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

Great Lakes Region

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On the cover:
Inland tier of limestone lakeshore cliff overlooking burned boreal forest and the Poverty Island shoreline, Green Bay National Wildlife Refuge.
Photograph: Scott Warner, July 28, 2021

Summary

Invasive species management is a major priority of 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 Lake Michigan called the Grand Traverse Islands, 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, 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 Poverty Island. Nearly the entire island, all but the area around the lighthouse, consists of high-quality natural communities. These habitats support at least two state-listed plants, Laurentian fragile fern and climbing fumitory, both observed in 2021, and historically supported state and federally threatened dwarf lake iris and state special concern Richardson's sedge. These conservation assets are threatened by a diversity of invasive species, several of them quite aggressive, including invasive common reed, reed canary grass, narrow-leaved cat-tail, bush honeysuckle, and wild parsnip. 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 project design, planning, and surveys on other islands. We thank the Little Traverse Bay Band of Odawa Indians Natural Resources Department for collaboration on surveys and logistical support, particularly Bill Parsons and Noah Jansen. We thank USFWS Region 3 sponsors Richard King and Joshua Booker. We thank the staff at Horicon 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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Narrative

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 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 common 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 fresh waterbodies are globally rare. The Great Lakes has the largest collection of freshwater islands in the world, with 32,000 islands. These islands are home to precious cultural resources, regionally endemic species such as dwarf lake iris (*Iris lacustris*), 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 Invasive Plant Management Plan IPMP for Poverty Island, a 474-acre (192-ha) island in Lake Michigan located 1.4 miles (2.3 km) off the Garden Peninsula in the State of Michigan 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

Poverty Island (45°32′N, 86°40′W in Delta County, Michigan, 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 a variant of limestone, but it consists of mainly magnesium calcium carbonate instead of calcite and aragonite and is more resistant to erosion (Albert et al. 1995). The Grand Traverse Islands are cherished for their 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).

Poverty Island is about 0.8 miles (1.3 km) long by 0.5 miles (0.8 km) wide. Its northern, eastern, and western shores consist of limestone shelves. Its western shore is formed by limestone cliffs, 10 – 40 ft (3 – 12 m) tall, inland from which is a 50 – 100 ft (15 – 30 m) wide terrace of boreal forest flanked on its other side by another tier of limestone cliff. The island interior is boreal forest on a thin layer of soil over limestone. The boreal forest contains limestone ledges throughout as well as 3 – 10 ft (1 – 3 m) deep crevices in exposed limestone, particularly near the northwest coast (Judziewicz 2001; Cohen et al. 2022). In 2016, lightning ignited a wildfire which went on to burn intermittently for three months. It burned over 30% of the boreal forest and locally burned along the western cliffs and the terraces between them. Due to crevices, blowdowns, and thick post-fire vegetation, walking is extremely difficult on parts of the island. Other than coastal cliffs, topographic relief is flat to rolling. There are no interior bodies of water (Cohen et al. 2022).

Within the last five years, Poverty Island was acquired by the United States Fish and Wildlife Service (USFWS) and placed within the Green Bay NWR (Salas et al. 2017). Prior to that, it was part of a state forest and used for hunting, still evidenced by an old hunting camp above the limestone bedrock lakeshore along the eastern shore (Figure 2). There was a lighthouse in operation from 1875 through 1995. An abandoned railroad grade can be found in part of the boreal forest and limestone bedrock lakeshore. Selective logging of the boreal forest likely occurred in the late 1800s and early 1900s (Cohen et al. 2022).

Historically, the island has not been extensively botanized. Limited collecting expeditions in 1989–90 and 1998 accumulated a record of 203 plant species. These expeditions documented the following rare plants and natural communities: dwarf lake iris, Richardson's sedge (*Carex richardsonii*), boreal forest, limestone lakeshore cliff, and limestone bedrock lakeshore (Albert et al. 1997, Judziewicz 2001).

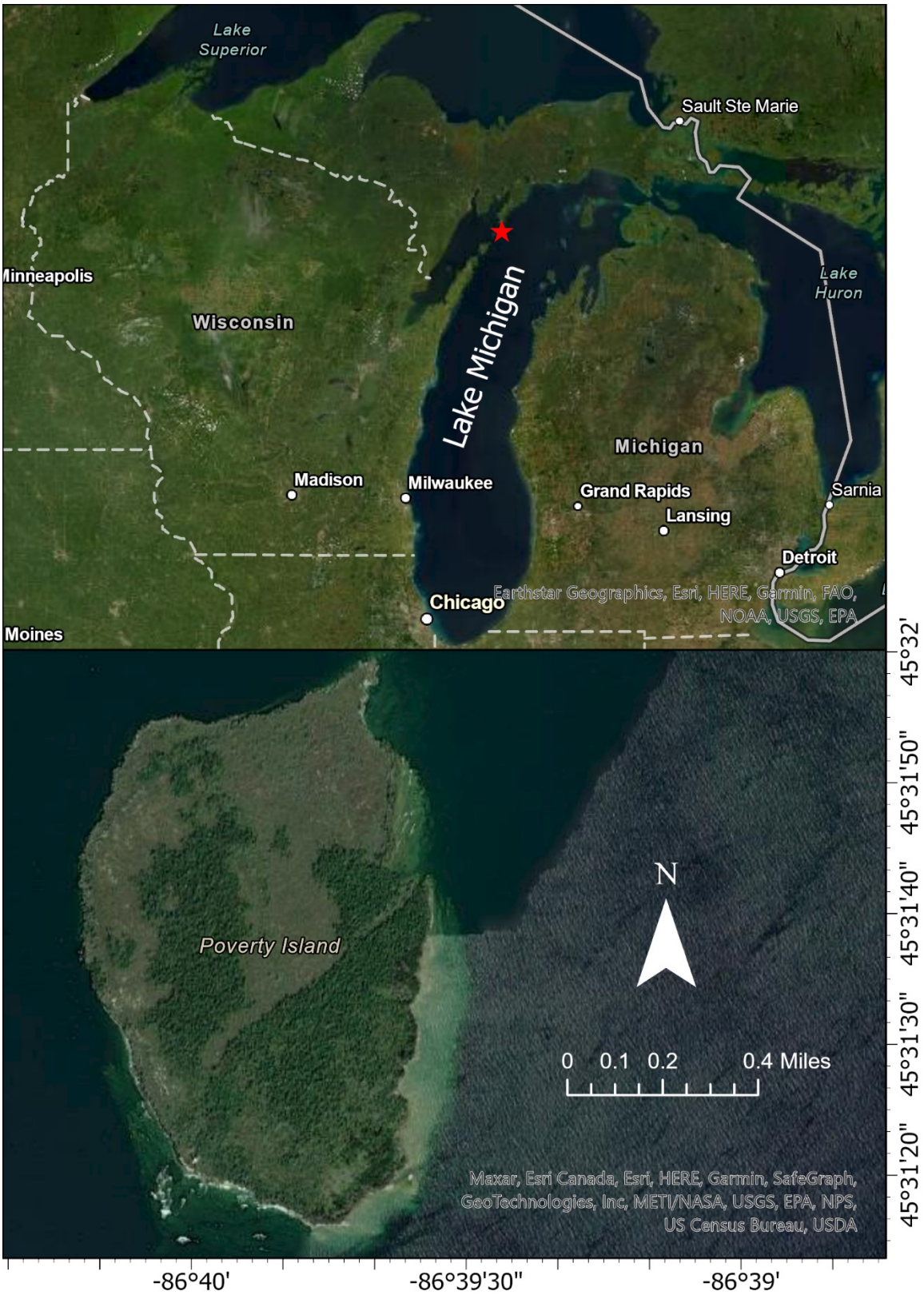

Figure 1. Poverty Island (bottom) is located in northern Lake Michigan, USA (top). The red star in the upper pane represents Poverty Island.

Conservation Assets

The 2021 ecological surveys revealed that quality natural communities occupy nearly all of the island (Table 1; Figure 2, Figure 3). Using natural heritage methodology, Michigan Natural Features Inventory (MNFI) staff assigned each of these a letter rank (A = excellent viability, D = poor viability). The 17-acre (7-ha) limestone lakeshore cliff was ranked A. The 17-acre (7-ha) limestone bedrock lakeshore was also ranked A, and the Ecology Team considers it one of the most pristine examples of that community in the state of Michigan. The 437-acre (177-ha) boreal forest was ranked B (Cohen et al. 2022).

Two listed plant species were previously known from the island: Richardson's sedge (state special concern) and dwarf lake iris (state and federally threatened). Extensive surveys for these species in their previously estimated location were unsuccessful. This does not preclude their continued presence. Logistical constraints prevented surveying for Richardson's sedge during the recommended window of late May – June. We were within the recommended window for dwarf lake iris, but a small portion of potential habitat [redacted] was not surveyed due to logistical constraints.

A new occurrence of state special concern climbing fumitory (*Adlumia fungosa*) was observed [redacted] Climbing fumitory is a calciphile with seeds that long persist in the seedbank and sprout when disturbance creates favorable conditions. It has been vouchered in 17 counties of southern and northern Michigan where it grows in forests and thickets and on cliffs and rocky shores. It can be found temporarily in large numbers following fire or clearing before retreating to the seedbank to await another disturbance (Reznicek et al. 2011).

A new occurrences of another state special concern species, Laurentian fragile fern (*Cystopteris laurentiana*; Bassett et al. 2022; Table 1; Figure 2, Figure 4). Laurentian fragile fern is a calciphile known in Michigan from just nine counties of the Upper Peninsula. It was in six polygons [redacted] (Bassett et al. 2022).

Many plants with no listed status but with high habitat conservatism or other sensitivity were observed (Bassett et al. 2022; Figure 5). The limestone bedrock lakeshore and limestone lakeshore cliff communities were rich with conservative shrubs such as shrubby cinquefoil (*Dasiphora fruticosa*), Kalm's St. John's wort (*Hypericum kalmianum*), and creeping juniper (*Juniperus horizontalis*) and forbs such as low calamint (*Clinopodium glabrum*), Gillman's goldenrod (*Solidago simplex* var. *gillmanii*), and white camas (*Anticlea elegans*). The boreal forest also supported many conservative plants and locally supported healthy patches of Canada yew (*Taxus canadensis*).

Troublesome invasive species occur within all of the natural communities described, as well as near the rare plants. Strategies to control these invasives are discussed in Chapter 3

Table 1. Element occurrence (EO) for rare native species and natural communities. EO ID is a unique identifier assigned to each EO in Michigan Natural Heritage Database. 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.

