



Michigan Islands National Wildlife Refuge **(Lake Huron islands managed by Shiawassee NWR)**

Habitat Management Plan

October 2018



Little Charity Island 2013. (Photo credit: USFWS)

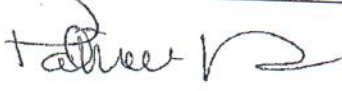
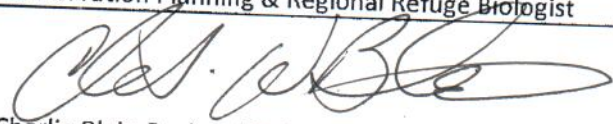


Habitat Management Plans provide long-term guidance for management decisions; set forth goals, objectives, and strategies needed to accomplish refuge purposes; and, identify the Fish and Wildlife Service's best estimate of future needs. These plans detail program planning levels that are sometimes substantially above current budget allocations and as such, are primarily for Service strategic planning and program prioritization purposes. The plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.

The National Wildlife Refuge System, managed by the U.S. Fish and Wildlife Service, is the world's premier system of public lands and waters set aside to conserve America's fish, wildlife, and plants. Since the designation of the first wildlife refuge in 1903, the System has grown to encompass more than 150 million acres, 556 national wildlife refuges and other units of the Refuge System, plus 38 wetland management districts.

Habitat Management Plan
Michigan Islands NWR
(Lake Huron islands managed by Shiawassee NWR)

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Chapter 1: Introduction

1.1 Scope and Rationale

Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands are part of the Michigan Islands National Wildlife Refuge (NWR) which is presently comprised of nine islands located in Lake Michigan and Lake Huron. Michigan Islands NWR is managed by the U.S. Fish and Wildlife Service (Service) as part of the National Wildlife Refuge System (NWRS). Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands are located in Lake Huron and are presently managed by staff at Shiawassee NWR. The other four islands, Gull, Pismire, Hat, and Shoe Islands, are located in Lake Michigan and are presently managed by staff at Seney NWR.

The mission of NWRS is: *“To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.”*

In 1997, Congress passed the National Wildlife Refuge System Refuge Improvement Act renewing its vision for the future of the refuge system where:

- Wildlife comes first
- Refuges are anchors for biodiversity and ecosystem-level conservation
- Lands and waters of the System are biologically healthy
- Refuge lands reflect national and international leadership in habitat management and wildlife conservation
- The biological integrity, diversity and environmental health must be maintained, defined in 601 FW 3.
- Monitoring of plant and animal populations is essential
- Growth of the NWRS and conservation of ecosystems across the United States.

In 2013 a Comprehensive Conservation Plan (CCP) was written for Gravel Island, Green Bay, Harbor Island, Huron, and Michigan Islands NWRs (i.e. Great Lakes Islands or GLI; USFWS 2013a). The CCP was designed to guide the management and administration of these Refuges for a period of 15 years while adhering to the NWRS and the Refuge’s missions and visions. Identified within the GLI CCP are broadly-defined goals and objectives for the management of wildlife and habitats within the Refuges. The Vision Statement of the 2013 Great Lakes Island CCP is:

“Management of Great Lakes islands refuges will reflect the mission of the National Wildlife Refuge System (NWRS, Refuge System) by conserving in perpetuity a rich mosaic of island habitats and enabling nesting and migrating birds and other wildlife of conservation concern in the Great Lakes to thrive here. The refuge islands will serve as a resilient source of evolving habitats and ecosystem processes even as structure and composition are altered due to climate change.”

The following Habitat Management Plan (HMP) serves as a step-down plan from the GLI CCP and provides a more precise guide to the goals, objectives, and strategies for the management of wildlife and habitats of the Michigan Islands NWR islands located in Lake Huron and managed by Shiawassee NWR (hereafter referred to as MI Islands NWR: Lake Huron). Presently these islands include Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands. Any islands acquired after the approval of this HMP and are managed by Shiawassee NWR will also adhere to the goals and objectives outlined in the following chapters.

The lifespan of this HMP is 15 years and was prepared in accordance with guidance for developing HMPs provided by the USFWS Habitat Management Plans policy (620 FW 1). It also complies with all applicable laws, regulations, and policies governing the management of units of the NWRS.

1.2 Legal Mandates

Michigan Islands NWR was established by Executive Order 265 in 1943. . .

" . . . as a refuge and breeding ground for migratory birds and other wildlife . . . "

" . . . for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act) and

" . . . conservation, management, and restoration of the fish, wildlife, and plant resources and their habitats for the benefit of present and future generations of Americans . . . " 16 U.S.C. § 668dd(a)(2) (National Wildlife Refuge System Administration Act)

This HMP will focus on the five Michigan Islands NWR islands that are located in Lake Huron and are managed by Shiawassee NWR. Presently, this includes Scarecrow Island, which was acquired in 1943 and was one of the first islands that established the Michigan Islands NWR; Thunder Bay Island, which was added in 1965 by a USCG /Service agreement; Big and Little Charity Islands, which were added to the refuge in 1999 and Sugar Island which was purchased by the Service in 2011 (USFWS 2013a).

On October 23, 1970 Public Law 91-504 established Scarecrow Island as a designated Federal Wilderness Areas.

In 2000, Scarecrow and Thunder Bay Islands were designated part of the Thunder Bay National Marine Sanctuary and Underwater Preserve.

Multiple additional laws and executive orders are applicable to the management and administration of Michigan Islands NWR and a full listing can be found in Appendix E of the GLI CCP (USFWS 2013a).

1.3 Relationship to Other Plans

This HMP is a step-down plan to Great Lakes Islands CCP (USFWS 2013a) and provides more specific information regarding habitat or resource management for MI Islands NWR: Lake Huron. The wildlife and habitat goals and objectives described in this HMP are consistent with other refuge plans, as well as, regional and national conservation plans. The 2013 GLI CCP and the plans listed below were used to help develop this HMP.

Michigan's Wildlife Action Plan

In 2005, Michigan's Wildlife Action Plan (Eagle et al. 2005) was completed to better manage wildlife species and their habitats of "greatest conservation need". The plan was developed with the support of funding from the State Wildlife Grant Program created by Congress in 2001. The goal of the plan is to provide a common strategic framework that enable Michigan's conservation partners to jointly implement a long-term holistic approach for the conservation of all wildlife species (Eagle et al. 2005). Members of the partnership include the Michigan Department of Natural Resources (MDNR or State), U.S. Fish and Wildlife Service, U.S. Forest Service, The Nature Conservancy, Michigan Natural Features Inventory, academics from several Michigan universities, as well as many other agencies and conservation organizations. In 2015 Michigan's Wildlife Action Plan (MDNR 2015) was revised based on new data and research, collaborative partnerships, and lessons learned in the last ten years. The work outlined can be connected with many state and national conservation and management plans and focuses on those species in greatest conservation need.

