comments	Additional relevant notes about the photo point location	captures half of the total infestation	
Obs_Event	Photo_Obs_ID	Unique label to indicate refuge, island, and target species of the photo taken (same as Photo_Point/Photo_ID). Generated automatically from Photo_ID	GBY_Plum_P HAU_3	X
Obs_Event	Date	Date of observation event	5/7/2018	X
Obs_Event	Comments	Additional relevant notes about photo point observation event	6 months post-treatment	
Obs_Event	Photos and Files	Photographs taken for observation event		

Table 1-3. Description of layers and metadata collected for USFWS Plant Invasive Location AGOL feature layer. There are three separate feature layer with the same metadata for mapping invasive species as a point, line, or polygon. Each feature layer contains only one layer/table. Data collect automatically by device that is hidden from the surveyor was not included in the metadata table (e.g., GPS location)

Display Name	Definitions and Values	Example	Required
Observer Name	Full names of surveyors	Josh Cohen; Jesse Lincoln	X
Observer Type	Affiliation of surveyors	University	
First Observation Date	Date-time of observation	07/21/2021, 4:45 PM	X
Select species	Accepted common name of invasive plant species	Leafy spurge	X
Growth Stage of Target	Current plant phenology of the majority of documented infestation	Pre-seed	
Approx. infestation area (sq. ft)	Estimate of area occupied by invasive plant species in square feet	55	X (if a point or line)
% of area infested	Percentage cover of invasive plant species inside occupied area	20%	X (if a polygon)
% of infestation that is under control, if applicable	What proportion of infestation is dead or dying from treatment	0%	
Funding Source	how was data collection funded	MNFI co-op grant	
General notes and comments	Additional relevant notes about invasive species population	near hiking trail	

Table 1-4. Description of layers and metadata collected for USFWS Plant Chemical AGOL feature layer. There are three separate feature layers with the same metadata for mapping invasive species as a point, line, or polygon. Each feature layer contains only one layer/table. Data collected automatically by the device that is hidden from the surveyor was not included in the metadata table (e.g., GPS location)

Display Name	Definitions and Values	Example	Required
Operator Name	Full name of applicator	John Doe	X
Operator Type	Affiliation of applicator	Contractor-Private	
Start Date	Start date of chemical treatment	10/3/2021	X
End Date (if different)	For multiday efforts, this is the end date of treatment	10/4/2021	
Pesticide Use Permit Number	PUP number	R3-21-31540-005	
Application Method	Type of chemical application	Foliar	
Application Equipment	type of equipment used to apply herbicide	backpack sprayer	
Total person Hours	Time spent (hours only) used to estimate treatment costs for reporting	2	
Approx area treat (sq. ft.)	Estimate of area treated in square feet	55	X (if a point or line)
Chemical 1 Trade Name	Enter the trade name of primary chemical. Long list, start typing to filter choices. If not found, please enter Other (see comments) and add it in the Comments field	Rodeo	X
Chemical 1 Concentration (number)	quantity or percentage of primary chemical in tank mix	3	
Chemical 1 Concentration (units)	measurement unit of primary chemical concentration	% solution	
Chemical 2 Trade Name	Enter the trade name of primary chemical. Long list, start typing to filter choices. If not found, please enter Other (see comments) and add it in the Comments field	Imazapyr 2 SL	
Chemical 2 Concentration (number)	quantity or percentage of primary chemical in tank mix	2	
Chemical 2 Concentration (units)	measurement unit of primary chemical concentration	% solution	
Quantity of solution applied	amount of herbicide used	0.5	X
Units for Quantity	units for amount of herbicide used	gallons	X
Primary Target Species	Primary target species. Long list, start typing common name or scientific name to filter list	purple loosestrife	X
Growth Stage of Target	Growth stage of the Primary Target Species	flowering	
Air Temperature	Degrees in Fahrenheit	82	
% Cloud Cover	number 0 to 100. Approximate % cloud cover	25	
Wind Direction	Direction the wind is coming from	North	
Est. wind speed	Wind speed in miles per hour (MPH)	10	
% chance of rain in next 72 hours	number 0 to 100. Determined from weather predictions	35	
% humidity during application	number 0 to 100. Approximate humidity	40	
Fire Funded Treatment	Yes or No	No	
Funding Source	how was data collection funded	MNFI co-op grant	

Display Name	Definitions and Values	Example	Required
General notes and comments	Any further comment, including info on fields that you selected Other (see comments) on above. 1500 character limit	Likely did not treat all plants. Very difficult to see with reed canary and other grasses in the way	

Table 1-5. Description of layers and metadata collected for USFWS Plant Chemical Search AGOL feature layer. There are three separate feature layers with the same metadata for mapping invasive species as a point, line, or polygon. Each feature layer contains only one layer/table. Data collected automatically by the device that is hidden from the surveyor was not included in the metadata table (e.g., GPS location)

Display Name	Definitions and Values	Example	Required
Primary Target Species	Primary target species. Long list, start typing common name or scientific name to filter list	European frog-bit	X
Search Date	Date of search effort	9/2/2021	X
Search Method	ATV/UTV, on foot, car or truck, other	Other	X
Relative Search Intensity	Incidental, Exhaustive, Formal Inventory, or Other (provide in Comment field)	Incidental	X
Approximate Search Width	for linear searches, search area width in feet	100	X for lines
Participant Names	Full name(s) of searchers	Jane Doe, John Doe	X
Fire Funded Treatment	Yes or No	No	
Funding Source	How was data collection funded	station funds	
General notes and comments	Any further comment, including info on fields that you selected Other (see comments) on above. 1500 character limit	visual search by airboat	

Appendix 2: Documenting Invasive Species to USFWS AGOL Features using ArcGIS Collector App

The USFWS Project Data Manager creates ArcGIS Online (AGOL) groups on a project-by-project basis to grant access of feature layers to data contributors. A contributor to these feature layers must have an AGOL organizational user account and be invited to the group by the Data Manager. This project had access to layers for "Plant Invasion Location", "Plant Chemical", and "Photo Point Survey". Other projects may be granted access to additional or different feature layers.

Feature layers are named for the type of data they contain (e.g., plant observation, treatment type) and the geometric shape (i.e., point, line, polygon) of the data within the feature like "Plant Invasive Location – Point". The data requirements and additional data fields remain the same per type of data regardless of shape (Appendix 1). There are two ways new data can be added to feature layers: 1) new records can be created, and 2) new data can be added to an existing feature record via a related table. Adding data to existing feature records via a related table is meant to group location revisit and retreatment data together to facilitate the appearance of trends. This action is most common in relation to treatment efficacy monitoring with the Photo Point Survey feature layer. Table 2-1 describes examples of desired actions of a data contributor with new data, the most appropriate feature layer, and required data of that feature layer.

Table 2-1. Action to feature layer guide. The "Action" column describes what the user wants to do with the new information they've gathered. The "Feature Layer" directs them to the appropriate feature layer and related table. Brackets […] indicate that the title of the feature layer may change based on the item in the bracket. For existing records that need new data added, the feature layer is named before the slash (/) and the related table where the new data is added is listed after the slash (/).