Element	Common name	EO ID	EO Rank	Last Observed	State Status	Global Status
Adlumia fungosa	Climbing fumitory	24393	D	2021	Special concern	G4
Carex richardsonii	Richardson's sedge	15243	C	1995	Special concern	G5
Cystopteris laurentiana	Laurentian fragile fern	24392	C	2021	Special concern	G3
Haliaeetus leucocephalus	Bald eagle	NA	NA	Recent (Salas et al. 2017)	Special concern	G5
Iris lacustris	Dwarf lake iris	11586	C	1998	Threatened (Both federal and state)	G3
Boreal forest	NA	7488	B	2021	S3	GU
Limestone bedrock lakeshore	NA	10717	B	2021	S2	G3
Limestone lakeshore cliff	NA	18991	A	2021	S1	G4G5

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.
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.

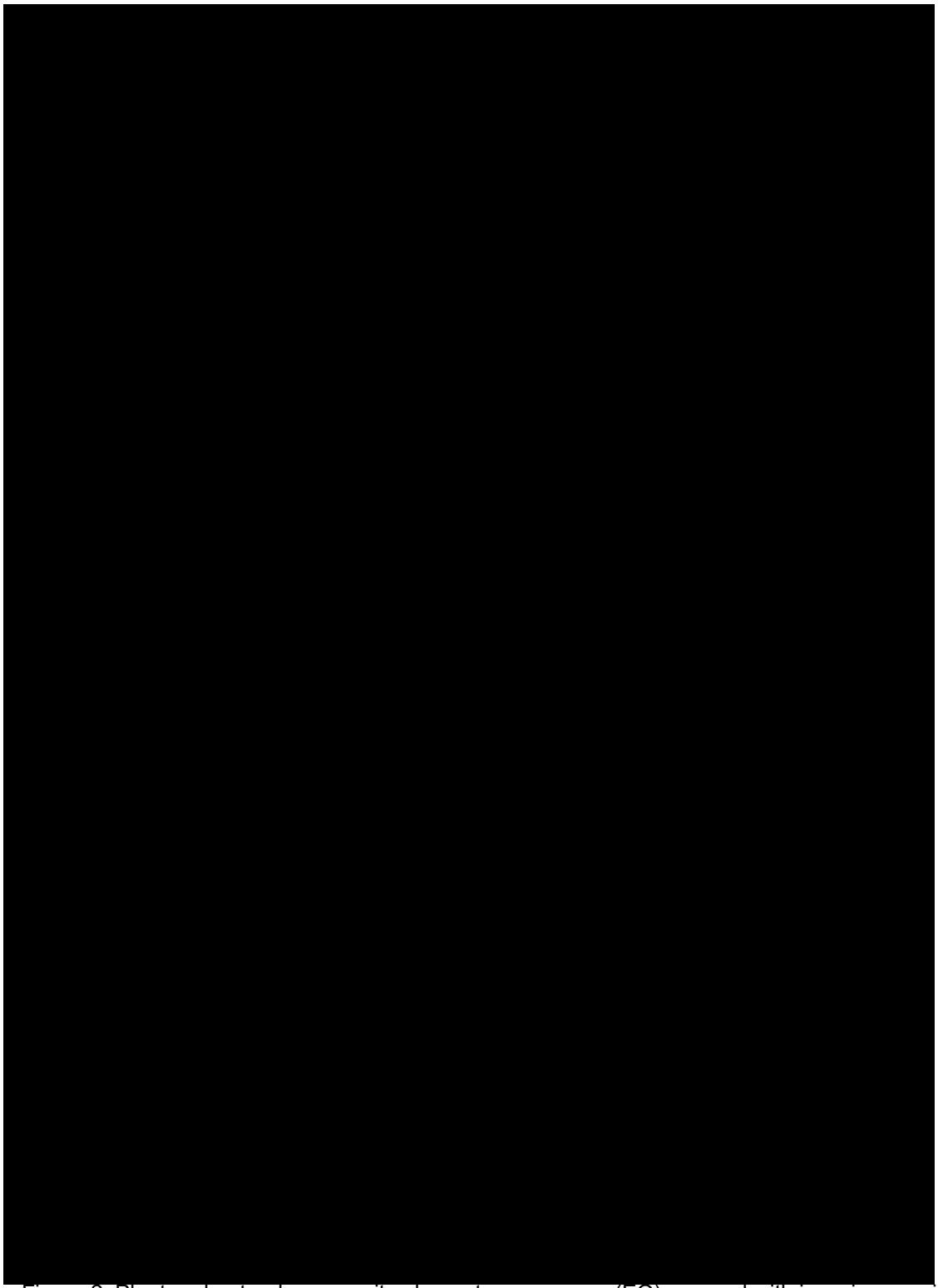

Figure 2. Plant and natural community element occurrences (EO) mapped with invasive species on Poverty Island in 2021 (Bassett et al. 2022).

Figure 3. High-quality natural communities on Poverty Island. Clockwise from upper left: unburned boreal forest, burned boreal forest (EO ID 7488), limestone lakeshore cliff (EO ID 1437), and limestone bedrock lakeshore (EO ID 4159). Photographs by Joshua Cohen, July 27 – 28, 2021.

Figure 4. Listed plant species on Poverty Island. Left to right: Laurentian fragile fern (*Cystopteris laurentiana*) and climbing fumitory (*Adlumia fungosa*). Photos by Tyler Bassett, July 27 – 28, 2021.

Figure 5. Flora of Poverty Island. Clockwise from upper left: creeping juniper (*Juniperus horizontalis*; photo: Tyler Bassett), Canada yew (*Taxus canadensis*; Scott Warner), shrubby cinquefoil (*Dasiphora fruticosa*; Scott Warner), low calamint *(Clinopodium glabrum*; Joshua Cohen), and Gillman's goldenrod (*Solidago simplex* var. *gillmanii*; Tyler Bassett), July 27 – 28, 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 objective specific to Green Bay NWR from the Habitat Management Plan (Salas et al. 2017):

- Maintain quality of limestone bedrock lakeshore (known in Wisconsin as Great Lakes alkaline rockshore)

We also advocate for maintaining the quality of the two additional natural communities on Poverty Island (Table 1; Figure 2):

- Boreal forest
- Limestone lakeshore cliff

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

History of Invasive Plant Management

Poverty Island is a recent addition to the NWR System. To date, no significant treatment of invasive plant species has occurred on the island.

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 from the Michigan Department of Environment, Great Lakes, and Energy (formerly Michigan Department of Environmental Quality) 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).

Chapter 2: Methods

This chapter identifies the who, what, why, and how in the development of this IPMP for Poverty 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 by members working on developing the IPMP [Scott Warner (MNFI), 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 instigated between other MNFI staff members who conducted the most recent surveys on Poverty Island (Tyler Bassett, Josh Cohen, Scott Warner) and Little Traverse Bay Band of Odawa Indians Natural Resources Department staff (Bill Parsons, Noah Jansen), who partnered with and accompanied MNFI staff on their surveys and own property on nearby St. Martin Island. Communication was also fostered with the local area Cooperative Invasive Species Management Area (CISMA): Elise Desjarlais, Lake-2-Lake CISMA. Lake-2-Lake CISMA is a project partner who will conduct invasive plant treatment in the State of Michigan 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 Michigan Natural Heritage Database contains Element Occurrences (EOs) of rare and listed species and natural communities. These records were mined for those located on Poverty Island and 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 Poverty 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 via MNFI's public Survey123 form: MNFI Rare Species Form. The form was designed to collect information on Michigan's endangered, threatened, and special

concern species (Appendix 1). All observations are reviewed by MNFI staff before being transcribed into the Michigan Natural Heritage Database. USFWS has a subscription to access the database via a web interface or ArcGIS Server Feature. For more information about Michigan's Natural Heritage Database, contact the MNFI Data Manager at mnfi@msu.edu.

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. Poverty Island was surveyed over July 27 – 28, 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 below 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 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 was 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 was 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).

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 (Bassett et al. 2022, 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 United States Department of Agriculture's (USDA's) PLANTS Database (https://plants.sc.egov.usda.gov/home/).

As the species of bush honeysuckle (*Lonicera* sp.) observed on the island all have the same NatureServe rankings and are not managed differently, they are pooled together for the purpose of the IPIEDPT.

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 Poverty 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. 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). The highly disturbed lighthouse area in the southwest was not included in the IPIEDPT.

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 Lake-2-Lake CISMA, 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 Poverty Island were divided into three categories: Priority 1, Priority 2, and Priority 3 (Table 4). Priority 1 species were observed on the island and impose a significant threat to natural communities and rare species (Figure 2, Figure 6). Management is likely to result in significant positive outcomes. Seven species were classified as Priority 1 (Table 5). Two herbaceous species were placed in Priority 1 category despite IPIEDPT scores closer in value to Priority 3 species: White sweet-clover (*Melilotus albus*) and wild parsnip (*Pastinaca sativa*). 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 were not observed on Poverty Island in 2021 but have been seen in nearby regions and would pose a significant threat if found on Poverty Island. Twenty-seven 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 Poverty Island and nearby islands (Table 5; Figure 2, Figure 6). These biennial 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. Management strategies such as outlier control would be difficult to achieve for these species given the remote island setting.

Table 4. Description of prioritization categories given to observed and potential invasive plant species on Poverty 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 Poverty Island.
Priority 3	Present but not prioritized: The species is often considered invasive and was observed in 2021 but has thoroughly naturalized on Poverty 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 ITIS	Common Name	Category	IPIEDPT Total Score
Centaurea stoebe ssp. *micranthos*	Spotted knapweed	Priority 1	9.00
Lonicera spp.	Bush honeysuckles	Priority 1	8.47
Melilotus albus	White sweet-clover	Priority 1	6.30
Pastinaca sativa	Wild parsnip	Priority 1	7.30
Phalaris arundinacea	Reed canary grass	Priority 1	9.07
Phragmites australis ssp. *australis*	Invasive common reed	Priority 1	9.10
Typha angustifolia	Narrow-leaved cat-tail	Priority 1	9.00
Cirsium arvense	Canada thistle	Priority 3	7.57
*Cirsium palustre**	European marsh thistle	Priority 3	6.77
Cirsium vulgare	Bull thistle	Priority 3	6.77
Cynoglossum officinale	Houndstongue	Priority 3	6.77

*Mapped as *Cirsium* sp because species name wasn't an option in mapping tool., along with emerging basal rosettes unidentifiable to species.

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 2).

Figure 6. Invasive plant species on Poverty Island. Left to right: marsh thistle (*Cirsium palustre*) and invasive common reed (*Phragmites australis* ssp. *australis*). Photos by Tyler Bassett, July 27 – 28, 2021.