"The overarching goal of Michigan's Wildlife Action Plan is to provide a common strategic framework to coordinate the conservation of wildlife and habitats in Michigan. This framework will help move wildlife conservation forward by highlighting ways to work together voluntarily and cooperatively towards shared goals." (MDNR 2015)

Selecting surrogate species for Strategic Habitat Conservation in the Upper Midwest Great Lakes geography (USFWS 2014)

A team of U.S. Fish and Wildlife Service staff and partners selected 36 surrogate species using an eight step selection process based on the elements of Strategic Habitat Conservation. These species represent seven broad habitat types within the Upper Midwest and Great Lakes geography. These species were considered during our evaluation of Resources of Concern (ROC) specific to MI Islands NWR: Lake Huron. (i.e. common tern, *Sterna hirundo*; black tern, *Chlidonias niger*)

Region 3 Fish & Wildlife Resource Conservation Priorities (USFWS 2002a)

<https://www.fws.gov/midwest/News/documents/priority.pdf>

In 2002, the USFWS identified species considered to be in the greatest need of attention in Region 3 (USFWS 2002a). This plan identifies conservation concerns, desired outcomes, conservation obstacles, and conservation strategies associated with each species and their associated habitats. Development of the plan is intended to help managers prioritize their workloads, identify research priorities and strategies, prepare management plans, and allocate funds and personnel that will benefit migratory birds, threatened and endangered species, and

interjurisdictional fish, as well as the habitats on which they depend. The species identified in this plan were considered during our evaluation of ROC specific to MI Islands NWR: Lake Huron.

Upper Mississippi River and Great Lakes Region Joint Venture

Plans include:

- Upper Mississippi River and Great Lakes Region Joint Venture Implementation Plan (UMRGLR JV. 2007)
- Upper Mississippi River and Great Lakes Region Joint Venture Shorebird Habitat Conservation Strategy (Potter et al. 2007a)
- Upper Mississippi River and Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy (Soulliere et al. 2007a)
- Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy (Soulliere et al. 2007b)
- Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy (Potter et al. 2007b)

The Upper Mississippi River and Great Lakes Region Joint Venture all-bird, shorebird, waterfowl, waterbird, and landbird plans provides land managers with guidance regarding conservation strategies that can be used in managing bird habitats. These plans establish regional bird population and habitat conservation objectives, and provide estimates of the size and types of habitats required to increase and sustain populations of focal bird species at target levels. Focal species identified in these plans were considered during our evaluation of ROC specific to MI Islands NWR: Lake Huron.

USFWS Birds of Conservation Concern 2008 (USFWS 2008)

(<https://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php>)

In 2008 the USFWS identified species, subspecies, and populations of all migratory nongame birds that were likely to become candidate species under the Endangered Species Act of 1973, as amended. This report identifies 37 Bird Conservation Regions (BCR) and the species associated with those regions that are priorities for conservation action. The MI Islands NWR: Lake Huron islands are located in BCR 12, the Boreal Hardwood Transition.

FWS FY2012- FY2016 Focal Species

(<https://www.fws.gov/birds/management/managed-species/focal-species.php>)

Focal Species are a subset of the USFWS Migratory Bird Program's Birds of Management Concern list (<https://www.fws.gov/migratorybirds/pdf/management/BMCFocalSpecies.pdf>). The Migratory Bird Program identifies Focal Species that need targeted investment because they: 1) have high conservation need, 2) are representative of a broader group of species sharing the same or similar conservation needs, 3) act as a potential unifier for partnerships, and/or 4) have a high likelihood that factors affecting status can be realistically addressed (<https://www.fws.gov/migratorybirds/pdf/management/focalspecies.pdf>).

Partners in Flight (Rosenberg et al. 2016)

Partners in Flight (PIF) Bird Conservation Plans identify species and habitats most in need of conservation, establish objectives for bird populations and habitats within physiographic areas, and make recommendations for needed conservation actions. MI Islands NWR: Lake Huron is located within the Boreal Hardwood Transition Region and the Upper Great Lakes Plain Region. Scarecrow, Thunder Bay, and Sugar Islands are within the Boreal Hardwood Transition Region (PIF 20; Matteson et al. 2009) and Big Charity, and Little Charity are within the Upper Great Lakes Plain Region (PIF 16; Knutson et al. 2001)

Pitcher's Thistle (Cirsium pitcheri) Recovery Plan (USFWS 2002b)

Pitcher's thistle is a Federally Threatened and State Threatened plant species that is found in open Great Lakes sand dune habitat that is subject to natural disturbance processes. This species is threatened by erosion when lake levels are high, disturbance, and invasive non-native plants and insects. This species is present on Big Charity Island.

Dwarf Lake Iris (Iris lacustris) Recovery Plan (USFWS 2013b)

Dwarf Lake Iris is a Federally Threatened and State Threatened plant species that is found growing on alvar barrens only around the Great Lakes. This species is threatened by erosion when lake levels are high, disturbance, and invasive non-native plants and insects. Occurrences of this species has been reported on Thunder Bay Island and may also occur on Sugar Island.

Wilderness Character Monitoring Reports

In 1970, Scarecrow Island, which is managed by Shiawassee NWR, as well as Pismire and Shoe Island, which are managed by Seney NWR, were officially designated as Michigan Islands Federal Wilderness Areas. *A Report on Wilderness Character Monitoring* was finalized for Michigan Islands Wilderness in 2012 (O'Dell 2012) and addendums were written in 2015 and 2017 (Gantz 2015; Gantz and Edwards 2017). Selected measures for Michigan Islands Wilderness were: 1) untrammeled quality, 2) natural quality, 3) undeveloped quality 4) solitude or primitive and unconfined recreation.

Chapter 2: Background

2.1 Location and Description of Islands

The Great Lakes of North America which include Lakes Superior, Michigan, Huron, Erie, and Ontario contain approximately 35,000 islands. Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands are just a few of these islands and are located in Lake Huron (Fig. 2.1). Lake Huron is the second largest Great Lake by surface area and third largest by volume. It is situated between the eastern shore of Michigan and Ontario, Canada, to the north. Lake Huron has an average depth of 195 feet (59 meters) and holds 850 cubic miles (3,540 cubic km) of water within a surface area of 23,000 square miles (59,600 square kilometers). Including its islands it has the longest shoreline of the Great Lakes measuring 3,827 miles (6,157 km). (EPA 2015).