Action	Feature Layer [5]	Required data to enter by user
Create new invasive species infestation record as a point	Plant Invasive Location – Point	Observer Name, First Observation Date, Select species
Create new invasive species infestation record as a line	Plant Invasive Location – Line	Observer Name, First Observation Date, Select species
Create new invasive species infestation record as a polygon	Plant Invasive Location – Polygon	Observer Name, First Observation Date, Select species
Add new monitoring information to *existing* invasive species infestation record	Plant Invasive Location – [Shape] / Table – Plant Monitoring	Monitoring Date, % Control, Assessment Method
Create new chemical treatment area	Plant Chemical – [Shape]	Operator Name, Start Date, Chemical1 Trade Name, Chemical2 Trade Name, Primary Target Species,
Create new mechanical treatment area	Plant Mechanical – [Shape]	Operator Name, Start Date, Action Type
Add new information to *existing* invasive species treatment record	Plant [Treatment Type] – [Shape] / Table - Plant Monitoring	Monitoring Date, % Control, Assessment Method
Create new photo point for treatment area	Photo Point Survey	Photo_ID, Photo_Direction
Add new photo to *existing* photo point	Photo Point Survey / Obs_Event	Date, Take/Attach photo

[5]Feature Layer Names may differ slightly to user based on naming in AGOL Group/Map by USFWS Data manager

The following procedure describes the preparation and procedure to follow to collect data and map features offline in the field to AGOL features such as "Plant Invasive Location - Point", "Photo Point Survey", and various invasive species management feature layers using ArcGIS Collector app (Esri 2020, Esri 2022b). Fields/data collected for each feature layer will differ. You must have an AGOL username from an organization and be granted access to a AGOL group with the feature layers or map you are contributing to in order to use the features mentioned here.

Element 1: Before entering the field…

These steps require connection to mobile data or wi-fi

1. Download ArcGIS Collector App
    a. Go to your device's Store App
    b. Search for "ArcGIS Collector"
    c. Download app
    d. Warning: ESRI is no longer updating the ArcGIS Collector App beyond 2020 in their conversion to ESRI FieldMaps App (Esri 2022a). At the time of this report, the FieldMaps app did not yet have all of the capabilities needed to collect data for these layers
2. Add offline maps
    a. Open ArcGIS Collector App on your device
    b. Sign in using your AGOL username associated with the USFWS group that contains the Feature Layers and Maps you wish to access in the field
    c. On the home page, select the Group with the Map you wish to download for offline use
    d. Select the Map from the Group
    e. Tap the three dot menu in the upper right
    f. Selected "Add Offline Area"
    g. Here you have two feature to select: 1) the map area, 2) the map detail.
    h. Using two fingers to zoom in and out of the map on the device. Fit the box to the area you want to download
    i. Tap on the blue word after "Level of detail" (e.g., Room, Building, City). Select the level of detail you want for your map. The finest detail settings are near the top of the list.
        i. If the area you wanted to download did not fit within the box, you can decrease the "Level of detail". This will increase the size of the box
        ii. If you do not want a courser "Level of detail" to get a map of your entire area of interest, you may want to download several maps of finer detail (e.g., Big Charity Island North, Big Charity Island South)
    j. When you have the map area and level of detail you, tap "Download Area"
    k. Once the map is downloaded, it should be listed as "On device"
    l. Tap the three dot menu to the right of your new map
    m. Select "Rename area"
    n. Type in your name for the map.
    o. Tap "OK"
3. Sync map before entering the field

a. If significant time has passed between when you downloaded the map for offline use and the time you are heading to field to use it, you may want to Sync the map to get the most up to date version
b. Open ArcGIS Collector App on your device
c. Sign in using your AGOL username associated with the USFWS group that contains the Feature Layers and Maps you wish to access in the field
d. On the home page, select the Group with the Map you wish to download for offline use
e. Select the Map from the Group
f. Your map should be listed here
g. Tap the three dot menu to the right of your new map
h. Select "Sync"
i. Under the map name, the most recent "Sync" date will be listed

Element 2: In the field…

These steps may be completed in "Airplane" mode with "Location" on and "Wi-Fi" off

1. Add records to offline Map Feature Layers
    a. Open ArcGIS Collector App on your device
    b. On the home page, select the Group with the Map you wish to download for offline use
    c. You should see all the Maps you downloaded in a list
    d. Tap on the Map you wish to add records to
    e. Find your location
        i. If in the field with "Location" on, you can center your location using the target button in the right. If there is not a dot in the center of the target, your location may not be on or your may not be on the map
        ii. If you want to select the location manually, zoom into the location and try to center the map at the point as best you can

    f. Tap the blue "+" icon in the bottom right
    g. Because of inherent uncertainty, your location could be anywhere within the circle surrounding the "+" on the map. Use two fingers to adjust the size of the uncertain circle and where the "+" on the map is located.

    h. Select the Feature Layer for which you want to add a record
    i. Complete the feature record.
    j. Tap "update point" if you have altered the location
    k. To add record, tap the check mark in the upper right when finished.
    l. To discard record, tap the "x" in the upper left when finished
2. To edit or add observation to existing record
    a. Zoom into the record feature on the map
    b. Tap on the feature record you wish to edit
    c. Several feature records may be listed, select the one you wish to edit
        i. Tap the pencil icon to edit the feature
            1. Edit the fields need
        ii. Tap the chain link to add an observation or other linked table
            1. Tab the blue "Add" button

2. Add date, comments, and take/attach photographs

iii. To save changes, tap the check mark in the upper right

iv. To discard changes, tap the "x" in the upper left

Element 3: After returning from the field…

These steps require connection to mobile data or wi-fi

1. Sync field collected or edited data with AGOL Map
    a. Tap the three dot menu to the right of your new map
    b. Select "Sync"
    c. Under the map name, the most recent "Sync" date will be listed
    d. Now your added/edited data is visible on AGOL Map to all members
2. Delete a feature record
    a. Open ArcGIS Collector App on your device
    b. Sign in using your AGOL username associated with the USFWS group that contains the Feature Layers and Maps you wish to access in the field
    c. On the home page, select the Group with the Map you wish to download for offline use
    d. Select the Map from the Group
    e. Select the offline map with the feature record you need to delete
    f. Tap and select the feature
    g. Search for a "Record Status" or similar field.
        i. If feature has such a field, select "Delete record" from list of options
    h. If feature does not have such a field, add a "Delete record" note to the "Comment" field To save changes, tap the check mark in the upper right
    i. To discard changes, tap the "x" in the upper left
    j. Follow the directions to "1. Sync field collected or edited data with AGOL Map" above
    k. The feature record may still appear on the Map for some time until data manager deletes the record.

Appendix 3. IPIEDPT Reports

Natural community areas and invasive species were ranked using the Invasive Plant Inventory and Early Detection Prioritization Tool (IPIEDPT). This tool was developed by the USFWS Inventory and Monitoring Initiative (Region 8) and Utah State University (USFWS 2016). The original objective of this tool was to identify areas for plant surveys and monitoring. In this IPMP it was used to identify potential threats and watch list species for each island area. For more details on species scores and ranking see Chapter 2: Prioritization of Species and Management Areas.

When prioritizing areas among the four surveyed Green Bay NWR islands (i.e., Detroit, Plum, Poverty, St. Martin), the IPIEDPT area prioritization results were not used. The emphasis on invasive species monitoring was evident when areas that had little to no invasive species present were ranked in the highest tier. Instead MNFI deferred to a "Stewardship Prioritization" matrix (See Chapter 2: Prioritization of Species and Management Areas; Cohen et al. 2022).