Species Descriptions and Priorities

Priority 1: Present Aggressive Species

SPOTTED KNAPWEED (*CENTAUREA STOEBE* SSP. *MICRANTHOS*)
Spotted knapweed was not collected in Michigan until 1911, yet it has since become a terrible invasive plant in open upland habitats throughout the state (Reznicek et al. 2011), 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 alone, its total 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: Spotted knapweed was mapped only one time on Poverty Island, in the southeast at the border of boreal forest and limestone bedrock lakeshore (Bassett et al. 2022; Figure 2). This was a 1 ft^2 (0.1 m^2) patch.

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 to reduce potential adverse reactions to this plant. 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 The species is viable in the seedbank for nine years (Czarapata 2005).

When using chemical treatment, an area 10 to 15 ft (3 to 4.5 m) beyond the invasion zone must be treated to control roots and seeds. For large infestations, chemical treatment may be inappropriate because of non-target effects. 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).

BUSH HONEYSUCKLES (*LONICERA* SPP.)

Invasive bush honeysuckles are allelopathic shrubs (Bauer et al. 2012) that have been established in Michigan since at least the 1890s. 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 was mapped at a single location, on the peninsula on the northeast of the island. The boreal forest on this peninsula was burned over and is rich in invasive species that are exploiting the recent disturbance. The peninsula is fringed by one of Michigan's finest examples of limestone bedrock lakeshore, a community imperiled at the statewide scale. The occurrence was mapped as *Lonicera sp*. because our several invasive species from that genus have similar ecology and require similar management. On this island, the occurrence represents hybrid honeysuckle *Lonicera* × *bella.* The small patch covers 12 ft^2 (1.1 m^2; Figure 2; Bassett et al. 2022).

Management: Effective treatments include hand-pulling (remove all roots), foliar spray, stump-cutting plus herbicide, and basal bark treatment (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 to 5 years until the seedbank is depleted (Czarapata 2005).

WHITE SWEET-CLOVER (*MELILOTUS ALBUS*)

White sweet-clover is a popular forage plant long naturalized throughout Michigan (Reznicek et al. 2011). It is found chiefly in disturbed areas but can also invade natural communities such as shores and alkaline sand dunes (Borland et al. 2015).

Species description: White sweet-clover is a tall biennial, reaching 3 – 5 ft (1 – 1.5 m) in its second year. It has a leafy, highly branched, even bushy appearance. Its leaves are compound, alternate, and clover-like. The fragrant, numerous small white flowers are pealike, and they bloom late May through September. They reproduce only by seed, producing up to 350,000 seeds, viable for up to 30 years, per plant (Czarapata 2005).

Habitat: Dry, open, recently disturbed areas, particularly in calcareous ground (Reznicek et al. 2011).

Current status in landscape: Invasion on Poverty Island is in its early stages. Three patches were mapped, all in burned boreal forest. One spanned 64 ft^2 (5.9 m^2) near the center of the island. Two patches were found near each other on the peninsula in the northeast, which together spanned 500 ft^2 (46 m^2; Bassett et al. 2022; Figure 2).

Management: Typically, this species can be manually controlled. Hand-pulling is effective. First-year plants should be removed in late fall after root-crown buds have developed. Pulling second-years is best done in May or June before flowering or, if pulled after flowering, they should be removed from the site. Second-years should not be removed too early in spring as they are prone to breaking off and resprout later. Late-starting plants may also be missed. Pulling when soil is moist is easiest. A follow-up in summer to look for late-bloomers is ideal. A blowtorch can also be used (Czarapata 2005).

If the above methods are not feasible, plants can be cut at ground level. If completed after flowering, remove plants from the site. Follow up within a week to catch missed individuals. If manual treatment is ineffective, chemical means are available (Czarapata 2005).

Vigilant monitoring of treated patches will be necessary given the persistence of seed in the soil. The rest of the island should be watched, as well, particularly along shores, old trails, in burned-over areas, and in anthropogenic areas (i.e., the lighthouse in the southwest and old hunting camp in the east). The flowering season, late May – September, is easiest for detection.

WILD PARSNIP (*PASTINACA SATIVA*)

Wild parsnip is a biennial that was first collected in Michigan in 1871; since then, it has established throughout the state. 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.

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 to 6 in (5 to 15.25 cm) broad. 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 4 years (Czarapata 2005). 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: One occurrence was spotted on Poverty Island, a 16 ft^2 (1.5 m^2) patch in the southwest in an anthropogenic opening near the lighthouse (Figure 2; Bassett et al. 2022). It is important to eradicate any invasive when it is early on the invasion curve (Harvey and Mazzotti 2014). Wild parsnip spreads in slow waves at first and then begins to spread rapidly.

Management: Plants can be uprooted when the soil is moist. Alternatively, the root can be cut 1 to 2 in (2.5 to 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. Larger populations can be cut at ground level with a power brush-cutter (Czarapata 2005).

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. Follow-up for any treatment is 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 is becoming 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 to 7 ft tall (0.5 to 2 m). Its leaves are 0.25 to 0.75 in (0.6 to 2 cm) wide and up to 10 in (25.5 cm) long. It blooms from May to 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 grass (*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: All occurrences should be considered invasive on Poverty Island. It was mapped in the south and southeast at the edge of boreal forest and limestone cobble shore in the form of two patches together covering 40 ft^2 (3.7 m^2) plus a 146 ft (44.5 m) linear patch. In the northwest, a 16 ft^2 (1.5 m^2) patch was mapped on limestone lakeshore cliff (Figure 2; Bassett et al. 2022).

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 to 10 years (Borland et al. 2015).

INVASIVE COMMON REED (*PHRAGMITES AUSTRALIS* SSP. *AUSTRALIS*)

Invasive common reed has formed large, dense monocultures to the near-total exclusion of other vegetation in wetlands throughout Michigan, particularly the Saginaw Bay area. Preventing further spread in northern Michigan is critical, especially in quality natural wetlands.

Species description: Invasive common reed is a perennial grass that can reach heights of 15 ft (4.5 m) with bluish-green leaves up to 1.5 in (3.8 cm) wide. Leaf sheaths remain tight on culms even after senescence. Flowers bloom from July to September. Invasive common reed can spread via fragments, rhizomes, root runners, and rarely by seed. It forms a thick system of rhizomes that can persist for 3 to 6 years (Borland et al. 2015). Stands at least 1 year old can often be detected any time of year from their tall dead stalks persisting from the previous year. New stands or those whose dead stalks were destroyed over winter are easiest to detect after June. The height and density of the species distinguishes it from most other plants.

Invasive common reed can be easily confused with the native reed *P. australis* ssp. *americanus*. Morphological distinction is subtle but reliable: stand density, stem color, fungus presence on the stem, leaf color, leaf sheath tightness on the stem, length of ligule, and length of glumes. The following sources will assist in the distinction:

- *Phragmites australis* species description and photographs, Reznicek et al. 2011, https://michiganflora.net/species.aspx?id=2184
- Identifying Native vs. Invasive Phragmites, Etienne Herrick, https://www.greatlakesphragmites.net/blog/20180830-native-vs-invasive/
- Phragmites—Native or Not?, MNFI, https://mnfi.anr.msu.edu/pdfs/phragmites-native-non-native.pdf
- Common Reed Plant Guide, USDA, https://plants.usda.gov/DocumentLibrary/plantguide/pdf/pg_phau7.pdf
- Native vs. Invasive, Ontario Phragmites Working Group, https://www.opwg.ca/phragmites/native-vs-invasive/

Habitat: Marshes, ditches, swales, swamps, fens, and wet shores, including in standing water wet shores.

Current status in landscape: On Poverty Island, invasive common reed was mapped in three patches, all nearby one another, totaling an estimated coverage of 42 ft^2 (3.9 m^2). These patches were found on the burned peninsula (Figure 2; Bassett et al. 2022).

Management: Mechanical treatment alone is ineffective. Cutting in early August can be effective in small infestations, if the new growth that resprouts from the cut stems is treated with glyphosate using a wick applicator. Alternatively, stems can be cut near the ground in July or August followed by the immediate dripping of glyphosate. Follow-up treatment will be required for at least the lifespan of the rhizomes, 3 – 6 years (Czarapata 2005).

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

Narrow-leaved cat-tail is a perennial and obligate wetland plant. It was first collected in Michigan in 1877. Since then it has taken over many disturbed wetlands and can become problematic in quality natural communities (Reznicek et al. 2011).

Species description: Long leaves stretch from the base, approximately 0.25 to 0.75 in wide (0.6 to 2 cm). It flowers from June to 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 (Czarapata 2005).

Michigan has two species of cat-tail (*Typha* sp.): narrow-leaved cat-tail and broad-leaved cat-tail (*T. latifolia*). The most distinguishing feature between the two species is the gap between female and male flowers in native broad-leaved cat-tail is absent or is less than 1 in (2 cm). The species are difficult to distinguish outside of the flowering season. Substantial overlap in the width of leaves [0.5 to 1 in (1.25 to 2.5 cm) of 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. Hybrid cat-tail is mostly sterile but also spreads via rhizomes. (Czarapata 2005). Misidentifications are frequent even among trained naturalists. 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: Cat-tail identified as *T. angustifolia* was observed in two patches along the east shore of Poverty Island, at the border of boreal forest and limestone bedrock lakeshore (Bassett et al. 2022; Figure 2). The patches covered a total estimated area of 6 ft^2 (0.6 m^2).

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 Poverty Island invasive species watch list is on moderately to highly invasive species that are known from nearby islands, Delta County, Michigan, Door County, Wisconsin, and other counties in the immediate vicinity (Table 6). The 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. Priority 2 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 Poverty Island, Delta County, Michigan, 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.
Berberis thunbergii	Japanese barberry	Bassett et al. 2022, Cohen et al. 2022	Detroit I. and Plum 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.
Epilobium hirsutum	Great hairy willow-herb	iNat 2021 (https://www.inaturalist.org/observations/90580693)	Door Co.
Elaeagnus umbellata	Autumn olive	Bassett et al. 2022, Cohen et al. 2022	St. Martin I., Delta 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.
Hesperis matronalis	Dame's rocket	Bassett et al. 2022, Cohen et al. 2022	Plum I., Door 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.
Lythrum salicaria	Purple loosestrife	Bassett et al. 2022, Cohen et al. 2022	Plum I., Door 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.
Pinus sylvestris	Scotch pine	iNat 2021 (https://www.inaturalist.org/observations/95590492)	Door Co.