The glacial history of Great Lakes islands varies (Soulé 1993) with the islands of Lake Huron being relatively young compared to the islands of the other Great Lakes. Islands in Lake Huron are described as either limestone and dolostone islands, dense archipelagos of small near shore Precambrian Shield islands, or as low-erodible islands. All of these island types are important for supporting colonial nesting birds, endemic species and communities, and migratory birds (Kraus et al. 2009).

The five islands described here are the focus of this HMP, are located in Lake Huron, and are managed by Shiawassee NWR.

- **Scarecrow Island** is a small, 8.96 acre island located at the southern limit of Thunder Bay. It is located 3 miles off shore from Hardwood Point and is part of Sanborn Township in Alpena County. This limestone bedrock island is covered with boulders and gravel, with a minimal soil layer supporting shrubs, scattered forbs, and a few snags. The main woody species include, common elderberry (*Sambucus Canadensis*), paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), quaking aspen (*Populus tremuloides*) and red-osier dogwood (*Cornus sericea*) (Mc Avinchey et al. 2005). Double-crested cormorants (*Phalacrocorax auritus*), great blue herons (*Ardea herodias*), black-crowned night-herons (*Nycticorax nycticorax*), common terns (*Sterna hirundo*), Caspian terns (*Hydroprogne caspia*), herring gulls (*Larus argentatus*) and ring-billed gulls (*Larus delawarensis*) nest on the island.
- **Thunder Bay Island** is a 121.7 acre island that is located east-northeast of the north point of Thunder Bay and is part of Alpena Township within Alpena County. An 1832 lighthouse remains on the island and until recently the U.S. Coast Guard retained primary jurisdiction for the area in the vicinity and surrounding the lighthouse. However, on October 25, 2014 ownership of the lighthouse was transferred to Alpena Township in which the maintenance of the lighthouse is now conducted by the Thunder Bay Island Preservation Society. The island supports rare endemic Great Lakes alvar ecological communities which include Little Bluestem Alvar Grassland (10 acres), Alvar

Nonvascular Pavement (10 acres), and Great Lakes Limestone - Dolostone Bedrock Shore (30 acres; Reschke et al. 1999). These areas contain shallow soils that support either scattered tall shrubs or sparse grasses and forbs. The forested areas on the island are dominated by northern white cedar (*Thuja occidentalis*) and birch (*Betula spp.*) but also contain balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*). Some forest stands have dense understories of American yew (*Taxus canadensis*), mountain maple (*Acer spicatum*) and/or *viburnum* spp. (Mc Avinchey et al. 2005). Dwarf lake iris (federal and state threatened) was recorded on the island in 1981 (USFWS 2013b).

- **Sugar Island** is 144 acres and is located west of Thunder Bay Island and is part of Alpena Township within Alpena County. The island was sold to TNC in 2009 and the Service recently acquired the island using Great Lakes Restoration Initiative funding. The island shoreline includes cobble beach, Alvar Nonvascular Pavement, scattered boulders, and freshwater, coastal wetlands. Sugar Island has a dense interior conifer forest. Tree species include black cherry (*Prunus serotina*), northern white cedar, balsam fir, tamarack (*Larix laricina*), white pine (*Pinus strobus*), white spruce, balsam poplar, quaking aspen, and paper birch. Songbirds, shorebirds, waterbirds, waterfowl, and raptors have been observed on the island.
- **Big Charity** is a 223.42 acres island with 3 miles of shoreline located in Saginaw Bay. Big Charity Island is part of Whitney Township within Arenac County. The Charity Islands are located near the mouth of Saginaw Bay, approximately 7 miles from the mainland. A lighthouse built in 1857 sits on approximately 20 acres of private land on the north point of Big Charity Island. The owners of the lighthouse and light keeper's home offer dinner cruises and bird watching excursions to the lighthouse. Most of the remaining acres are owned and managed by the U.S. Fish and Wildlife Service, but a few private parcels still remain from the former condo association. Big Charity is heavily wooded, with an 11-acre lake in the center. The forested blocks on Big Charity Island consist of either mixed oaks (*Quercus spp.*), red maple (*Acer rubrum*), and white pine or sugar maple (*Acer saccharum*), oak, basswood (*Tilia Americana*), black cherry, and beech (*Fagus grandifolia*). Red pine (*Pinus resinosa*), green ash (*Fraxinus pennsylvanica*), paper birch and northern white cedar are also present (Mc Avinchey et al. 2005). Bald Eagles (*Haliaeetus leucocephalus*) and neotropical songbirds nest on the island, and pitcher's thistle (federal and state threatened) is present on the island.
- **Little Charity** is an 11 acre undeveloped island located approximately 2 miles south of Big Charity in Saginaw Bay. The island is part of the Sims Township within Arenac County. Common hackberry (*Celtis occidentalis*) is now the dominant tree species, with a few black willows (*Salix nigra*) and cottonwoods (*Populus deltoids*) in the non-forested stand (Mc Avinchey et al. 2005). The island is mostly wooded, and colonial waterbirds such as double-crested cormorants, great egrets (*Ardea alba*), great blue herons, Caspian terns, herring gulls, and ring-billed gulls nest throughout the island.