Although the results were not used, we included a description of the IPIEDPT ranked factors for area prioritization and the results here (Table 1-1). The ranked factors fell into three categories, each with multiple factors:

- Area description (weighted 0.4)
    - Ecological integrity
    - Innate resistance to invasion
    - Importance to Federal or State-listed species
    - Importance to other priority natural resources of conservation
- Invasion risk (weighted 0.3)
    - Relative to terrestrial pathways
    - Relative to aquatic pathways
    - Relative to transport vectors
    - Relative to anthropogenic disturbances
- Invasive plant status (weighted 0.3)
    - Relative to most recent inventory and monitoring event
    - Relative to overall infestation level
    - Number of invasive plant species present in area

The scores of each category were averaged (mean), weighed, then the three category scores were summed to derive the total score for the area. IPIEDPT default weights were used for each category.

For area description factors, categorical rankings were determined using 2021 ecological survey data and notes, NatureServe-MNFI resilience rankings of the natural community, NatureServe-MNFI biodiversity rankings of the natural community, NatureServe-MNFI state rarity score of natural community in Michigan, and expert opinion (Cohen et al. 2019, Cohen et al. 2022). For invasion risk factors, categorical rankings were determined using 2021 ecological survey data and notes; geospatial variables of proximity to shoreline and presence of trails, roads, human structures; evidence of past logging, and expert opinion (Cohen et al. 2022). For invasive plant status factors, categorical rankings were determined using the invasives species population data

described in Chapter 2: Methods – Information Gathering. All areas had been comprehensively monitored within the last five years. Opinions on the highest value natural areas during the 2021 surveys were shared in virtual meetings among MNFI, USFWS, Horicon NWR Complex, and Lake-2-Lake CISMA, and applied as expert opinion where applicable.

Table 3-1. IPIEDPT area prioritization scores for Green Bay NWR. Plum Island areas are bolded. MNFI Stewardship Score Sum was included for comparison (Cohen et al. 2022).

Island	Area	EO ID	EO Rank	Description Score	Risk Score	Status Score	Total Score	MNFI Stewardship Score Sum
Detroit	Sand and gravel beach / Great Lakes beach	24387	BC	1.7	1.8	2.1	**5.6**	**7**
Plum	**Great Lakes marsh / emergent marsh**	**24367**	**C**	**2.8**	**1.8**	**0.5**	**5.1**	**9**
St. Martin	Limestone cliff	24350	B	1.8	1.2	1.8	**4.8**	**9.25**
St. Martin	Limestone lakeshore cliff	24348	A	1.8	1.2	1.8	**4.8**	**10**
St. Martin	Limestone cobble shore	24353	B	1.7	1.2	1.8	**4.7**	**9.25**
Detroit	Limestone lakeshore cliff / moist cliff	24372	BC	1.4	1.8	1.4	**4.6**	**8.5**
Detroit	Limestone cliff / dry cliff	24373	BC	1.4	1.5	1.5	**4.4**	**7.25**
Detroit	Limestone cobble shore / Great Lakes alkaline rockshore	24375	BC	1.7	1.8	0.9	**4.4**	**9.5**
Detroit	Limestone bedrock lakeshore / Great Lakes alkaline rockshore	24374	B	1.8	1.8	0.5	**4.1**	**10**
Plum	**Mesic northern forest**	**24369**	**D**	**2.3**	**1.5**	**0.3**	**4.1**	**8**
St. Martin	Mesic northern forest	24349	BC	2.7	0.9	0.5	**4.1**	**9**
Plum	**Limestone cobble shore / Great Lakes alkaline rockshore**	**24370**	**C**	**1.3**	**1.8**	**0.9**	**4.0**	**8.5**
Poverty	Limestone bedrock lakeshore	4159	AB	2.5	0.9	0.5	**3.9**	**10.5**
Poverty	Limestone lakeshore cliff	1437	A	2.1	0.9	0.9	**3.9**	**10**
Plum	**Limestone lakeshore cliff / moist cliff**	**24368**	**C**	**1.4**	**1.8**	**0.5**	**3.7**	**8.5**
Detroit	Disturbed mesic northern forest	---	---	1.6	1.5	0.3	**3.4**	---
St. Martin	Lighthouse	---	---	1.1	1.8	0.3	**3.2**	---
St. Martin	South dock	---	---	1.1	1.8	0.3	**3.2**	---
St. Martin	Northern hardwood swamp	24352	C	1.3	0.9	0.9	**3.1**	**8.5**
Plum	**Disturbed boreal forest**	**---**	**---**	**1.1**	**1.5**	**0.3**	**2.9**	---
St. Martin	Boreal forest north	24351	B	1.3	0.9	0.5	**2.7**	**8.5**
St. Martin	Boreal forest south	24351	B	1.3	0.9	0.5	**2.7**	**8.5**
Poverty	Boreal forest	7488	B	1.3	0.4	0.5	**2.2**	**10.5**

Table 3-2. IPIEDPT species prioritization scores. As bush honeysuckle (*Lonicera* sp.) observed on the island all have the same NatureServe rankings, they are pooled together in the table.

Scientific Name ITIS	**Common Name**	**ITIS TSN**	**USDA Symbol**	**Invasiveness Score**	**Status Score**	**Impacts Score**	**Legal Score**	**Total Score**
Agrostis gigantea	redtop, black bent, water bentgrass	40414	AGGI2	0.6	4	0.3	0	4.9
Arctium minus	lesser burdock,burrdock, burdock, small burdock, smaller burdock, bardane, beggar's button, common burdock, wild burdock, wild rhubarb	36546	ARMI2	0.2	4	0.9	0	5.1
Alliaria petiolata	Garlic mustard	184481	ALPE4	1.4	4	3	1	9.4
Berberis thunbergii	Japanese barberry	18835	BETH	1.4	3.6	3	1	9
Centaurea stoebe ssp. *micranthos*	spotted knapweed	780711	CEST8	1.4	3.6	3	1	9
Cerastium fontanum ssp. *vulgare*	common mouse-ear chickweed, big chickweed, mouseear chickweed	523831	CEFOV2	0	3.6	0.3	0	3.9
Cirsium arvense	Canada thistle, Canadian thistle, Californian thistle, creeping thistle, field thistle	36335	CIAR4	1.4	3.07	2.1	1	7.57
Cirsium palustre	marsh thistle	36394	CIPA6	0.6	3.07	2.1	1	6.77
Cirsium vulgare	bull thistle, common thistle, spear thistle	36428	CIVU	0.6	3.07	2.1	1	6.77
Cynoglossum officinale	houndstongue, gypsy-flower, common houndstongue, hound's tongue, gypsyflower	31890	CYOF	0.6	3.07	2.1	1	6.77
Dactylis glomerata	cocksfoot, orchardgrass, orchard grass	193446	DAGL	0.2	3.6	0.3	0	4.1
Daucus carota	bird's nest, wild carrot, Queen Anne's lace	29477	DACA6	0.2	3.6	0.3	1	5.1
Elaeagnus umbellata	oleaster, autumn olive, autumn-olive	27776	ELUM	0.2	4	0.9	1	6.1
Elymus repens	quackgrass	512839	ELRE4	1.4	4	0.3	0	5.7
Epilobium parviflorum	Smallflower hairy willow herb	27321	EPPA5	1	4	0.3	0	5.3
Epipactis helleborine	broadleaf helleborine, helleborine	43482	EPHE	0.6	3.07	0.3	1	4.97
Erysimum cheiranthoides	Wormseed wallflower	22933	ERCH9	1	3.6	0.3	0	4.9
Euphorbia esula	spurge, wolf's milk, wolf's-milk, leafy spurge	28064	EUES	1.4	3.6	2.1	1	8.1
Fallopia convolvulus	black bindweed, wild buckwheat	513511	POCO10	0.2	3.2	0.3	0	3.7
Galeopsis tetrahit	bristlestem hempnettle, brittle-stem hemp-nettle, common hempnettle	32499	GATE2	0.2	3.6	0.3	1	5.1
Galium sylvaticum	Scotch mist	34930	GASY	0.2	3.6	0.3	0	4.1