Scientific name	Common name	Source and year of most recent observation	Location
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.
Rosa multiflora	Multiflora rose	Bassett et al. 2022, Cohen et al. 2022	Plum I., Door Co.
Torilis japonica	Erect hedge-parsley	Bassett et al. 2022, Cohen et al. 2022	Plum I. 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

Poverty Island had the 3 of natural community EOs among Detroit, Plum, Poverty, and St. Martin Islands (Cohen et al. 2022). All 3 EOs were ranked in the high stewardship tier (Table 7). The EOs 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 common reed (*Phragmites australis* ssp. *australis*) in disturbed areas (Cohen et al. 2022). Each EO on Poverty Island is examined for sensitive resource, important abiotic factors, important biotic factors, invasive plant status, and invasive vectors and pathways in more detail in the following Area Descriptions and Priorities section.

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. Poverty 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	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	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	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 four natural community areas above the others: limestone cliff, limestone cobble shore, limestone lakeshore cliff, and mesic northern forest (Table 8). This does not align with the expert opinion of MNFI for stewardship priority. The recent fire disturbance and currently small invasive populations in the boreal forest elevate its stewardship priority for invasive treatment. Limestone bedrock lakeshore scored slightly higher than limestone lakeshore cliff due to the

global rarity of the community. Each area is described briefly. Management recommendations are discussed in Chapter 4.

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

Area	Description Score	Risk Score	Status Score	Total Score
Limestone bedrock lakeshore	2.5	0.9	0.5	3.9
Limestone lakeshore cliff	2.1	0.9	0.9	3.9
Boreal forest	1.3	0.38	0.5	2.18

Boreal Forest (EO ID 7488)

Boreal forest is a conifer or conifer-hardwood forest occurring on a variety of substrates including sand dunes, glacial lakeplains, and thin soil over bedrock or cobble. The canopy is dominated by northern white cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and balsam fir (*Abies balsamea*). Boreal forests that are influenced by their proximity to the Great Lakes have high levels of windthrow and climatic conditions with low summer temperatures, high levels of humidity, snowfall, and summer fog. Fires and insects infrequently cause natural disturbance that adds diversity and influence microhabitats in the community (Figure 7). Historical logging practices targeting northern white cedar and other conifers favored the conversion of boreal forest to early-successional forests dominated by deciduous species. Threats to boreal forests include logging, shoreline development, and deer browse (Cohen 2007, Cohen et al. 2015).

Figure 7. Burned boreal forest on Poverty Island. Photo: Joshua Cohen, July 27, 2021.

Sensitive resources: [redacted]

Important biotic factors: The boreal forest EO on Poverty Island has been affected by a severe wildfire in 2016. Over 30% of the boreal forest was burned, and much of the tree canopy was eliminated. The unburned portion of the boreal forest is dominated by northern white cedar. Canopy associates include balsam fir, balsam poplar (*Populus balsamifera*), and paper birch (*Betula papyrifera*). DBH of canopy trees ranges from 12 – 20 in (30 – 50 cm). One canopy white cedar was cored and estimated to be over 173 years old. The burned boreal forest has an open canopy with a dense understory of regenerating tree and shrub species including white cedar, paper birch, trembling aspen (*Populus tremuloides*), balsam poplar, staghorn sumac (*Rhus typhina*), and pin cherry (*Prunus pensylvanica*). Abundant plants of lower stature include fireweed (*Chamerion angustifolium* ssp. *circumvagum*) and wild red raspberry (*Rubus sachalinensis* var. *sachalinensis*). Open conditions are also found locally in part of the unburned boreal forest due to windthrow (Cohen et al. 2022).

Important abiotic factors: The boreal forest on Poverty Island occupies 177 acres (72 ha) of flat to rolling ground on shallow soils overlying limestone bedrock. Abundant crevasses and fire- and wind-induced snags make walking a challenge. Soils range from 8 – 12 in (20 – 30 cm) deep in unburned portions to <1 cm (<0.4 in) deep in severely burned portions (Cohen et al. 2022).

Identified vectors and pathways: There is no dock on Poverty Island. Nonetheless, occasional unauthorized visitors may travel to the island and bring propagules of invasive species. The boreal forest is also near Lake Michigan itself with only the narrow limestone communities between. High lake levels and high waves wash debris including invasive species reproductive parts into the natural community.

Invasive plant status: The Priority 1 species invasive common reed was present in three patches spanning a total of 42 ft^2 (3.9 m^2) on the burned northeast peninsula. On that same peninsula, the Priority 1 species bush honeysuckle and white sweet-clover occupied a 12 ft^2 (1.1 m^2) patch and two patches spanning 500 ft^2 (46.6 m^2), respectively. Three additional Priority 1 species were observed in the southeast at the edge of limestone bedrock lakeshore: narrow-leaved cat-tail occupying a 2 ft^2 (0.2 m^2) and a 4 ft^2 (0.4 m^2) patch, spotted knapweed (1 ft^2; 0.1 m^2), and reed canary grass (44-ft (13-m) line; Bassett et al. 2022). Twenty other exotic species were present. These were not mapped except for thistles (*Cirsium* sp.) and houndstongue (*Cynoglossum officinale*).

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

- Japanese barberry (*Berberis thunbergii*)
- Autumn olive (*Elaeagnus umbellata*)
- Dame's rocket (*Hesperis matronalis*)
- Multiflora rose (*Rosa multiflora*)
- Wild parsnip
- Erect hedge parsley (*Torilis japonica*)
- Garlic mustard

Table 9. IPIEDPT area-species link scores for the boreal forest. Species with a non-zero "Status Score" were observed in the area during the 2021 surveys (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
Bush honeysuckle	***Lonicera* sp.**	**10**	**10**	**10**	**30**	**8.47**	**38.47**
Canada thistle	*Cirsium arvense*	10	10	10	30	7.57	37.57
Houndstongue	*Cynoglossum officinale*	10	10	10	30	6.77	36.77
Reed canary grass	***Phalaris arundinacea***	**10**	**10**	**5**	**25**	**9.07**	**34.07**
Helleborine	*Epipactis helleborine*	10	7	10	27	4.97	31.97
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Orange hawkweed	*Hieracium aurantiacum*	10	7	10	27	4.5	31.5
Flannel plant, common mullein	*Verbascum thapsus*	10	7	10	27	4.37	31.37
Jack-go-to-bed-at-noon	*Tragopogon pratensis*	10	7	10	27	4.3	31.3
White sweet-clover	***Melilotus albus***	**10**	**5**	**10**	**25**	**6.3**	**31.3**
Canada bluegrass	*Poa compressa*	10	7	10	27	4.1	31.1
Dandelion	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Kentucky bluegrass	*Poa pratensis*	10	7	10	27	3.43	30.43
Common reed	***Phragmites australis***	**10**	**5**	**5**	**20**	**9.1**	**29.1**
Strawberry clover	*Trifolium fragiferum*	10	10	5	25	3.57	28.57
Bull thistle	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Marsh thistle	*Cirsium palustre*	10	1	10	21	6.77	27.77
Yellow hawkweed	*Hieracium caespitosum*	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
Goldmoss stonecrop	*Sedum acre*	10	10	1	21	4.37	25.37
Norway spruce	*Picea abies*	10	10	1	21	4.1	25.1
Common hempnettle	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Redtop	*Agrostis gigantea*	10	0	10	20	4.9	24.9
Garlic mustard	*Alliaria petiolata*	5	0	10	15	9.4	24.4
Narrow-leaf cat-tail	*Typha angustifolia*	10	0	5	15	9	24
Japanese barberry	*Berberis thunbergii*	5	0	10	15	9	24
Common mouse-ear chickweed	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Dame's rocket	*Hesperis matronalis*	5	0	10	15	7.7	22.7
Garden valerian, common valerian	*Valeriana officinalis*	5	0	10	15	7.3	22.3
Multiflora rose	*Rosa multiflora*	5	0	10	15	7.3	22.3
Wild parsnip	*Pastinaca sativa*	5	0	10	15	7.3	22.3

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Erect hedge parsley	*Torilis japonica*	5	0	10	15	5.9	20.9
Lesser burdock	*Arctium minus*	5	0	10	15	5.1	20.1
Spotted knapweed	*Centaurea stoebe* ssp. *micranthos*	10	0	1	11	9	20
Common gypsy-weed	*Veronica officinalis*	5	0	10	15	4.9	19.9
Wormseed wallflower	*Erysimum cheiranthoides*	10	0	5	15	4.9	19.9
Thyme-leaf speedwell	*Veronica serpyllifolia*	5	0	10	15	4.5	19.5
Red clover	*Trifolium pratense*	5	0	10	15	4.5	19.5
Meadow fescue	*Schedonorus pratensis*	5	0	10	15	4.5	19.5
Soapwort, bouncing bet	*Saponaria officinalis*	5	0	10	15	4.5	19.5
Black medick	*Medicago lupulina*	10	0	5	15	4.5	19.5
Bladder campion	*Silene vulgaris*	5	0	10	15	4.1	19.1
White campion	*Silene latifolia*	5	0	10	15	4.1	19.1
Bitter dock, broadleaf dock	*Rumex obtusifolius*	5	0	10	15	4.1	19.1
Tall buttercup	*Ranunculus acris*	5	0	10	15	4.1	19.1
Spotted ladysthumb, ladysthumb	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Scotch mist	*Galium sylvaticum*	5	0	10	15	4.1	19.1
Proso millet	*Panicum miliaceum*	10	0	5	15	3.9	18.9
Wood bluegrass	*Poa nemoralis*	5	0	10	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
Smallflower hairy willow herb	*Epilobium parviflorum*	10	0	1	11	5.3	16.3
Quackgrass	*Elymus repens*	5	0	5	10	5.7	15.7
European cranberry-bush	*Viburnum opulus*	5	0	5	10	5.1	15.1
Purple loosestrife	*Lythrum salicaria*	5	0	1	6	9.1	15.1
Queen Anne's lace	*Daucus carota*	5	0	5	10	5.1	15.1
Common timothy	*Phleum pratense*	5	0	5	10	4.9	14.9
Butter and eggs	*Linaria vulgaris*	5	0	5	10	4.37	14.37
Common St. John's wort	*Hypericum perforatum*	5	0	5	10	4.37	14.37
Motherwort	*Leonurus cardiaca*	5	0	5	10	4.1	14.1
Orchard grass	*Dactylis glomerata*	5	0	5	10	4.1	14.1
Black bindweed, wild buckwheat	*Fallopia convolvulus*	5	0	5	10	3.7	13.7
Annual bluegrass	*Poa annua*	5	0	5	10	3.57	13.57

Limestone Bedrock Lakeshore (EO ID 10717)

Limestone bedrock lakeshore is a state-imperiled community comprised of ancient limestone pavement occurring along Great Lakes shores in six Michigan counties. It is also called alvar pavement and limestone pavement lakeshore. Vegetation is limited to cracks, joints, and depressions in the bedrock (Figure 8). Trees are generally limited to the inland edge. Characteristic plants include low calamint, silverweed (*Potentilla anserina*), mountain rush (*Juncus balticus* ssp. *littoralis*), Kalm's St. John's wort, balsam ragwort (*Packera paupercula*), Ohio goldenrod (*Solidago ohioensis*), white camas, northern white cedar, paper birch, balsam poplar, and shrubby cinquefoil. Fluctuating water levels make for a dynamic flora. The pH of what little soil can develop tends to be mildly alkaline. Exposure to storms, wind, ice, fluctuating water levels, and desiccating conditions make for a harsh environment (Cohen et al. 2015).