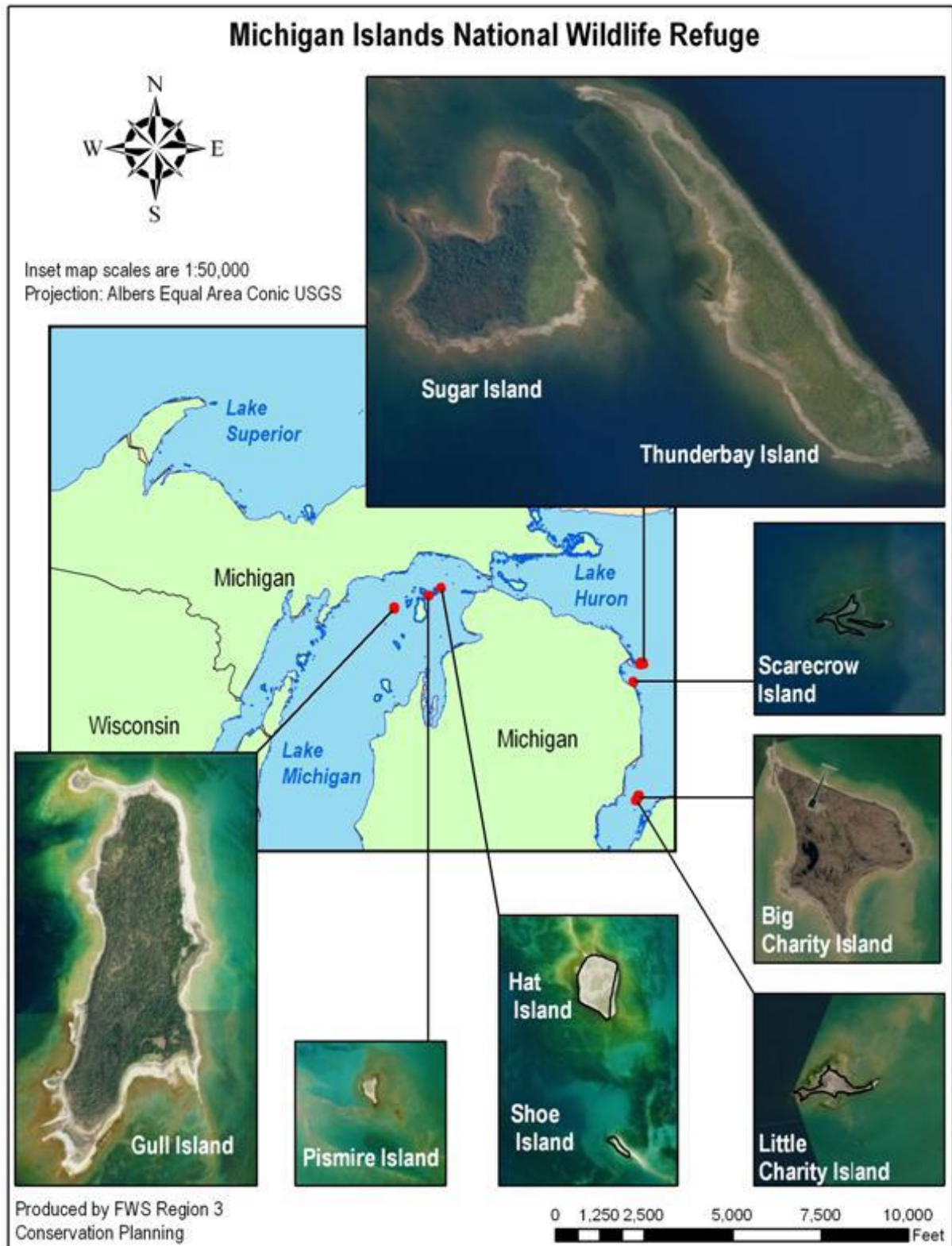


Figure 2.1. Locations of islands within the Michigan Islands NWR. Islands within Lake Huron are managed by Shiawassee NWR and islands within Lake Michigan are managed by Seney NWR.

2.3 Climate

Due to its inland location, northern latitude, and relatively high elevation, the Great Lakes islands refuges are characterized by a relatively severe climate. Growing season ranges from 70 to 130 days, with spring freezes common. Extreme temperatures recorded range from -50 °F to over 105 °F. Snowfall is heavy, with up to 140 inches recorded annually in some localities. Average annual precipitation is relatively uniform across the area, between 28 inches and 32 inches (Albert 1995).

The U.S. Department of the Interior issued Secretarial Order 3226 in January 2001 requiring Federal agencies under its direction that have land management responsibilities to consider potential climate change impacts as part of long range planning endeavors. The impacts of climate change are already evident in warmer water, longer ice-free season, earlier spring runoff, changing water levels and resulting habitat alterations and impacts to water quality and ecological processes (GLISA 2014). Species range shift, species extinction, phenological changes, and community restructuring are the major climate change issues affecting the Great Lakes Region.

However, these small islands in the Great Lakes may provide important refugia for species sensitive to climate change and, in some cases, are buffered from colonization by invasive species, especially small islands with little human activity. The regional effects of climate change projections are discussed further in the Comprehensive Conservation Plan for the Great Lake islands (USFWS 2013a). The Water Resource Inventory and Assessment (WRIA; Newman 2011) for Shiawassee National Wildlife Refuge contains additional information and resources regarding the effects of climate change on water levels in Lake Huron.

2.4 Historical Perspective

Most of the Great Lakes islands have had little or no opportunity to receive immigrants from the mainland, and therefore the species composition on these islands may reflect what was present when the islands were first formed, nearly 10,000 years ago (Myers et al. 2009). However, due to the small size and isolation of many of the Great Lakes islands, human influence and natural processes can make islands vulnerable to changes. Many of the islands in the Great Lakes have been influenced by human pressures such as habitat loss, fragmentation, overharvesting, toxic substances, invasive species, and climate change (Soulé 1991). Although Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands are surrounded by treacherous waters and all of these islands are currently closed to the public, these islands have still seen changes due to human disturbances.

The Great Lakes islands are known to be associated with Native American use, although no archeological sites can be confirmed at this time. There is evidence that many of the islands in the Great Lakes were used as stop-over points and later for commercial fishing operations. In the 1800's, the U.S. Coast Guard built a lighthouse tower, several residences, a life-saving station, and a few other buildings, which were manned until the 1980's, on the southern tip of Thunder Bay Island. Some of these structures are now managed by the Thunder Bay Island

Preservation Society. Big Charity Island also has a lighthouse which is located on the north point of the island. Beginning in 1992 a harbor and breakwall was constructed on the northeast side of the island, a selective timber harvest of larger hardwood trees was conducted in the forests, a couple small cabins were built on private parcels southeast of the harbor, and the old lighthouse keeper's house was replaced on the original foundations with a new house.

Protection of MI Islands NWR: Lake Huron from any further human disturbance will be maintained by keeping these islands closed to the public. Any access to the islands will require permits and will only be allowed for research and management purposes.

2.5 Current Land Classification and Plant Communities

Utilizing the descriptions within the Michigan Natural Communities (MDNR 2010), NVCS Association Classification (Faber-Langendoen, 2001), and our best professional judgment, we developed a table of the natural communities documented or having the potential to occur on these islands (Table 2.1). Figures 2.2 through 2.5 reflect the spatial distribution of the broad habitat classifications. These habitat classifications will be used to guide us in the selection of resources of concern and the development of goals and objectives in the subsequent chapters.

Table 2.1: Habitat types and plant communities of MI Islands NWR: Lake Huron.