Scientific Name ITIS	Common Name	ITIS TSN	USDA Symbol	Invasiveness Score	Status Score	Impacts Score	Legal Score	Total Score
Hesperis matronalis	dame's rocket, dames violet, mother-of-the-evening, dames rocket, damesrocket	23138	HEMA3	0.6	4	2.1	1	7.7
Hieracium aurantiacum	orange hawkweed	37697	HIAU	0.6	3.6	0.3	0	4.5
Hieracium caespitosum	meadow hawkweed, yellow hawkweed	503009	HICA10	0.2	3.6	0.3	0	4.1
Hypericum perforatum	St. John's wort, common St. John's wort, Klamathweed, Klamath weed, St. Johnswort, common St. Johnswort	21454	HYPE	1.4	2.67	0.3	0	4.37
Leonurus cardiaca	Motherwort	32548	LECA2	0.2	3.6	0.3	0	4.1
Leucanthemum vulgare	oxeye daisy, oxeye-daisy, oxeyedaisy, ox-eye daisy	37903	LEVU	0.6	3.07	0.3	0	3.97
Linaria vulgaris	butter and eggs, greater butter-and-eggs, yellow toadflax, flaxweed, Jacob's ladder, ramsted, wild snapdragon	33216	LIVU2	1	3.07	0.3	0	4.37
Lonicera sp.	bush honeysuckle	35286	LOBE	1.4	3.07	3	1	8.47
Lythrum salicaria	purple lythrum, rainbow weed, spiked loosetrife, purple loosestrife	27079	LYSA2	2	4	2.1	1	9.1
Medicago lupulina	black medick, black medic clover, black medic, hop clover, hop medic, nonesuch, yellow trefoil	503721	MELU	0.2	4	0.3	0	4.5
Melilotus albus	Bokhara-clover, honey-clover, white melilot, white sweet-clover	516979	MEALA2	0.2	4	2.1	0	6.3
Nepeta cataria	Cat-nip	32623	NECA2	0.2	3.07	0.3	0	3.57
Panicum miliaceum	Proso millet	792496	PAMI2	0	3.6	0.3	0	3.9
Pastinaca sativa	wild parsnip	29795	PASA2	0.2	4	2.1	1	7.3
Persicaria maculosa	spotted ladysthumb, ladysthumb	823821	POPE3	0.2	3.6	0.3	0	4.1
Phalaris arundinacea	reed canary grass, reed canarygrass	41335	PHAR3	2	3.07	3	1	9.07
Phleum pratense	common timothy, timothy	41062	PHPR3	1	3.6	0.3	0	4.9
Phragmites australis ssp. *australis*	common reed	41072	PHAU7	2	4	2.1	1	9.1
Picea abies	Norway spruce	183289	PIAB	0.2	3.6	0.3	0	4.1
Poa annua	annual blue grass, walkgrass, annual bluegrass	41107	POAN	0.2	3.07	0.3	0	3.57
Poa compressa	Canada bluegrass, flat-stem blue grass	41082	POCO	1	2.8	0.3	0	4.1
Poa nemoralis	Wood bluegrass	41146	PONE	0.2	3.07	0.3	0	3.57

Scientific Name ITIS	Common Name	ITIS TSN	USDA Symbol	Invasiveness Score	Status Score	Impacts Score	Legal Score	Total Score
Poa pratensis	Kentucky bluegrass	41088	POPR	1	2.13	0.3	0	3.43
Populus alba	white poplar	22451	POAL7	1	3.6	0.9	1	6.5
Ranunculus acris	meadow buttercup, tall buttercup	18583	RAAC3	0.2	3.6	0.3	0	4.1
Rosa multiflora	multiflora rose	24833	ROMU	0.6	3.6	2.1	1	7.3
Rumex obtusifolius	bluntleaf dock, bitter dock, broadleaf dock	20939	RUOB	0.2	3.6	0.3	0	4.1
Saponaria officinalis	soapwort, bouncingbet, bouncingbet soapweed, bouncing bet, sweet Betty	20039	SAOF4	0.2	4	0.3	0	4.5
Schedonorus pratensis	Meadow fescue	784877	SCPR4	0.2	4	0.3	0	4.5
Sedum acre	Goldmoss stonecrop	24105	SECA	1	3.07	0.3	0	4.37
Silene ~~latifolia~~	blader campion, bladder-campion, white campion	565517	SILA21	0.2	3.6	0.3	0	4.1
Silene vulgaris	bladder silene, maiden's-tears, bladder campion, cowbell, maiden's tears, rattleweed, maidenstears	20142	SIVU	0.2	3.6	0.3	0	4.1
Solanum dulcamara	climbing nightshade, bitter nightshade, bittersweet nightshade, blue nightshade, European bittersweet, fellenwort, woody nightshade	30414	SODU	0.2	2.8	0.9	1	4.9
Taraxacum officinale	common dandelion, blowball, faceclock, dandelion	36213	TAOF	0.2	3.07	0.3	0	3.57
Torilis japonica	Erect hedge parsley	29895	TOJA	1	3.6	0.3	1	5.9
Tragopogon pratensis	Jack-go-to-bed-at-noon	38569	TRPR	0	4	0.3	0	4.3
Trifolium fragiferum	Strawberry clover	26251	TRFR2	0.2	3.07	0.3	0	3.57
Trifolium pratense	red clover	26313	TRPR2	0.2	4	0.3	0	4.5
Typha angustifolia	narrowleaf cattail, narrow-leaf cat-tail	42325	TYAN	1.4	3.6	3	1	9
Valeriana officinalis	garden heliotrope, garden valerian, common valerian	35363	VAOF	0.2	4	2.1	1	7.3
Verbascum thapsus	big taper, flannel plant, velvet dock, velvet plant, woolly mullein, flannel mullein, great mullein, mullein, common mullein	33394	VETH	1	3.07	0.3	0	4.37
Veronica officinalis	Common gypsy-weed	33398	VEOF2	1	3.6	0.3	0	4.9
Veronica serpyllifolia	Thyme-leaf speedwell	33423	VESE	0.2	4	0.3	0	4.5
Viburnum opulus	European cranberry-bush	35270	VIOP	0.6	3.6	0.9	0	5.1

Table 3-3. IPIEDPT area-species link scores for Plum Island, sorted by species. Table 9 through Table 13 list scores for each area.