Figure 8. Limestone bedrock lakeshore on Poverty Island with low calamint (*Clinopodium glabrum*) growing out of a splash pool. Photo: Joshua Cohen, July 27, 2021.

Sensitive resources: [redacted]

Important biotic factors: The sparse vegetation is dominated by herbaceous plants such as rushes, low calamint, Kalm's lobelia (*Lobelia kalmii*), silverweed, and white camas. Trees and shrubs, generally restricted to the inland edge, cracks, and crevices, include white cedar,

trembling aspen, balsam fir, red elderberry (*Sambucus racemosa*), and shrubby cinquefoil. Recent high-water years have led the dieback of both woody and herbaceous vegetation. Occasional splash pools support aquatic vegetation.

Important abiotic factors: The limestone bedrock lakeshore occupies about a mile-long stretch on the eastern shore of Poverty Island. On the northern and southern shores, limestone bedrock lakeshore and limestone lakeshore cliff intergrade. Small inclusions of limestone cobble shore also occur locally within the limestone bedrock lakeshore. The inland edge of the bedrock lakeshore is bordered by boreal forest. The inland edge of the bedrock lakeshore burned along with much of the boreal forest in 2016. The extent of the bedrock lakeshore fluctuates interannually. Consecutive high-water years in the Great Lakes from 2016 through 2020 made the shoreline relatively narrow in 2021. Soils are shallow alkaline organics restricted to cracks, crevices, depressions, ledges, and tree bases.

Identified vectors and pathways: Occasional unauthorized visitors will find it relatively easy to walk along the bedrock lakeshore. The position along the lake makes this community vulnerable to the washup of invasive-plant propagules.

Invasive plant status: Three Priority 1 invasive species were present along the southeast of the shoreline at its border with the boreal forest. Two patches of narrow-leaved cat-tail covered a total of 6 ft^2 (0.6 m^2). One patch of spotted knapweed covered 1 ft^2 (0.1 m^2). Two patches of reed canary grass covered 40 ft^2 (3.7 m^2; Bassett et al. 2022). Twenty-one other exotic species were present. Only thistles and houndstongue were mapped.

The most likely new invaders of this area include four 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 common reed
- White sweet-clover
- Wild parsnip
- Bush honeysuckle
- Purple loosestrife (*Lythrum salicaria*)
- Autumn olive

Table 10. IPIEDPT area-species link scores for the limestone bedrock lakeshore area. Species with a non-zero "Status Score" were observed in the area during the 2021 surveys (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
Narrow-leaf cat-tail	***Typha angustifolia***	**10**	**10**	**10**	**30**	**9**	**39**
Spotted knapweed	***Centaurea stoebe* ssp. *micranthos***	**10**	**10**	**10**	**30**	**9**	**39**
Houndstongue	*Cynoglossum officinale*	10	10	10	30	6.77	36.77
Reed canary grass	***Phalaris arundinacea***	**10**	**10**	**5**	**25**	**9.07**	**34.07**
Smallflower hairy willow herb	*Epilobium parviflorum*	10	7	10	27	5.3	32.3
Common hempnettle	*Galeopsis tetrahit*	10	7	10	27	5.1	32.1
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Wormseed wallflower	*Erysimum cheiranthoides*	10	7	10	27	4.9	31.9
Black medick	*Medicago lupulina*	10	7	10	27	4.5	31.5
Orange hawkweed	*Hieracium aurantiacum*	10	7	10	27	4.5	31.5
Flannel plant, common mullein	*Verbascum thapsus*	10	7	10	27	4.37	31.37
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
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
Cat-nip	*Nepeta cataria*	10	7	10	27	3.57	30.57
Kentucky bluegrass	*Poa pratensis*	10	7	10	27	3.43	30.43
Redtop	*Agrostis gigantea*	10	5	10	25	4.9	29.9
Goldmoss stonecrop	*Sedum acre*	10	5	10	25	4.37	29.37
Common reed	*Phragmites australis*	10	0	10	20	9.1	29.1
Bush honeysuckle	*Lonicera* sp.	10	0	10	20	8.47	28.47
Bull thistle	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Marsh thistle	*Cirsium palustre*	10	1	10	21	6.77	27.77
Canada thistle	*Cirsium arvense*	10	0	10	20	7.57	27.57
White sweet-clover	*Melilotus albus*	10	0	10	20	6.3	26.3
Helleborine	*Epipactis helleborine*	10	10	1	21	4.97	25.97
Proso millet	*Panicum miliaceum*	10	7	5	22	3.9	25.9
Canada bluegrass	*Poa compressa*	10	5	5	20	4.1	24.1
Purple loosestrife	*Lythrum salicaria*	5	0	10	15	9.1	24.1
Garden valerian, common valerian	*Valeriana officinalis*	5	0	10	15	7.3	22.3
Wild parsnip	*Pastinaca sativa*	5	0	10	15	7.3	22.3

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Quackgrass	*Elymus repens*	5	0	10	15	5.7	20.7
Lesser burdock	*Arctium minus*	5	0	10	15	5.1	20.1
Thyme-leaf speedwell	*Veronica serpyllifolia*	5	0	10	15	4.5	19.5
Red clover	*Trifolium pratense*	5	0	10	15	4.5	19.5
Meadow fescue	*Schedonorus pratensis*	5	0	10	15	4.5	19.5
Soapwort, bouncing bet	*Saponaria officinalis*	5	0	10	15	4.5	19.5
Butter and eggs	*Linaria vulgaris*	5	0	10	15	4.37	19.37
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
Tall buttercup	*Ranunculus acris*	5	0	10	15	4.1	19.1
Yellow hawkweed	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Annual bluegrass	*Poa annua*	5	0	10	15	3.57	18.57
Leafy spurge	*Euphorbia esula*	5	0	5	10	8.1	18.1
Multiflora rose	*Rosa multiflora*	5	0	5	10	7.3	17.3
Erect hedge parsley	*Torilis japonica*	5	0	5	10	5.9	15.9
European cranberry-bush	*Viburnum opulus*	5	0	5	10	5.1	15.1
Norway spruce	*Picea abies*	10	0	1	11	4.1	15.1
Queen Anne's lace	*Daucus carota*	5	0	5	10	5.1	15.1
Japanese barberry	*Berberis thunbergii*	5	0	1	6	9	15
Common gypsy-weed	*Veronica officinalis*	5	0	5	10	4.9	14.9
Common timothy	*Phleum pratense*	5	0	5	10	4.9	14.9
Strawberry clover	*Trifolium fragiferum*	10	0	1	11	3.57	14.57
Garlic mustard	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Common St. John's wort	*Hypericum perforatum*	5	0	5	10	4.37	14.37
Bitter dock, broadleaf dock	*Rumex obtusifolius*	5	0	5	10	4.1	14.1
Motherwort	*Leonurus cardiaca*	5	0	5	10	4.1	14.1
Orchard grass	*Dactylis glomerata*	5	0	5	10	4.1	14.1
Dame's rocket	*Hesperis matronalis*	5	0	1	6	7.7	13.7
Black bindweed, wild buckwheat	*Fallopia convolvulus*	5	0	5	10	3.7	13.7
Wood bluegrass	*Poa nemoralis*	5	0	5	10	3.57	13.57
White poplar	*Populus alba*	5	0	1	6	6.5	12.5
Scotch mist	*Galium sylvaticum*	5	0	1	6	4.1	10.1

Limestone Lakeshore Cliff (EO ID 18991)

Limestone lakeshore cliff is made up of vertical exposures of limestone along the Great Lakes. Their sparse soils are 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 (*Acer saccharum*), northern white cedar, balsam fir, and paper birch (Figure 9). This community is critically imperiled at the state level, occurring along the Niagara Escarpment in just three Michigan counties (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 9. Limestone lakeshore cliff on Poverty Island. Photo: Joshua Cohen, July 28, 2021.

Sensitive resources: [redacted]

Important biotic factors: Vegetation is sparse, generally restricted to lips, cracks, ledges, and along the base. Recent wind and fire events have impacted canopy trees at cliff tops and on

terraces between cliffs. A white cedar was cored and its age estimated at over 153 years (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).

Important abiotic factors: The cliffs span a stretch of about 1 mile (1.6 km) along the western shore. The cliffs are typically 10 – 20 ft (3 – 6 m) tall but locally reach heights of 30 – 40 ft (9 – 12 m). Soils, where present, are alkaline and shallow. Included in this community are not only cliffs immediately adjacent to Lake Michigan but a second tier of cliffs, inland by about 50 – 100 ft (15 – 30 m) and separated from the first cliff by a forested terrace (Cohen et al. 2022).

Identified vectors and pathways: The position along the lake makes this community vulnerable to shore invaders. Deer and unauthorized human visitors are likely to walk along the ridge and bring seeds of invasives on gear, hair, and clothing.