Broad Habitat Type	MI Natural Communities ¹	NVCS Association Classification ²	Populations and Habitat Attributes	Natural Processes Responsible for these Conditions	Limiting Factors/Threats	State Rank (MI/NVCS) ⁴
Forest	Boreal Forest	White-cedar - Boreal Conifer Mesic Forest CEGL002449	Forested minerotrophic wetland on rich, neutral to alkaline substrates with seepages, springs, and spring runs; dominated by white cedar (<i>Thuja occidentalis</i>), also balsam fir (<i>Abies balsamea</i>), black ash (<i>Fraxinus nigra</i>), and spruces (<i>Picea glauca</i> and <i>P. mariana</i>); understory rich in sedges (<i>Carex disperma</i> and <i>C. trisperma</i>), orchids (e.g., <i>Platanthera obtusata</i> and <i>Listera cordata</i>), wildflowers, goldthread (<i>Coptis trifolia</i>), fringed polygala (<i>Polygala pauciflora</i>), and naked miterwort (<i>Mitella nuda</i>), and trailing sub-shrubs such as twinflower (<i>Linnaea borealis</i>) and creeping snowberry (<i>Gaultheria hispidula</i>).	Natural hydrologic functions with seeps, springs; windthrow, insect defoliation, and fire	Altered hydrology; invasive species such as buckthorn and others	S3
	Mesic Northern Forest	Great Lakes Hemlock - Beech - Hardwood Forest CEGL005042	Moist to dry-mesic sites, dominated by sugar maple (<i>Acer saccharum</i>) and American beech (<i>Fagus grandifolia</i>). Hemlock (<i>Tsuga canadensis</i>) and white pine (<i>Pinus strobus</i>) are canopy associates as well as yellow birch (<i>Betula alleghaniensis</i>), white ash (<i>Fraxinus americana</i>), basswood (<i>Tilia americana</i>), red oak (<i>Quercus rubra</i>), northern white-cedar (<i>Thuja occidentalis</i>); shrub layer is characterized by striped maple (<i>Acer pensylvanicum</i>), mountain maple (<i>A. spicatum</i>), alternate-leaved dogwood (<i>Cornus alternifolia</i>), beaked hazelnut (<i>Corylus cornuta</i>), leatherwood (<i>Dirca palustris</i>), American fly honeysuckle (<i>Lonicera canadensis</i>), prickly gooseberry (<i>Ribes cynosbati</i>), red elderberry (<i>Sambucus pubescens</i>), and maple-leaved arrow-wood (<i>Viburnum acerifolium</i>)	Frequent, small-scale wind disturbance or gap-phase dynamics and infrequent intermediate- and large-scale wind events.	Pervasive anthropogenic disturbance; invasive species threaten diversity and structure.	S3

Broad Habitat Type	MI Natural Communities ¹	NVCS Association Classification ²	Populations and Habitat Attributes	Natural Processes Responsible for these Conditions	Limiting Factors/Threats	State Rank (MI/NVCS) ⁴
Alvar / Shore	Alvar	Little Bluestem Alvar Grassland CEGL005234	Grass- and sedge-dominated community, with scattered shrubs and sometimes trees; occurs on broad, flat expanses of calcareous bedrock (limestone or dolostone) covered by a thin veneer of mineral soil, often less than 25 cm deep; dominated primarily by grasses and sedges, with mosses and lichens dominant in the driest areas.	Shallow soil and extreme fluctuations in soil-water availability play an important role in controlling the establishment of trees; fire and windthrow also limit tree establishment	Road construction, quarry development, off-road vehicle use, invasive species, and trampling of vegetation.	S1
		Alvar Nonvascular Pavement CEGL005192	Exposed, flat limestone or dolostone pavement that is sparsely vegetated with a mosaic of mossy patches and exposed bedrock that is covered with crustose and foliose lichens. Soils lacking or very shallow; usually less than 10 cm deep. (Reschke et al. 1999).			S1
	Limestone Bedrock Lakeshore	Great Lakes Limestone - Dolostone Bedrock Shore CEGL002506	Limestone bedrock lakeshore is a sparsely vegetated natural community dominated by lichens, mosses, and herbaceous vegetation, including Baltic rush (<i>Juncus balticus</i>), silverweed (<i>Potentilla anserina</i>), and Balsam Poplar (<i>Populus balsamifera</i>), Interspersed with areas of limestone cobble shore and sand and gravel beach.	Almost no soil; Storms, wind, winter ice scour, fluctuating water levels, and severe desiccation produce a stressful, unstable environment for vegetation establishment and growth.	Trampling of vegetation and off-road vehicle traffic use	S2
	Sand and Gravel Beach	Great Lakes Beach CEGL005162	Sand and gravel beaches occur along the shorelines of the Great Lakes; high levels of disturbance, support little or no vegetation; when present sea rocket (<i>Cakile edentula</i>), seaside spurge (<i>Euphorbia polygonifolia</i>), baltic rush, silverweed, beach pea (<i>Lathyrus japonicus</i>), marram grass (<i>Ammophila breviligulata</i>) and the rare Great Lakes endemic pitcher's thistle (<i>Cirsium pitcheri</i> , federal/state threatened)	Unstable sediment conditions caused by wind, waves, and winter ice.	Off-road vehicles can destabilize beach areas; zebra mussel build up	S3
	Limestone Cobble Shore	Great Lakes Limestone Cobble - Gravel Shore CEGL005169	Occurs along the northern Lake Michigan and Lake Huron shorelines. Sparsely vegetated, because cobbles cover most of the surface; includes; bluebell (<i>Campanula rotundifolia</i>), little green sedge (<i>Carex viridula</i>), baltic rush, Dudley's rush (<i>Juncus dudleyi</i>), balsam poplar, silverweed and Ohio goldenrod (<i>Solidago ohioensis</i>).	Storm waves prevent the development of a diverse, persistent plant community.	Trampling of vegetation and off-road vehicle traffic use	S3

¹ Michigan Department of Natural Resources. 2010. Michigan's Natural Communities. Retrieved from <https://mnfi.anr.msu.edu/pub/abstracts.cfm>

² MI Habitat type maps, [http://mnfi.anr.msu.edu/reports/2008-01-Distribution Maps of Michigan's Natural Communities.pdf](http://mnfi.anr.msu.edu/reports/2008-01-Distribution%20Maps%20of%20Michigan's%20Natural%20Communities.pdf)

³ Faber-Langendoen, D., editor. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. + appendix (705 pp.). Retrieved from <http://www.natureserve.org/library/plantcommappendix.pdf>