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Boreal forest	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Plum Great Lakes marsh	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Plum Limestone cobble shore	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Plum Limestone lakeshore cliff	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Plum Mesic northern forest	*Agrostis gigantea*	5	0	10	15	4.9	19.9
Plum Boreal forest	*Alliaria petiolata*	5	0	10	15	9.4	24.4
Plum Great Lakes marsh	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Plum Limestone cobble shore	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Plum Limestone lakeshore cliff	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Plum Mesic northern forest	*Alliaria petiolata*	5	0	10	15	9.4	24.4
Plum Boreal forest	*Arctium minus*	10	0	10	20	5.1	25.1
Plum Great Lakes marsh	*Arctium minus*	10	0	10	20	5.1	25.1
Plum Limestone cobble shore	*Arctium minus*	10	0	10	20	5.1	25.1
Plum Limestone lakeshore cliff	*Arctium minus*	10	5	10	25	5.1	30.1
Plum Mesic northern forest	*Arctium minus*	10	0	10	20	5.1	25.1
Plum Boreal forest	*Berberis thunbergii*	10	1	10	21	9	30
Plum Great Lakes marsh	*Berberis thunbergii*	10	5	5	20	9	29
Plum Limestone cobble shore	*Berberis thunbergii*	10	5	5	20	9	29
Plum Limestone lakeshore cliff	*Berberis thunbergii*	10	0	1	11	9	20
Plum Mesic northern forest	*Berberis thunbergii*	10	1	10	21	9	30
Plum Boreal forest	*Centaurea stoebe* ssp. *micranthos*	10	0	1	11	9	20
Plum Great Lakes marsh	*Centaurea stoebe* ssp. *micranthos*	10	5	5	20	9	29
Plum Limestone cobble shore	*Centaurea stoebe* ssp. *micranthos*	10	5	10	25	9	34
Plum Limestone lakeshore cliff	*Centaurea stoebe* ssp. *micranthos*	10	10	10	30	9	39
Plum Mesic northern forest	*Centaurea stoebe* ssp. *micranthos*	10	0	1	11	9	20
Plum Boreal forest	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Plum Great Lakes marsh	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Plum Limestone cobble shore	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Plum Limestone lakeshore cliff	*Cerastium fontanum* ssp. *vulgare*	10	7	10	27	3.9	30.9