Invasive plant status: Priority 1 reed canary grass was present in a single 16 ft^2 (1.5 m^2) patch (Bassett et al. 2022). 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 two Priority 2 species that scored greater than 20 due to suitable habitat and/or proximity in adjacent areas/nearby islands (Table 11):

- Invasive common reed
- Narrow-leaved cat-tail
- Spotted knapweed
- Bush honeysuckle
- Wild parsnip
- Purple loosestrife
- Autumn olive
- White sweet-clover

Table 11. 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 (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
Houndstongue	*Cynoglossum officinale*	10	10	10	30	6.77	36.77
Reed canary grass	***Phalaris arundinacea***	**10**	**10**	**5**	**25**	**9.07**	**34.07**
Common hempnettle	*Galeopsis tetrahit*	10	7	10	27	5.1	32.1
Bittersweet nightshade, woody nightshade	*Solanum dulcamara*	10	7	10	27	4.9	31.9
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
Cat-nip	*Nepeta cataria*	10	7	10	27	3.57	30.57
Goldmoss stonecrop	*Sedum acre*	10	5	10	25	4.37	29.37
Common reed	*Phragmites australis*	10	0	10	20	9.1	29.1
Narrow-leaf cat-tail	*Typha angustifolia*	10	0	10	20	9	29
Spotted knapweed	*Centaurea stoebe* ssp. *micranthos*	10	0	10	20	9	29
Bush honeysuckle	*Lonicera* sp.	10	0	10	20	8.47	28.47
Bull thistle	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Marsh thistle	*Cirsium palustre*	10	1	10	21	6.77	27.77
Canada thistle	*Cirsium arvense*	10	0	10	20	7.57	27.57
White sweet-clover	*Melilotus albus*	10	0	10	20	6.3	26.3
Canada bluegrass	*Poa compressa*	10	7	5	22	4.1	26.1
Yellow hawkweed	*Hieracium caespitosum*	10	7	5	22	4.1	26.1
Smallflower hairy willow herb	*Epilobium parviflorum*	10	0	10	20	5.3	25.3
Wormseed wallflower	*Erysimum cheiranthoides*	10	0	10	20	4.9	24.9
Redtop	*Agrostis gigantea*	10	0	10	20	4.9	24.9
Black medick	*Medicago lupulina*	10	0	10	20	4.5	24.5
Orange hawkweed	*Hieracium aurantiacum*	10	0	10	20	4.5	24.5
Flannel plant, common mullein	*Verbascum thapsus*	10	0	10	20	4.37	24.37
Jack-go-to-bed-at-noon	*Tragopogon pratensis*	10	0	10	20	4.3	24.3
Spotted ladysthumb, ladysthumb	*Persicaria maculosa*	10	0	10	20	4.1	24.1
Purple loosestrife	*Lythrum salicaria*	5	0	10	15	9.1	24.1
Kentucky bluegrass	*Poa pratensis*	10	0	10	20	3.43	23.43
Garden valerian, common valerian	*Valeriana officinalis*	5	0	10	15	7.3	22.3
Wild parsnip	*Pastinaca sativa*	5	0	10	15	7.3	22.3

Common Name	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Autumn-olive	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Quackgrass	*Elymus repens*	5	0	10	15	5.7	20.7
Lesser burdock	*Arctium minus*	5	0	10	15	5.1	20.1
Common timothy	*Phleum pratense*	5	0	10	15	4.9	19.9
Thyme-leaf speedwell	*Veronica serpyllifolia*	5	0	10	15	4.5	19.5
Red clover	*Trifolium pratense*	5	0	10	15	4.5	19.5
Meadow fescue	*Schedonorus pratensis*	5	0	10	15	4.5	19.5
Soapwort, bouncing bet	*Saponaria officinalis*	5	0	10	15	4.5	19.5
Butter and eggs	*Linaria vulgaris*	5	0	10	15	4.37	19.37
Bladder campion	*Silene vulgaris*	5	0	10	15	4.1	19.1
White campion	*Silene latifolia*	5	0	10	15	4.1	19.1
Tall buttercup	*Ranunculus acris*	5	0	10	15	4.1	19.1
Proso millet	*Panicum miliaceum*	10	0	5	15	3.9	18.9
Annual bluegrass	*Poa annua*	5	0	10	15	3.57	18.57
Leafy spurge	*Euphorbia esula*	5	0	5	10	8.1	18.1
Multiflora rose	*Rosa multiflora*	5	0	5	10	7.3	17.3
Helleborine	*Epipactis helleborine*	10	0	1	11	4.97	15.97
Erect hedge parsley	*Torilis japonica*	5	0	5	10	5.9	15.9
European cranberry-bush	*Viburnum opulus*	5	0	5	10	5.1	15.1
Norway spruce	*Picea abies*	10	0	1	11	4.1	15.1
Queen Anne's lace	*Daucus carota*	5	0	5	10	5.1	15.1
Japanese barberry	*Berberis thunbergii*	5	0	1	6	9	15
Common gypsy-weed	*Veronica officinalis*	5	0	5	10	4.9	14.9
Strawberry clover	*Trifolium fragiferum*	10	0	1	11	3.57	14.57
Garlic mustard	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Common St. John's wort	*Hypericum perforatum*	5	0	5	10	4.37	14.37
Bitter dock, broadleaf dock	*Rumex obtusifolius*	5	0	5	10	4.1	14.1
Motherwort	*Leonurus cardiaca*	5	0	5	10	4.1	14.1
Orchard grass	*Dactylis glomerata*	5	0	5	10	4.1	14.1
Dame's rocket	*Hesperis matronalis*	5	0	1	6	7.7	13.7
Black bindweed, wild buckwheat	*Fallopia convolvulus*	5	0	5	10	3.7	13.7
Wood bluegrass	*Poa nemoralis*	5	0	5	10	3.57	13.57
White poplar	*Populus alba*	5	0	1	6	6.5	12.5
Scotch mist	*Galium sylvaticum*	5	0	1	6	4.1	10.1

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.

Invasive Plant Management Objectives

- Elimination of 7 of 7 Priority 1 species within ten years
- Eradication of 4 of 7 Priority 1 species within fifteen years
- 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 100 m of Laurentian fragile fern and climbing fumitory EOs within fifteen years

Management Strategies and Actions

Ongoing actions

- Regular *monitoring* of areas on and near the shore for new occurrences of invasives plant species, especially the limestone bedrock lakeshore, northeast peninsula, lighthouse area, old hunting camp, and within 330 ft (100 m) of the climbing fumitory and Laurentian fragile fern EOs
- Set management threshold and develop action plan for deer population on island. *Monitor* population regularly and initiate management efforts when approaching threshold.

Actions to be initiated within five years

- *Elimination* of wild parsnip in lighthouse area. Declare *eradication* after monitoring efforts fail to find the species over five years.
- *Elimination* of spotted knapweed, narrow-leaved cat-tail, and reed canary grass from the southeast of the island at the edge of boreal forest and limestone cobble lakeshore. Declare *eradication* after monitoring efforts fail to find the species over ten years.
- *Elimination* of reed canary grass from the northwest of the island at the edge of boreal forest and limestone lakeshore cliff. Declare *eradication* after monitoring efforts fail to find the species over ten years.
- *Elimination* of bush honeysuckle from the burned boreal forest on the northeast peninsula. Declare *eradication* after monitoring efforts fail to find the species over ten years.
- *Perimeter control* to *elimination* of white sweet-clover from burned boreal forest in the central portion of the island and the northeast peninsula. Declare *eradication* after monitoring efforts fail to find the species over ten years.
- *Perimeter control* to *elimination* of invasive common reed from burned boreal forest in the northeast peninsula. Declare *eradication* after monitoring efforts fail to find the species over ten years.

Actions to be initiated within ten years

- *Sustained control* of houndstongue, thistle, helleborine, and bittersweet nightshade within 330 ft (100 m) of climbing fumitory 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 common 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, especially the limestone bedrock lakeshore, northeast peninsula, lighthouse area, old hunting camp, and the vicinity of the climbing fumitory 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 10).

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 10, 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".

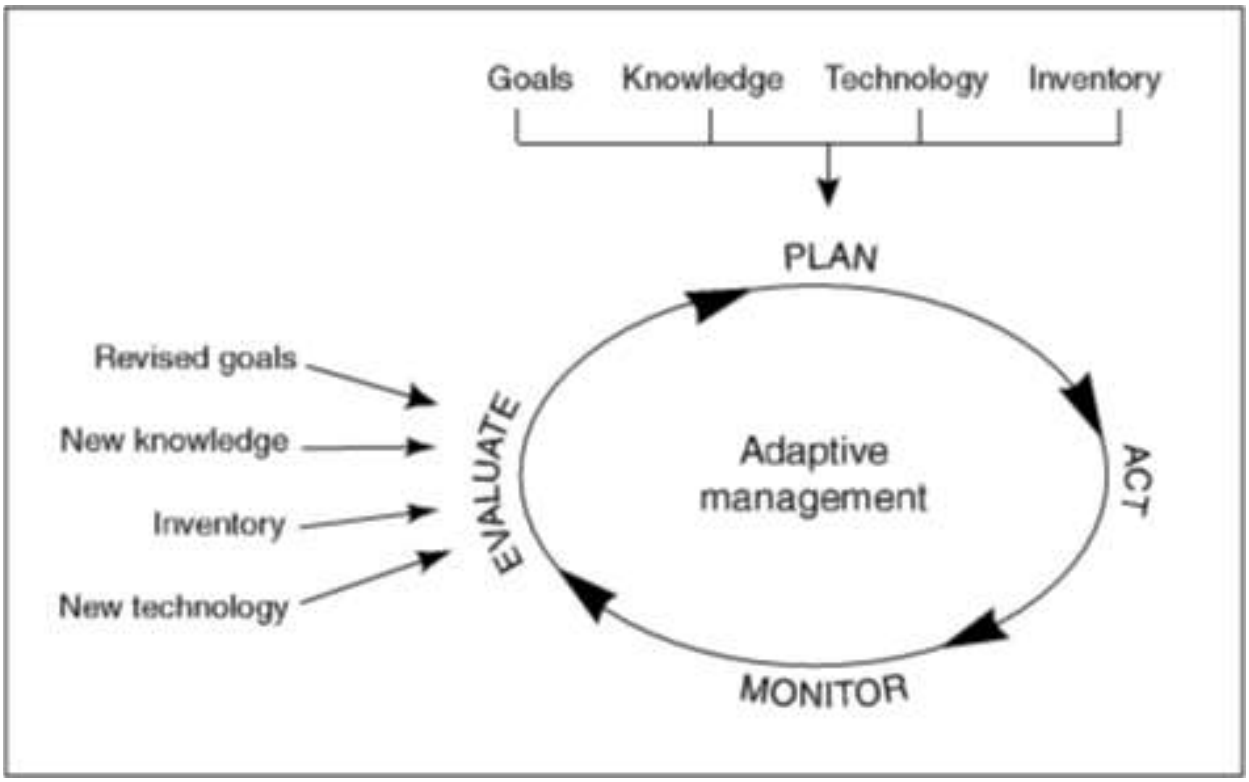

Figure 10. The adaptive management cycle. Figure reproduced from USDA USDI (1994) and Lowell et al. (2014).