⁴ MI State Rankings: S1-critically imperiled, S2-imperiled, S3-vulnerable, S4-uncommon but not rare, S5-common and widespread, SX-presumed to be extirpated. Retrieved from <https://mnfi.anr.msu.edu/communities/>

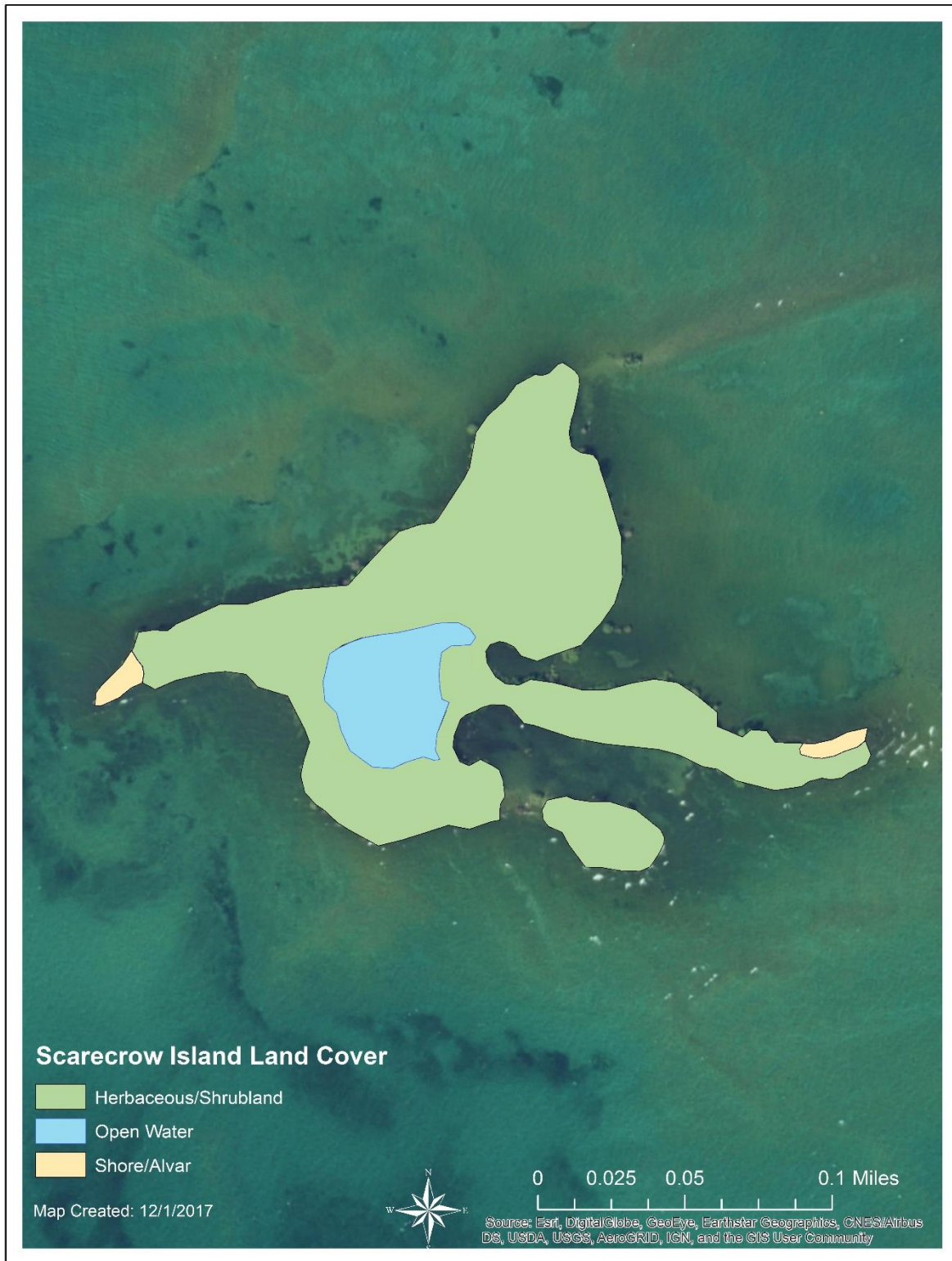


Figure 2.2. Land cover classification of Scarecrow Island. Scarecrow Island is located in Lake Huron and is part of Michigan Island NWR.



Figure 2.3. Land cover classification of Thunder Bay and Sugar Island. Thunder Bay and Sugar Island are located in Lake Huron and are part of Michigan Island NWR.