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Mesic northern forest	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Plum Boreal forest	*Cirsium arvense*	10	0	10	20	7.57	27.57
Plum Great Lakes marsh	*Cirsium arvense*	10	0	5	15	7.57	22.57
Plum Limestone cobble shore	*Cirsium arvense*	10	0	10	20	7.57	27.57
Plum Limestone lakeshore cliff	*Cirsium arvense*	10	0	10	20	7.57	27.57
Plum Mesic northern forest	*Cirsium arvense*	10	7	10	27	7.57	34.57
Plum Boreal forest	*Cirsium palustre*	10	0	10	20	6.77	26.77
Plum Great Lakes marsh	*Cirsium palustre*	10	1	10	21	6.77	27.77
Plum Limestone cobble shore	*Cirsium palustre*	10	0	10	20	6.77	26.77
Plum Limestone lakeshore cliff	*Cirsium palustre*	10	0	10	20	6.77	26.77
Plum Mesic northern forest	*Cirsium palustre*	10	1	10	21	6.77	27.77
Plum Boreal forest	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Plum Great Lakes marsh	*Cirsium vulgare*	10	10	10	30	6.77	36.77
Plum Limestone cobble shore	*Cirsium vulgare*	10	0	10	20	6.77	26.77
Plum Limestone lakeshore cliff	*Cirsium vulgare*	10	10	10	30	6.77	36.77
Plum Mesic northern forest	*Cirsium vulgare*	10	10	10	30	6.77	36.77
Plum Boreal forest	*Cynoglossum officinale*	10	5	10	25	6.77	31.77
Plum Great Lakes marsh	*Cynoglossum officinale*	10	10	10	30	6.77	36.77
Plum Limestone cobble shore	*Cynoglossum officinale*	10	5	10	25	6.77	31.77
Plum Limestone lakeshore cliff	*Cynoglossum officinale*	10	1	10	21	6.77	27.77
Plum Mesic northern forest	*Cynoglossum officinale*	10	5	10	25	6.77	31.77
Plum Boreal forest	*Dactylis glomerata*	10	0	5	15	4.1	19.1
Plum Great Lakes marsh	*Dactylis glomerata*	10	0	5	15	4.1	19.1
Plum Limestone cobble shore	*Dactylis glomerata*	10	0	5	15	4.1	19.1
Plum Limestone lakeshore cliff	*Dactylis glomerata*	10	7	5	22	4.1	26.1
Plum Mesic northern forest	*Dactylis glomerata*	10	7	5	22	4.1	26.1
Plum Boreal forest	*Daucus carota*	10	0	5	15	5.1	20.1
Plum Great Lakes marsh	*Daucus carota*	10	0	5	15	5.1	20.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Limestone cobble shore	*Daucus carota*	10	0	5	15	5.1	20.1
Plum Limestone lakeshore cliff	*Daucus carota*	10	7	5	22	5.1	27.1
Plum Mesic northern forest	*Daucus carota*	10	0	5	15	5.1	20.1
Plum Boreal forest	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Plum Great Lakes marsh	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Plum Limestone cobble shore	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Plum Limestone lakeshore cliff	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Plum Mesic northern forest	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Plum Boreal forest	*Elymus repens*	5	0	5	10	5.7	15.7
Plum Great Lakes marsh	*Elymus repens*	5	0	5	10	5.7	15.7
Plum Limestone cobble shore	*Elymus repens*	5	0	10	15	5.7	20.7
Plum Limestone lakeshore cliff	*Elymus repens*	5	0	10	15	5.7	20.7
Plum Mesic northern forest	*Elymus repens*	5	0	5	10	5.7	15.7
Plum Boreal forest	*Epilobium parviflorum*	5	0	1	6	5.3	11.3
Plum Great Lakes marsh	*Epilobium parviflorum*	5	0	10	15	5.3	20.3
Plum Limestone cobble shore	*Epilobium parviflorum*	5	0	10	15	5.3	20.3
Plum Limestone lakeshore cliff	*Epilobium parviflorum*	5	0	10	15	5.3	20.3
Plum Mesic northern forest	*Epilobium parviflorum*	5	0	1	6	5.3	11.3
Plum Boreal forest	*Epipactis helleborine*	10	7	10	27	4.97	31.97
Plum Great Lakes marsh	*Epipactis helleborine*	10	0	1	11	4.97	15.97
Plum Limestone cobble shore	*Epipactis helleborine*	10	0	1	11	4.97	15.97
Plum Limestone lakeshore cliff	*Epipactis helleborine*	10	10	1	21	4.97	25.97
Plum Mesic northern forest	*Epipactis helleborine*	10	7	10	27	4.97	31.97
Plum Boreal forest	*Erysimum cheiranthoides*	10	0	5	15	4.9	19.9
Plum Great Lakes marsh	*Erysimum cheiranthoides*	10	7	10	27	4.9	31.9
Plum Limestone cobble shore	*Erysimum cheiranthoides*	10	7	10	27	4.9	31.9
Plum Limestone lakeshore cliff	*Erysimum cheiranthoides*	10	0	10	20	4.9	24.9
Plum Mesic northern forest	*Erysimum cheiranthoides*	10	0	5	15	4.9	19.9
Plum Boreal forest	*Euphorbia esula*	5	0	5	10	8.1	18.1
Plum Great Lakes marsh	*Euphorbia esula*	5	0	1	6	8.1	14.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Limestone cobble shore	*Euphorbia esula*	5	0	5	10	8.1	18.1
Plum Limestone lakeshore cliff	*Euphorbia esula*	5	0	5	10	8.1	18.1
Plum Mesic northern forest	*Euphorbia esula*	5	0	5	10	8.1	18.1
Plum Boreal forest	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Plum Great Lakes marsh	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Plum Limestone cobble shore	*Fallopia convolvulus*	10	7	5	22	3.7	25.7
Plum Limestone lakeshore cliff	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Plum Mesic northern forest	*Fallopia convolvulus*	10	0	5	15	3.7	18.7
Plum Boreal forest	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Plum Great Lakes marsh	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Plum Limestone cobble shore	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Plum Limestone lakeshore cliff	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Plum Mesic northern forest	*Galeopsis tetrahit*	10	7	10	27	5.1	32.1
Plum Boreal forest	*Galium sylvaticum*	5	0	10	15	4.1	19.1
Plum Great Lakes marsh	*Galium sylvaticum*	5	0	1	6	4.1	10.1
Plum Limestone cobble shore	*Galium sylvaticum*	5	0	1	6	4.1	10.1
Plum Limestone lakeshore cliff	*Galium sylvaticum*	5	0	1	6	4.1	10.1
Plum Mesic northern forest	*Galium sylvaticum*	5	0	10	15	4.1	19.1
Plum Boreal forest	*Hesperis matronalis*	10	0	10	20	7.7	27.7
Plum Great Lakes marsh	*Hesperis matronalis*	10	0	1	11	7.7	18.7
Plum Limestone cobble shore	*Hesperis matronalis*	10	0	1	11	7.7	18.7
Plum Limestone lakeshore cliff	*Hesperis matronalis*	10	0	1	11	7.7	18.7
Plum Mesic northern forest	*Hesperis matronalis*	10	5	10	25	7.7	32.7
Plum Boreal forest	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Plum Great Lakes marsh	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Plum Limestone cobble shore	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Plum Limestone lakeshore cliff	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Plum Mesic northern forest	*Hieracium aurantiacum*	5	0	10	15	4.5	19.5
Plum Boreal forest	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Plum Great Lakes marsh	*Hieracium caespitosum*	10	0	1	11	4.1	15.1
Plum Limestone cobble shore	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Plum Limestone lakeshore cliff	*Hieracium caespitosum*	10	7	5	22	4.1	26.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Mesic northern forest	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Plum Boreal forest	*Hypericum perforatum*	10	10	5	25	4.37	29.37
Plum Great Lakes marsh	*Hypericum perforatum*	10	0	1	11	4.37	15.37
Plum Limestone cobble shore	*Hypericum perforatum*	10	7	5	22	4.37	26.37
Plum Limestone lakeshore cliff	*Hypericum perforatum*	10	0	5	15	4.37	19.37
Plum Mesic northern forest	*Hypericum perforatum*	10	10	5	25	4.37	29.37
Plum Boreal forest	*Leonurus cardiaca*	10	0	5	15	4.1	19.1
Plum Great Lakes marsh	*Leonurus cardiaca*	10	0	1	11	4.1	15.1
Plum Limestone cobble shore	*Leonurus cardiaca*	10	0	5	15	4.1	19.1
Plum Limestone lakeshore cliff	*Leonurus cardiaca*	10	7	5	22	4.1	26.1
Plum Mesic northern forest	*Leonurus cardiaca*	10	0	5	15	4.1	19.1
Plum Boreal forest	*Leucanthemum vulgare*	10	0	5	15	3.97	18.97
Plum Great Lakes marsh	*Leucanthemum vulgare*	10	0	1	11	3.97	14.97
Plum Limestone cobble shore	*Leucanthemum vulgare*	10	7	10	27	3.97	30.97
Plum Limestone lakeshore cliff	*Leucanthemum vulgare*	10	7	10	27	3.97	30.97
Plum Mesic northern forest	*Leucanthemum vulgare*	10	7	5	22	3.97	25.97
Plum Boreal forest	*Linaria vulgaris*	10	5	5	20	4.37	24.37
Plum Great Lakes marsh	*Linaria vulgaris*	10	0	1	11	4.37	15.37
Plum Limestone cobble shore	*Linaria vulgaris*	10	1	10	21	4.37	25.37
Plum Limestone lakeshore cliff	*Linaria vulgaris*	10	1	10	21	4.37	25.37
Plum Mesic northern forest	*Linaria vulgaris*	10	5	5	20	4.37	24.37
Plum Boreal forest	*Lonicera x bella*	10	1	10	21	8.47	29.47
Plum Great Lakes marsh	*Lonicera x bella*	10	1	10	21	8.47	29.47
Plum Limestone cobble shore	*Lonicera x bella*	10	1	10	21	8.47	29.47
Plum Limestone lakeshore cliff	*Lonicera x bella*	10	1	10	21	8.47	29.47
Plum Mesic northern forest	*Lonicera x bella*	10	1	10	21	8.47	29.47
Plum Boreal forest	*Lythrum salicaria*	10	0	1	11	9.1	20.1
Plum Great Lakes marsh	*Lythrum salicaria*	10	10	10	30	9.1	39.1
Plum Limestone cobble shore	*Lythrum salicaria*	10	0	10	20	9.1	29.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Limestone lakeshore cliff	*Lythrum salicaria*	10	0	10	20	9.1	29.1
Plum Mesic northern forest	*Lythrum salicaria*	10	0	1	11	9.1	20.1
Plum Boreal forest	*Medicago lupulina*	5	0	5	10	4.5	14.5
Plum Great Lakes marsh	*Medicago lupulina*	5	0	1	6	4.5	10.5
Plum Limestone cobble shore	*Medicago lupulina*	5	0	10	15	4.5	19.5
Plum Limestone lakeshore cliff	*Medicago lupulina*	5	0	10	15	4.5	19.5
Plum Mesic northern forest	*Medicago lupulina*	5	0	10	15	4.5	19.5
Plum Boreal forest	*Melilotus albus*	5	0	5	10	6.3	16.3
Plum Great Lakes marsh	*Melilotus albus*	5	0	1	6	6.3	12.3
Plum Limestone cobble shore	*Melilotus albus*	5	0	10	15	6.3	21.3
Plum Limestone lakeshore cliff	*Melilotus albus*	5	0	10	15	6.3	21.3
Plum Mesic northern forest	*Melilotus albus*	5	0	5	10	6.3	16.3
Plum Boreal forest	*Nepeta cataria*	10	0	5	15	3.57	18.57
Plum Great Lakes marsh	*Nepeta cataria*	10	0	1	11	3.57	14.57
Plum Limestone cobble shore	*Nepeta cataria*	10	0	10	20	3.57	23.57
Plum Limestone lakeshore cliff	*Nepeta cataria*	0	0	0	0	3.57	3.57
Plum Mesic northern forest	*Nepeta cataria*	10	7	5	22	3.57	25.57
Plum Boreal forest	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Plum Great Lakes marsh	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Plum Limestone cobble shore	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Plum Limestone lakeshore cliff	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Plum Mesic northern forest	*Panicum miliaceum*	5	0	5	10	3.9	13.9
Plum Boreal forest	*Pastinaca sativa*	10	0	10	20	7.3	27.3
Plum Great Lakes marsh	*Pastinaca sativa*	10	0	10	20	7.3	27.3
Plum Limestone cobble shore	*Pastinaca sativa*	10	0	10	20	7.3	27.3
Plum Limestone lakeshore cliff	*Pastinaca sativa*	10	0	10	20	7.3	27.3
Plum Mesic northern forest	*Pastinaca sativa*	10	10	10	30	7.3	37.3
Plum Boreal forest	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Plum Great Lakes marsh	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Plum Limestone cobble shore	*Persicaria maculosa*	10	7	10	27	4.1	31.1
Plum Limestone lakeshore cliff	*Persicaria maculosa*	10	0	10	20	4.1	24.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Mesic northern forest	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Plum Boreal forest	*Phalaris arundinacea*	10	0	5	15	9.07	24.07
Plum Great Lakes marsh	*Phalaris arundinacea*	10	1	10	21	9.07	30.07
Plum Limestone cobble shore	*Phalaris arundinacea*	10	0	5	15	9.07	24.07
Plum Limestone lakeshore cliff	*Phalaris arundinacea*	10	0	5	15	9.07	24.07
Plum Mesic northern forest	*Phalaris arundinacea*	10	7	5	22	9.07	31.07
Plum Boreal forest	*Phleum pratense*	10	0	5	15	4.9	19.9
Plum Great Lakes marsh	*Phleum pratense*	10	0	5	15	4.9	19.9
Plum Limestone cobble shore	*Phleum pratense*	10	7	10	27	4.9	31.9
Plum Limestone lakeshore cliff	*Phleum pratense*	10	7	10	27	4.9	31.9
Plum Mesic northern forest	*Phleum pratense*	10	0	5	15	4.9	19.9
Plum Boreal forest	*Phragmites australis*	5	0	1	6	9.1	15.1
Plum Great Lakes marsh	*Phragmites australis*	5	0	10	15	9.1	24.1
Plum Limestone cobble shore	*Phragmites australis*	5	0	10	15	9.1	24.1
Plum Limestone lakeshore cliff	*Phragmites australis*	5	0	10	15	9.1	24.1
Plum Mesic northern forest	*Phragmites australis*	5	0	1	6	9.1	15.1
Plum Boreal forest	*Picea abies*	5	0	1	6	4.1	10.1
Plum Great Lakes marsh	*Picea abies*	5	0	1	6	4.1	10.1
Plum Limestone cobble shore	*Picea abies*	5	0	1	6	4.1	10.1
Plum Limestone lakeshore cliff	*Picea abies*	5	0	1	6	4.1	10.1
Plum Mesic northern forest	*Picea abies*	5	0	1	6	4.1	10.1
Plum Boreal forest	*Poa annua*	5	0	5	10	3.57	13.57
Plum Great Lakes marsh	*Poa annua*	5	0	5	10	3.57	13.57
Plum Limestone cobble shore	*Poa annua*	5	0	10	15	3.57	18.57
Plum Limestone lakeshore cliff	*Poa annua*	5	0	10	15	3.57	18.57
Plum Mesic northern forest	*Poa annua*	5	0	5	10	3.57	13.57
Plum Boreal forest	*Poa compressa*	10	0	10	20	4.1	24.1
Plum Great Lakes marsh	*Poa compressa*	10	0	1	11	4.1	15.1
Plum Limestone cobble shore	*Poa compressa*	10	7	5	22	4.1	26.1
Plum Limestone lakeshore cliff	*Poa compressa*	10	7	5	22	4.1	26.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Mesic northern forest	*Poa compressa*	10	0	10	20	4.1	24.1
Plum Boreal forest	*Poa nemoralis*	10	0	5	15	3.57	18.57
Plum Great Lakes marsh	*Poa nemoralis*	10	0	1	11	3.57	14.57
Plum Limestone cobble shore	*Poa nemoralis*	10	0	5	15	3.57	18.57
Plum Limestone lakeshore cliff	*Poa nemoralis*	10	7	10	27	3.57	30.57
Plum Mesic northern forest	*Poa nemoralis*	10	0	10	20	3.57	23.57
Plum Boreal forest	*Poa pratensis*	10	0	10	20	3.43	23.43
Plum Great Lakes marsh	*Poa pratensis*	10	0	1	11	3.43	14.43
Plum Limestone cobble shore	*Poa pratensis*	10	0	10	20	3.43	23.43
Plum Limestone lakeshore cliff	*Poa pratensis*	10	7	10	27	3.43	30.43
Plum Mesic northern forest	*Poa pratensis*	10	7	10	27	3.43	30.43
Plum Boreal forest	*Populus alba*	5	0	5	10	6.5	16.5
Plum Great Lakes marsh	*Populus alba*	5	0	1	6	6.5	12.5
Plum Limestone cobble shore	*Populus alba*	5	0	1	6	6.5	12.5
Plum Limestone lakeshore cliff	*Populus alba*	5	0	1	6	6.5	12.5
Plum Mesic northern forest	*Populus alba*	5	0	5	10	6.5	16.5
Plum Boreal forest	*Ranunculus acris*	10	7	10	27	4.1	31.1
Plum Great Lakes marsh	*Ranunculus acris*	10	0	5	15	4.1	19.1
Plum Limestone cobble shore	*Ranunculus acris*	10	0	10	20	4.1	24.1
Plum Limestone lakeshore cliff	*Ranunculus acris*	10	7	10	27	4.1	31.1
Plum Mesic northern forest	*Ranunculus acris*	10	7	10	27	4.1	31.1
Plum Boreal forest	*Rosa multiflora*	10	0	10	20	7.3	27.3
Plum Great Lakes marsh	*Rosa multiflora*	10	0	1	11	7.3	18.3
Plum Limestone cobble shore	*Rosa multiflora*	10	0	5	15	7.3	22.3
Plum Limestone lakeshore cliff	*Rosa multiflora*	10	10	5	25	7.3	32.3
Plum Mesic northern forest	*Rosa multiflora*	10	10	10	30	7.3	37.3
Plum Boreal forest	*Rumex obtusifolius*	10	0	10	20	4.1	24.1
Plum Great Lakes marsh	*Rumex obtusifolius*	10	0	5	15	4.1	19.1
Plum Limestone cobble shore	*Rumex obtusifolius*	10	0	5	15	4.1	19.1
Plum Limestone lakeshore cliff	*Rumex obtusifolius*	10	0	5	15	4.1	19.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Mesic northern forest	*Rumex obtusifolius*	10	0	10	20	4.1	24.1
Plum Boreal forest	*Saponaria officinalis*	10	0	10	20	4.5	24.5
Plum Great Lakes marsh	*Saponaria officinalis*	10	0	5	15	4.5	19.5
Plum Limestone cobble shore	*Saponaria officinalis*	10	7	10	27	4.5	31.5
Plum Limestone lakeshore cliff	*Saponaria officinalis*	10	0	10	20	4.5	24.5
Plum Mesic northern forest	*Saponaria officinalis*	10	0	10	20	4.5	24.5
Plum Boreal forest	*Schedonorus pratensis*	10	0	10	20	4.5	24.5
Plum Great Lakes marsh	*Schedonorus pratensis*	10	0	5	15	4.5	19.5
Plum Limestone cobble shore	*Schedonorus pratensis*	10	0	10	20	4.5	24.5
Plum Limestone lakeshore cliff	*Schedonorus pratensis*	10	7	10	27	4.5	31.5
Plum Mesic northern forest	*Schedonorus pratensis*	10	0	10	20	4.5	24.5
Plum Boreal forest	*Sedum acre*	10	0	1	11	4.37	15.37
Plum Great Lakes marsh	*Sedum acre*	10	0	10	20	4.37	24.37
Plum Limestone cobble shore	*Sedum acre*	10	0	10	20	4.37	24.37
Plum Limestone lakeshore cliff	*Sedum acre*	10	7	10	27	4.37	31.37
Plum Mesic northern forest	*Sedum acre*	10	0	1	11	4.37	15.37
Plum Boreal forest	*Silene latifolia*	5	0	10	15	4.1	19.1
Plum Great Lakes marsh	*Silene latifolia*	5	0	5	10	4.1	14.1
Plum Limestone cobble shore	*Silene latifolia*	5	0	10	15	4.1	19.1
Plum Limestone lakeshore cliff	*Silene latifolia*	5	0	10	15	4.1	19.1
Plum Mesic northern forest	*Silene latifolia*	5	0	10	15	4.1	19.1
Plum Boreal forest	*Silene vulgaris*	10	10	5	25	4.1	29.1
Plum Great Lakes marsh	*Silene vulgaris*	10	0	5	15	4.1	19.1
Plum Limestone cobble shore	*Silene vulgaris*	10	7	10	27	4.1	31.1
Plum Limestone lakeshore cliff	*Silene vulgaris*	10	0	10	20	4.1	24.1
Plum Mesic northern forest	*Silene vulgaris*	5	0	10	15	4.1	19.1
Plum Boreal forest	*Solanum dulcamara*	10	0	10	20	4.9	24.9
Plum Great Lakes marsh	*Solanum dulcamara*	10	0	10	20	4.9	24.9
Plum Limestone cobble shore	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Plum Limestone lakeshore cliff	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Plum Mesic northern forest	*Solanum dulcamara*	10	5	10	25	4.9	29.9