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 12. 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 12. 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 (1 d)	Low (1-2 d)	Medium (1-3 d)	High (2-3 d)	Highest (3-4 d)
Treatment efficacy photo points	X	X	X	X	X
Invasive species survey on burned peninsula in northeast	X	X	X	X	X
Rare species occurrences of climbing fumitory and Laurentian fragile fern		X	X	X	X
Invasive species survey on perimeter of island, lighthouse area, hunting camp in east		X	X	X	X
Invasive species in limestone bedrock lakeshore, limestone lakeshore cliff			X	X	X
Invasive species survey in both burned and unburned boreal forest				X	X
Rare species survey for new occurrences in limestone bedrock lakeshore, limestone lakeshore cliff				X	X
Invasive species survey in all island communities					X
Rare species survey for new occurrences in boreal forest					X
Rare species survey in all island communities					X

A monitoring schedule including desired effort should be planned and budgeted (Table 13). This schedule should be flexible to adapt the IPMP based on evaluation of new data acquired after treatment and/or monitoring (Figure 10). 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 13).

Table 13. 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.

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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_Poverty_PHAU_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_Poverty_PHAU_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	Pesticide Use Permit 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 [1]	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

[1] 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 the USFWS 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 offline
    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. Select "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 want, 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 offline
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 of interest
    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 on the right. If there is not a dot in the center of the target, your device's location may not be on or you may not be within the map extent
        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 uncertainty 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. Open ArcGIS Collector App on your device
    b. On the home page, select the Group with the Map with the record feature of interest
    c. You should see all the Maps you downloaded in a list
    d. Tap on the Map with the record feature of interest
    e. Zoom into the record feature of interest on the map
    f. Tap on the feature record of interest
    g. Several feature records may be listed, select the one you wish to edit

i. To edit
    1. Tap the pencil icon at the bottom of the screen to edit the feature
    2. Edit the fields need
ii. To add new data (e.g., revisit data):
    1. Scroll down the record to the section marked "Related"
    2. Tap the chain link to add an observation or other linked table (e.g., Table – Plant Monitoring, Table – Obs_Event)
    3. Tab the blue "Add" button
    4. Add new data to fields
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. 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
    c. On the home page, select the Group with the Map you wish to sync
    d. Tap the three dot menu to the right of the map you wish to sync
    e. Select "Sync"
    f. Under the map name, the most recent "Sync" date will be listed
    g. 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
    c. On the home page, select the Group with the Map that has the features you wish to delete
    d. Select the map with the feature record you need to delete
    e. Tap and select the feature
    f. Search for a "Record Status" or similar field
        i. If feature has such a field, select "Delete record" from list of options
    g. If feature does not have such a field, add a "Delete record" note to the "Comment" field
    h. 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 "Element 3: 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. Poverty 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* spp.) 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
Alliaria petiolata	garlic mustard, garlic-mustard	184481	ALPE4	1.4	4	3	1	9.4
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
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	LONIC	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 Poverty Island, sorted by species. Table 9 through Table 11 list scores for each area. As bush honeysuckle (*Lonicera* sp.) observed on the island all have the same NatureServe rankings, they are pooled together in the table.

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Boreal forest	*Agrostis gigantea*	10	0	10	20	4.9	24.9
Limestone bedrock lakeshore	*Agrostis gigantea*	10	5	10	25	4.9	29.9
Limestone lakeshore cliff	*Agrostis gigantea*	10	0	10	20	4.9	24.9
Boreal forest	*Alliaria petiolata*	5	0	10	15	9.4	24.4
Limestone bedrock lakeshore	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Limestone lakeshore cliff	*Alliaria petiolata*	5	0	0	5	9.4	14.4
Boreal forest	*Arctium minus*	5	0	10	15	5.1	20.1
Limestone bedrock lakeshore	*Arctium minus*	5	0	10	15	5.1	20.1
Limestone lakeshore cliff	*Arctium minus*	5	0	10	15	5.1	20.1
Boreal forest	*Berberis thunbergii*	5	0	10	15	9	24
Limestone bedrock lakeshore	*Berberis thunbergii*	5	0	1	6	9	15
Limestone lakeshore cliff	*Berberis thunbergii*	5	0	1	6	9	15
Boreal forest	*Centaurea stoebe* ssp. *micranthos*	10	0	1	11	9	20
Limestone bedrock lakeshore	*Centaurea stoebe* ssp. *micranthos*	10	10	10	30	9	39
Limestone lakeshore cliff	*Centaurea stoebe* ssp. *micranthos*	10	0	10	20	9	29
Boreal forest	*Cerastium fontanum* ssp. *vulgare*	10	0	10	20	3.9	23.9
Limestone bedrock lakeshore	*Cerastium fontanum* ssp. *vulgare*	10	7	10	27	3.9	30.9
Limestone lakeshore cliff	*Cerastium fontanum* ssp. *vulgare*	10	7	10	27	3.9	30.9
Boreal forest	*Cirsium arvense*	10	10	10	30	7.57	37.57
Limestone bedrock lakeshore	*Cirsium arvense*	10	0	10	20	7.57	27.57
Limestone lakeshore cliff	*Cirsium arvense*	10	0	10	20	7.57	27.57
Boreal forest	*Cirsium palustre*	10	1	10	21	6.77	27.77
Limestone bedrock lakeshore	*Cirsium palustre*	10	1	10	21	6.77	27.77
Limestone lakeshore cliff	*Cirsium palustre*	10	1	10	21	6.77	27.77
Boreal forest	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Limestone bedrock lakeshore	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Limestone lakeshore cliff	*Cirsium vulgare*	10	1	10	21	6.77	27.77
Boreal forest	*Cynoglossum officinale*	10	10	10	30	6.77	36.77
Limestone bedrock lakeshore	*Cynoglossum officinale*	10	10	10	30	6.77	36.77

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Limestone lakeshore cliff	*Cynoglossum officinale*	10	10	10	30	6.77	36.77
Boreal forest	*Dactylis glomerata*	5	0	5	10	4.1	14.1
Limestone bedrock lakeshore	*Dactylis glomerata*	5	0	5	10	4.1	14.1
Limestone lakeshore cliff	*Dactylis glomerata*	5	0	5	10	4.1	14.1
Boreal forest	*Daucus carota*	5	0	5	10	5.1	15.1
Limestone bedrock lakeshore	*Daucus carota*	5	0	5	10	5.1	15.1
Limestone lakeshore cliff	*Daucus carota*	5	0	5	10	5.1	15.1
Boreal forest	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Limestone bedrock lakeshore	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Limestone lakeshore cliff	*Elaeagnus umbellata*	5	0	10	15	6.1	21.1
Boreal forest	*Elymus repens*	5	0	5	10	5.7	15.7
Limestone bedrock lakeshore	*Elymus repens*	5	0	10	15	5.7	20.7
Limestone lakeshore cliff	*Elymus repens*	5	0	10	15	5.7	20.7
Boreal forest	*Epilobium parviflorum*	10	0	1	11	5.3	16.3
Limestone bedrock lakeshore	*Epilobium parviflorum*	10	7	10	27	5.3	32.3
Limestone lakeshore cliff	*Epilobium parviflorum*	10	0	10	20	5.3	25.3
Boreal forest	*Epipactis helleborine*	10	7	10	27	4.97	31.97
Limestone bedrock lakeshore	*Epipactis helleborine*	10	10	1	21	4.97	25.97
Limestone lakeshore cliff	*Epipactis helleborine*	10	0	1	11	4.97	15.97
Boreal forest	*Erysimum cheiranthoides*	10	0	5	15	4.9	19.9
Limestone bedrock lakeshore	*Erysimum cheiranthoides*	10	7	10	27	4.9	31.9
Limestone lakeshore cliff	*Erysimum cheiranthoides*	10	0	10	20	4.9	24.9
Boreal forest	*Euphorbia esula*	5	0	5	10	8.1	18.1
Limestone bedrock lakeshore	*Euphorbia esula*	5	0	5	10	8.1	18.1
Limestone lakeshore cliff	*Euphorbia esula*	5	0	5	10	8.1	18.1
Boreal forest	*Fallopia convolvulus*	5	0	5	10	3.7	13.7
Limestone bedrock lakeshore	*Fallopia convolvulus*	5	0	5	10	3.7	13.7
Limestone lakeshore cliff	*Fallopia convolvulus*	5	0	5	10	3.7	13.7
Boreal forest	*Galeopsis tetrahit*	10	0	10	20	5.1	25.1
Limestone bedrock lakeshore	*Galeopsis tetrahit*	10	7	10	27	5.1	32.1
Limestone lakeshore cliff	*Galeopsis tetrahit*	10	7	10	27	5.1	32.1
Boreal forest	*Galium sylvaticum*	5	0	10	15	4.1	19.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Limestone bedrock lakeshore	*Galium sylvaticum*	5	0	1	6	4.1	10.1
Limestone lakeshore cliff	*Galium sylvaticum*	5	0	1	6	4.1	10.1
Boreal forest	*Hesperis matronalis*	5	0	10	15	7.7	22.7
Limestone bedrock lakeshore	*Hesperis matronalis*	5	0	1	6	7.7	13.7
Limestone lakeshore cliff	*Hesperis matronalis*	5	0	1	6	7.7	13.7
Boreal forest	*Hieracium aurantiacum*	10	7	10	27	4.5	31.5
Limestone bedrock lakeshore	*Hieracium aurantiacum*	10	7	10	27	4.5	31.5
Limestone lakeshore cliff	*Hieracium aurantiacum*	10	0	10	20	4.5	24.5
Boreal forest	*Hieracium caespitosum*	10	7	5	22	4.1	26.1
Limestone bedrock lakeshore	*Hieracium caespitosum*	10	0	5	15	4.1	19.1
Limestone lakeshore cliff	*Hieracium caespitosum*	10	7	5	22	4.1	26.1
Boreal forest	*Hypericum perforatum*	5	0	5	10	4.37	14.37
Limestone bedrock lakeshore	*Hypericum perforatum*	5	0	5	10	4.37	14.37
Limestone lakeshore cliff	*Hypericum perforatum*	5	0	5	10	4.37	14.37
Boreal forest	*Leonurus cardiaca*	5	0	5	10	4.1	14.1
Limestone bedrock lakeshore	*Leonurus cardiaca*	5	0	5	10	4.1	14.1
Limestone lakeshore cliff	*Leonurus cardiaca*	5	0	5	10	4.1	14.1
Boreal forest	*Leucanthemum vulgare*	10	7	5	22	3.97	25.97
Limestone bedrock lakeshore	*Leucanthemum vulgare*	10	7	10	27	3.97	30.97
Limestone lakeshore cliff	*Leucanthemum vulgare*	10	7	10	27	3.97	30.97
Boreal forest	*Linaria vulgaris*	5	0	5	10	4.37	14.37
Limestone bedrock lakeshore	*Linaria vulgaris*	5	0	10	15	4.37	19.37
Limestone lakeshore cliff	*Linaria vulgaris*	5	0	10	15	4.37	19.37
Boreal forest	*Lonicera* sp.	10	10	10	30	8.47	38.47
Limestone bedrock lakeshore	*Lonicera* sp.	10	0	10	20	8.47	28.47
Limestone lakeshore cliff	*Lonicera* sp.	10	0	10	20	8.47	28.47
Boreal forest	*Lythrum salicaria*	5	0	1	6	9.1	15.1
Limestone bedrock lakeshore	*Lythrum salicaria*	5	0	10	15	9.1	24.1
Limestone lakeshore cliff	*Lythrum salicaria*	5	0	10	15	9.1	24.1
Boreal forest	*Medicago lupulina*	10	0	5	15	4.5	19.5
Limestone bedrock lakeshore	*Medicago lupulina*	10	7	10	27	4.5	31.5
Limestone lakeshore cliff	*Medicago lupulina*	10	0	10	20	4.5	24.5
Boreal forest	*Melilotus albus*	10	5	10	25	6.3	31.3