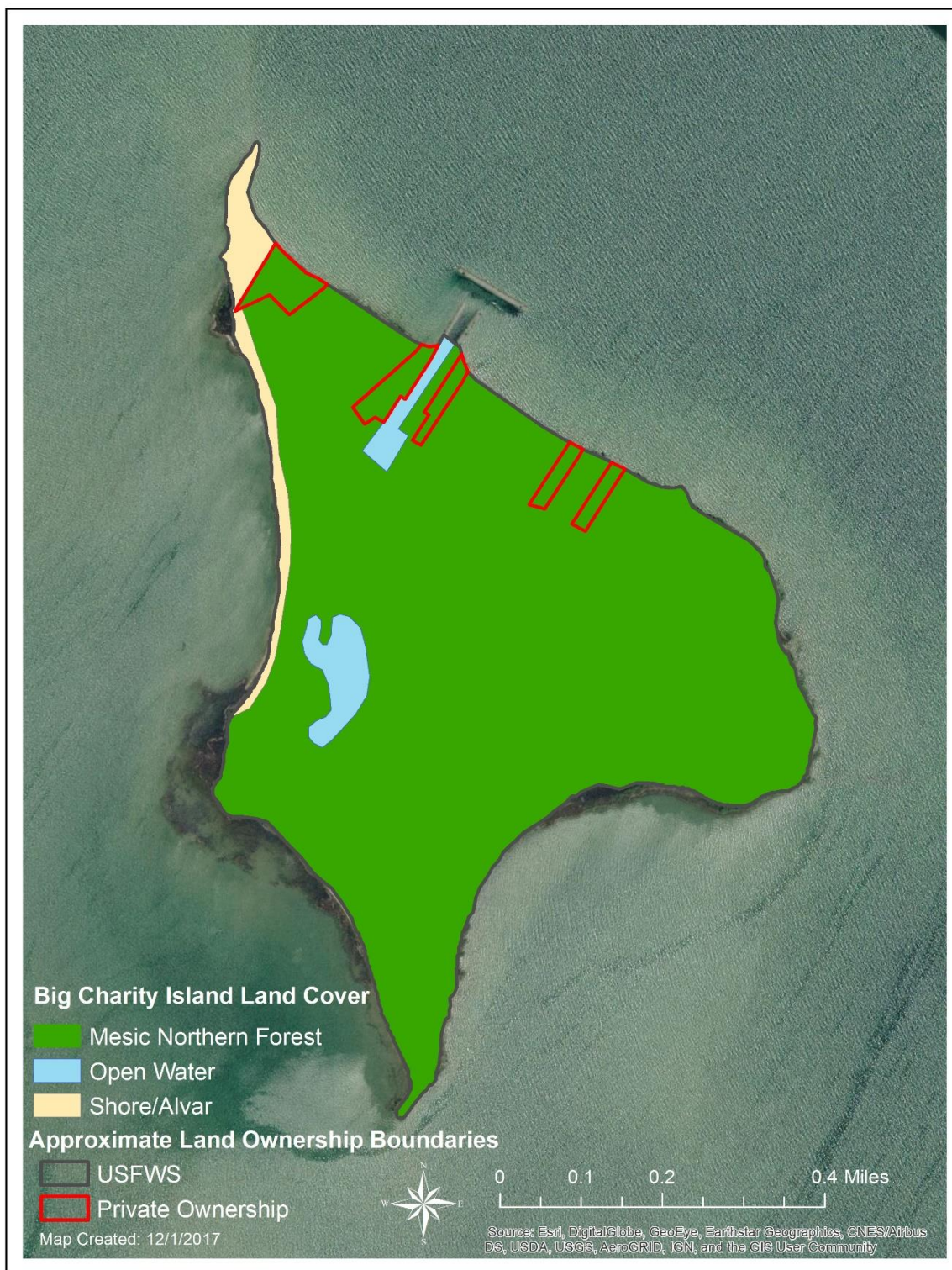


Figure 2.4. Land cover classification of Big Charity Island. Big Charity Island is located in Lake Huron and is part of Michigan Island NWR.



Figure 2.5. Land cover classification of Little Charity Island. Little Charity Island is located in Lake Huron and is part of Michigan Island NWR.

Chapter 3: Resources of Concern

3.1. Introduction

Resources of concern (ROC) are the primary focus of this HMP and are central to the work of the NWRs. The FWS's HMP Policy (620 FW 1) defines "resources of concern" as

All plant and/or animal species, species groups, or communities specifically identified in Refuge purpose(s), System mission, or international, national, regional, State, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are resources of concern on a refuge whose purpose is to protect "migrating waterfowl and shorebirds." Federal or State threatened and endangered species on that same Refuge are also resources of concern under terms of the respective threatened and endangered species acts.

The USFWS is entrusted with conserving and protecting migratory birds, federally listed threatened and endangered species, inter-jurisdictional fishes, and certain marine mammals (i.e. "trust species"). Additionally, each refuge has one or more purposes for which it was established. As a result, management goals and objectives for each refuge is determined by the direction of the refuge purpose(s) and statutory mandates, coupled with species and habitat priorities. Refuges also support other elements of biological diversity including invertebrates, rare plants, unique natural communities, and ecological processes that contribute to biological integrity and environmental health at the refuge, ecosystem, and broader scales (601 FW 3).

Given the multitude of purposes, mandates, policies, and plans that can apply to a refuge, it is necessary to explicitly identify resources of concern and identify those resources for which the refuge is best suited to focus its management activities. The process used to identify resources of concern and habitat types and communities that represent biological integrity, diversity, and environmental health (BIDEH) are described in this chapter. Resources of concern and habitat priorities were then used to develop habitat goals, objectives, and strategies.

3.2. Comprehensive Resources of Concern

To develop a focused habitat management plan we first must define the Refuge's comprehensive list of species. A tool was developed to assist in this process, the Resources of Concern Selection Tool for America's Refuges (ROCSTAR; Salas and Prankus 2015) which was populated with species that are likely to occur on any of the islands in the Great Lakes NWRs. ROCSTAR was populated with the Great Lakes Islands NWR's comprehensive list of species by consulting several plans and lists, including District and Refuge species lists, national and regional priority documents, state fish and wildlife plans, and Federal and State endangered species lists (Table 3.1). Any species known to occur or that could reasonably occur on any of the islands within the Great Lakes NWRs *and* was included in any of the resources consulted was added to the comprehensive list. Key ecosystems were also added because of their importance under the auspices of the Biological Integrity, Diversity, and Ecosystem Health policy (see section 3.3). The ROCSTAR comprehensive list for the Great Lakes Islands NWR is a

large list and includes species and ecosystems for all of the islands within the Great Lakes Islands NWR and also includes a number of species that are unlikely to occur on the small islands in Lake Huron. Therefore, species that are unlikely to occur on MI Islands NWR: Lake Huron were removed from the list as described in Section 3.4.

Surveys that document the species and ecosystems on Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands were also consulted but these surveys are not available for all of the islands or are limited in scope. Appendix A includes a list of the plant species that were recorded on the west shore of Charity Island in 1991 and the results of a vegetation survey conducted by McAvinchey et al. in 2005 for Scarecrow, Thunder Bay, Big Charity, and Little Charity Islands (Sugar Island was not surveyed). Appendix B lists the mammals and birds that were documented on the Charity Islands (Big Charity and Little Charity) in 1910 as part of an expedition conducted by the University of Michigan Museum (Wood 1911 a, b). Additional birds were added to the list in 1911 when the author returned to the island during the breeding season (Wood 1912). Appendix C summarizes the results of the waterbird surveys that have been conducted annually on Scarecrow and Little Charity Island. For the purpose of this document we used the available species lists, the ROCSTAR tool, which was used to assist us in querying the multiple published conservation priority lists of plants, animal, and ecosystems (Table 3.1), and our best professional judgment to select our priority resources of concern.

Table 3.1. Resources from which potential resources of concern were identified.