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Boreal forest	*Taraxacum officinale*	10	0	10	20	3.57	23.57
Plum Great Lakes marsh	*Taraxacum officinale*	10	0	1	11	3.57	14.57
Plum Limestone cobble shore	*Taraxacum officinale*	10	0	10	20	3.57	23.57
Plum Limestone lakeshore cliff	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Plum Mesic northern forest	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Plum Boreal forest	*Torilis japonica*	10	0	10	20	5.9	25.9
Plum Great Lakes marsh	*Torilis japonica*	10	0	1	11	5.9	16.9
Plum Limestone cobble shore	*Torilis japonica*	10	0	5	15	5.9	20.9
Plum Limestone lakeshore cliff	*Torilis japonica*	10	0	5	15	5.9	20.9
Plum Mesic northern forest	*Torilis japonica*	10	10	10	30	5.9	35.9
Plum Boreal forest	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
Plum Great Lakes marsh	*Tragopogon pratensis*	5	0	5	10	4.3	14.3
Plum Limestone cobble shore	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
Plum Limestone lakeshore cliff	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
Plum Mesic northern forest	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
Plum Boreal forest	*Trifolium fragiferum*	5	0	5	10	3.57	13.57
Plum Great Lakes marsh	*Trifolium fragiferum*	10	0	0	10	3.57	13.57
Plum Limestone cobble shore	*Trifolium fragiferum*	5	0	1	6	3.57	9.57
Plum Limestone lakeshore cliff	*Trifolium fragiferum*	5	0	1	6	3.57	9.57
Plum Mesic northern forest	*Trifolium fragiferum*	5	0	5	10	3.57	13.57
Plum Boreal forest	*Trifolium pratense*	5	0	10	15	4.5	19.5
Plum Great Lakes marsh	*Trifolium pratense*	5	0	5	10	4.5	14.5
Plum Limestone cobble shore	*Trifolium pratense*	5	0	10	15	4.5	19.5
Plum Limestone lakeshore cliff	*Trifolium pratense*	5	0	10	15	4.5	19.5
Plum Mesic northern forest	*Trifolium pratense*	5	0	10	15	4.5	19.5
Plum Boreal forest	*Typha angustifolia*	10	0	1	11	9	20
Plum Great Lakes marsh	*Typha angustifolia*	10	10	10	30	9	39
Plum Limestone cobble shore	*Typha angustifolia*	10	0	10	20	9	29
Plum Limestone lakeshore cliff	*Typha angustifolia*	10	0	10	20	9	29
Plum Mesic northern forest	*Typha angustifolia*	10	0	10	20	9	29