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Limestone bedrock lakeshore	*Melilotus albus*	10	0	10	20	6.3	26.3
Limestone lakeshore cliff	*Melilotus albus*	10	0	10	20	6.3	26.3
Boreal forest	*Nepeta cataria*	10	7	5	22	3.57	25.57
Limestone bedrock lakeshore	*Nepeta cataria*	10	7	10	27	3.57	30.57
Limestone lakeshore cliff	*Nepeta cataria*	10	7	10	27	3.57	30.57
Boreal forest	*Panicum miliaceum*	10	0	5	15	3.9	18.9
Limestone bedrock lakeshore	*Panicum miliaceum*	10	7	5	22	3.9	25.9
Limestone lakeshore cliff	*Panicum miliaceum*	10	0	5	15	3.9	18.9
Boreal forest	*Pastinaca sativa*	5	0	10	15	7.3	22.3
Limestone bedrock lakeshore	*Pastinaca sativa*	5	0	10	15	7.3	22.3
Limestone lakeshore cliff	*Pastinaca sativa*	5	0	10	15	7.3	22.3
Boreal forest	*Persicaria maculosa*	10	0	5	15	4.1	19.1
Limestone bedrock lakeshore	*Persicaria maculosa*	10	7	10	27	4.1	31.1
Limestone lakeshore cliff	*Persicaria maculosa*	10	0	10	20	4.1	24.1
Boreal forest	*Phalaris arundinacea*	10	10	5	25	9.07	34.07
Limestone bedrock lakeshore	*Phalaris arundinacea*	10	10	5	25	9.07	34.07
Limestone lakeshore cliff	*Phalaris arundinacea*	10	10	5	25	9.07	34.07
Boreal forest	*Phleum pratense*	5	0	5	10	4.9	14.9
Limestone bedrock lakeshore	*Phleum pratense*	5	0	5	10	4.9	14.9
Limestone lakeshore cliff	*Phleum pratense*	5	0	10	15	4.9	19.9
Boreal forest	*Phragmites australis* ssp. *australis*	10	5	5	20	9.1	29.1
Limestone bedrock lakeshore	*Phragmites australis* ssp. *australis*	10	0	10	20	9.1	29.1
Limestone lakeshore cliff	*Phragmites australis* ssp. *australis*	10	0	10	20	9.1	29.1
Boreal forest	*Picea abies*	10	10	1	21	4.1	25.1
Limestone bedrock lakeshore	*Picea abies*	10	0	1	11	4.1	15.1
Limestone lakeshore cliff	*Picea abies*	10	0	1	11	4.1	15.1
Boreal forest	*Poa annua*	5	0	5	10	3.57	13.57
Limestone bedrock lakeshore	*Poa annua*	5	0	10	15	3.57	18.57
Limestone lakeshore cliff	*Poa annua*	5	0	10	15	3.57	18.57
Boreal forest	*Poa compressa*	10	7	10	27	4.1	31.1
Limestone bedrock lakeshore	*Poa compressa*	10	5	5	20	4.1	24.1
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
Boreal forest	*Poa nemoralis*	5	0	10	15	3.57	18.57
Limestone bedrock lakeshore	*Poa nemoralis*	5	0	5	10	3.57	13.57
Limestone lakeshore cliff	*Poa nemoralis*	5	0	5	10	3.57	13.57
Boreal forest	*Poa pratensis*	10	7	10	27	3.43	30.43
Limestone bedrock lakeshore	*Poa pratensis*	10	7	10	27	3.43	30.43
Limestone lakeshore cliff	*Poa pratensis*	10	0	10	20	3.43	23.43
Boreal forest	*Populus alba*	5	0	5	10	6.5	16.5
Limestone bedrock lakeshore	*Populus alba*	5	0	1	6	6.5	12.5
Limestone lakeshore cliff	*Populus alba*	5	0	1	6	6.5	12.5
Boreal forest	*Ranunculus acris*	5	0	10	15	4.1	19.1
Limestone bedrock lakeshore	*Ranunculus acris*	5	0	10	15	4.1	19.1
Limestone lakeshore cliff	*Ranunculus acris*	5	0	10	15	4.1	19.1
Boreal forest	*Rosa multiflora*	5	0	10	15	7.3	22.3
Limestone bedrock lakeshore	*Rosa multiflora*	5	0	5	10	7.3	17.3
Limestone lakeshore cliff	*Rosa multiflora*	5	0	5	10	7.3	17.3
Boreal forest	*Rumex obtusifolius*	5	0	10	15	4.1	19.1
Limestone bedrock lakeshore	*Rumex obtusifolius*	5	0	5	10	4.1	14.1
Limestone lakeshore cliff	*Rumex obtusifolius*	5	0	5	10	4.1	14.1
Boreal forest	*Saponaria officinalis*	5	0	10	15	4.5	19.5
Limestone bedrock lakeshore	*Saponaria officinalis*	5	0	10	15	4.5	19.5
Limestone lakeshore cliff	*Saponaria officinalis*	5	0	10	15	4.5	19.5
Boreal forest	*Schedonorus pratensis*	5	0	10	15	4.5	19.5
Limestone bedrock lakeshore	*Schedonorus pratensis*	5	0	10	15	4.5	19.5
Limestone lakeshore cliff	*Schedonorus pratensis*	5	0	10	15	4.5	19.5
Boreal forest	*Sedum acre*	10	10	1	21	4.37	25.37
Limestone bedrock lakeshore	*Sedum acre*	10	5	10	25	4.37	29.37
Limestone lakeshore cliff	*Sedum acre*	10	5	10	25	4.37	29.37
Boreal forest	*Silene latifolia*	5	0	10	15	4.1	19.1
Limestone bedrock lakeshore	*Silene latifolia*	5	0	10	15	4.1	19.1
Limestone lakeshore cliff	*Silene latifolia*	5	0	10	15	4.1	19.1
Boreal forest	*Silene vulgaris*	5	0	10	15	4.1	19.1
Limestone bedrock lakeshore	*Silene vulgaris*	5	0	10	15	4.1	19.1
Limestone lakeshore cliff	*Silene vulgaris*	5	0	10	15	4.1	19.1

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Boreal forest	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Limestone bedrock lakeshore	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Limestone lakeshore cliff	*Solanum dulcamara*	10	7	10	27	4.9	31.9
Boreal forest	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Limestone bedrock lakeshore	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Limestone lakeshore cliff	*Taraxacum officinale*	10	7	10	27	3.57	30.57
Boreal forest	*Torilis japonica*	5	0	10	15	5.9	20.9
Limestone bedrock lakeshore	*Torilis japonica*	5	0	5	10	5.9	15.9
Limestone lakeshore cliff	*Torilis japonica*	5	0	5	10	5.9	15.9
Boreal forest	*Tragopogon pratensis*	10	7	10	27	4.3	31.3
Limestone bedrock lakeshore	*Tragopogon pratensis*	5	0	10	15	4.3	19.3
Limestone lakeshore cliff	*Tragopogon pratensis*	10	0	10	20	4.3	24.3
Boreal forest	*Trifolium fragiferum*	10	10	5	25	3.57	28.57
Limestone bedrock lakeshore	*Trifolium fragiferum*	10	0	1	11	3.57	14.57
Limestone lakeshore cliff	*Trifolium fragiferum*	10	0	1	11	3.57	14.57
Boreal forest	*Trifolium pratense*	5	0	10	15	4.5	19.5
Limestone bedrock lakeshore	*Trifolium pratense*	5	0	10	15	4.5	19.5
Limestone lakeshore cliff	*Trifolium pratense*	5	0	10	15	4.5	19.5
Boreal forest	*Typha angustifolia*	10	0	5	15	9	24
Limestone bedrock lakeshore	*Typha angustifolia*	10	10	10	30	9	39
Limestone lakeshore cliff	*Typha angustifolia*	10	0	10	20	9	29
Boreal forest	*Valeriana officinalis*	5	0	5	10	7.3	17.3
Limestone bedrock lakeshore	*Valeriana officinalis*	5	0	10	15	7.3	22.3
Limestone lakeshore cliff	*Valeriana officinalis*	5	0	10	15	7.3	22.3
Boreal forest	*Verbascum thapsus*	10	7	10	27	4.37	31.37
Limestone bedrock lakeshore	*Verbascum thapsus*	10	7	10	27	4.37	31.37
Limestone lakeshore cliff	*Verbascum thapsus*	10	0	10	20	4.37	24.37
Boreal forest	*Veronica officinalis*	5	0	10	15	4.9	19.9
Limestone bedrock lakeshore	*Veronica officinalis*	5	0	5	10	4.9	14.9
Limestone lakeshore cliff	*Veronica officinalis*	5	0	5	10	4.9	14.9
Boreal forest	*Veronica serpyllifolia*	5	0	10	15	4.5	19.5
Limestone bedrock lakeshore	*Veronica serpyllifolia*	5	0	10	15	4.5	19.5
Limestone lakeshore cliff	*Veronica serpyllifolia*	5	0	10	15	4.5	19.5

Area	Scientific Name ITIS	Presence Score	Status Score	Habitat Score	Total Score	Species Score	Overall Score
Boreal forest	*Viburnum opulus*	5	0	5	10	5.1	15.1
Limestone bedrock lakeshore	*Viburnum opulus*	5	0	5	10	5.1	15.1
Limestone lakeshore cliff	*Viburnum opulus*	5	0	5	10	5.1	15.1