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Plum Boreal forest	*Valeriana officinalis*	10	1	10	21	7.3	28.3
Plum Great Lakes marsh	*Valeriana officinalis*	10	0	5	15	7.3	22.3
Plum Limestone cobble shore	*Valeriana officinalis*	10	0	10	20	7.3	27.3
Plum Limestone lakeshore cliff	*Valeriana officinalis*	10	0	10	20	7.3	27.3
Plum Mesic northern forest	*Valeriana officinalis*	10	1	10	21	7.3	28.3
Plum Boreal forest	*Verbascum thapsus*	10	0	10	20	4.37	24.37
Plum Great Lakes marsh	*Verbascum thapsus*	10	0	5	15	4.37	19.37
Plum Limestone cobble shore	*Verbascum thapsus*	10	7	10	27	4.37	31.37
Plum Limestone lakeshore cliff	*Verbascum thapsus*	10	7	10	27	4.37	31.37
Plum Mesic northern forest	*Verbascum thapsus*	10	0	10	20	4.37	24.37
Plum Boreal forest	*Veronica officinalis*	10	7	10	27	4.9	31.9
Plum Great Lakes marsh	*Veronica officinalis*	10	0	1	11	4.9	15.9
Plum Limestone cobble shore	*Veronica officinalis*	10	0	5	15	4.9	19.9
Plum Limestone lakeshore cliff	*Veronica officinalis*	10	0	5	15	4.9	19.9
Plum Mesic northern forest	*Veronica officinalis*	10	7	10	27	4.9	31.9
Plum Boreal forest	*Veronica serpyllifolia*	10	0	10	20	4.5	24.5
Plum Great Lakes marsh	*Veronica serpyllifolia*	10	0	1	11	4.5	15.5
Plum Limestone cobble shore	*Veronica serpyllifolia*	10	0	10	20	4.5	24.5
Plum Limestone lakeshore cliff	*Veronica serpyllifolia*	10	7	10	27	4.5	31.5
Plum Mesic northern forest	*Veronica serpyllifolia*	10	0	10	20	4.5	24.5
Plum Boreal forest	*Viburnum opulus*	10	0	5	15	5.1	20.1
Plum Great Lakes marsh	*Viburnum opulus*	5	0	5	10	5.1	15.1
Plum Limestone cobble shore	*Viburnum opulus*	5	0	5	10	5.1	15.1
Plum Limestone lakeshore cliff	*Viburnum opulus*	10	7	5	22	5.1	27.1
Plum Mesic northern forest	*Viburnum opulus*	10	0	5	15	5.1	20.1