<u>Resource</u>	Bird	Herp	Fish	Insect	Mammal	Arachnid	Crustacean	Mollusca	Plant	Habitat
Federal T&E (USFWS 2015a)	X	X	X	X	X	X	X	X	X	
MI State T&E (MSUE 2013)	X	X	X	X	X	X	X	X	X	
MI Wildlife Action Plan (MDNR 2015)	X	X	X	X	X	X	X	X	X	X
Birds of Conservation Concern, BCR 12 (USFWS 2008)	X									
Midwest Birds of Concern (USFWS 2012)	X									
FWS FY2012- FY2016 Focal Species (USFWS 2011)	X									
Regional Conserv. Priority List UMR GRL (USFWS 2002)	X	X	X	X	X	X	X	X		
PIF 16 Upper Great Lakes Plain (Knutson et al. 2001)	X									
PIF 20 Boreal Hardwood Trans (Matteson et al. 2009)	X									
UMGL Surrogate Spp. (USFWS 2014)	X	X	X	X	X	X	X	X		
UMRGLR JV All Bird Implementation Plan, (UMRGLR JV 2007)	X									
UMRGLR JV/BCR 12 Priority Spp. Waterbirds (Soulliere et al. 2007b)	X									
UMRGLR JV/BCR 12 Priority Spp. Shorebird (Potter et al. 2007a)	X									
UMRGLR JV Priority Spp. Landbird (Potter et al. 2007b)	X									
UMRGLR JV/BCR 12 Priority Spp. Waterfowl (Soulliere et al. 2007a)	X									
American Bird Conservation Watchlist (Rosenberg et al. 2014)	X									
Interjurisdictional Fish (MICRA 2009)			X							
Partners for Amphibian and Reptile Conservation (2011)		X								
Xerces Society Redlist of Butterflies and Moths (Xerces Society n.d)				X						

3.3. Biological Integrity, Diversity, and Environmental Health

The National Wildlife Refuge System Improvement Act of 1997 states that, in administering the System, the Service shall “ensure that the biological integrity, diversity, and environmental health of the System are maintained...” The Service’s policy discusses the role of biological integrity, diversity, and environmental health (BIDEH). It also provides managers with an evaluation process to analyze their refuge and recommend the best management direction to prevent further degradation of environmental conditions; and where appropriate and in concert with refuge purposes and System mission, restore lost or degraded components (601 FW 3). The Service defines BIDEH as follows:

- **Biological Integrity** - Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.
- **Biological Diversity** - The variety of life and its processes, including the variety of living organisms, the genetic differences between them, and the communities and ecosystems in which they occur.
- **Environmental Health** - Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.

As described in the BIDEH policy (601 FW 3), the goal of habitat management on units of the NWRS is to ensure the long-term maintenance and where possible, restoration of healthy populations of native fish, wildlife, plants, and their habitats. In addition to providing habitat for trust species, refuges support other elements of biodiversity including invertebrates, rare plants, unique natural communities, and ecological processes (USFWS 1999). Where possible, refuge management restores or mimics natural ecosystem processes or functions and thereby maintains biological diversity, integrity, and environmental health.

The native plant communities presented in Chapter 2, Table 2.1, provides guidance on what conditions constitute biological integrity, diversity and environmental health of Refuge habitats; how those conditions are maintained; how and when it is appropriate to restore degraded conditions; and provides an awareness of external threats to those habitats and ecosystems. Given the continually changing environmental conditions and landscape patterns of the past and present (e.g., rapid development, climate change, sea level rise), relying on natural processes is not always feasible, nor always the best management strategy for conserving wildlife resources. Uncertainty about the future requires that the Refuge manage within a natural range of variability.

Due to their remote location and difficulty to access, Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands have not experienced the level of development or disturbances that a mainland refuge or other islands may have seen. Regardless, they still have seen impacts associated with coastal history and navigational use. Historically, Thunder Bay and

Big Charity Islands have hosted small human communities and have been subject to the construction of lighthouses and other structures. Selective logging has also taken place on the larger islands with substantial forest cover. These activities served as vectors for invasive species introduction. A more broad-scale disturbance to the area, as mentioned previously in Chapter 2, will be climate change and the hydrological cycles of Lake Huron. Forecasted climate trends may push some of the dominant forest species out of the area, and expose or submerge additional shoreline or land cover. More details of historic habitat alteration are provided in the CCP (USFWS 2012).

The diverse and sensitive habitats on the islands and their remote nature require effective conservation and management of natural resources to maintain or restore BIDEH and meet refuge purposes. The Great Lakes Islands CCP (USFWS 2013a) includes wildlife and habitat related goals and supporting objectives (Appendix D). However, to be in compliance with BIDEH policy (610 FW 3) and to encourage the successful protection and restoration of BIDEH, this HMP has amended the original objectives from the CCP to add specificity and account for BIDEH in development of the associated management objectives and strategies. By maintaining existing BIDEH and sustainably managing it over the life of this HMP, we will support the refuge purpose and habitat needs of priority resources and other benefitting species. These changes and the rationale behind them are summarized in Chapter 4.

3.4. Priority Refuge Resources of Concern

The ROCSTAR comprehensive list of potential resources of concern (Appendix E) contains many species with a wide array of habitat needs and life history requirements. To best evaluate the effects of our management of habitats, as well as the effects on the species using those habitats, a lesser number of priority resources of concern are needed. Priority resources of concern are species or species groups that are representative of the spectrum of habitats found on the Islands and will serve as indicators during monitoring.

To guide in the selection of priority resources of concern we used the steps outlined in the Service's Identifying Refuge Resources of Concern Handbook (i.e. Handbook; Taylor and Pavaglio 2017). The Handbook guides the selection of the ROCs and their associated habitats by considering where we can make the greatest contribution to conservation efforts while taking into account three important considerations: 1) relevance to legal mandates, 2) management significance, and 3) ecological significance.

The following filters were applied to select potential ROCs:

- Filter 1: Basic assessment of importance: species were removed from consideration if they are not included on any threatened or endangered, conservation need, or other priority lists (ROI=0.0). See Table 3.1 for all plans and lists.
- Filter 2: Removals were made based on the species' probability of occurrence using range maps and refuge species lists. Species removed from consideration included those that were unlikely to occur on the islands.

- Filter 3: All fish and mollusks were removed from list. These species are not managed by Shiawassee NWR.
- Filter 3: All UMGL Surrogate Species (USFWS 2014) were added to potential ROC list.
- Filter 4: All Federal T & E species were added to the potential ROC list.
- Filter 5: All State T & E species were added to the potential ROC list.
- Filter 6: species other than birds were removed if they had a relatively low number of inclusions on priority lists; known occurrence was also taken into consideration again.
- Filter 7: Birds species were removed if they are only present during migration. Species breeding on islands were kept. Birds using island habitats during migration will also benefit from habitat manipulations for breeding birds.

In addition to the above filters, we also relied heavily on our own knowledge and experiences (i.e. ease of monitoring, abundance on islands, etc.) related to each species. Once potential ROCs are selected each species was scored based on the following;

- 1) Number of priority rankings or listings in Federal, State, or regional plans
- 2) Ability to be supported by current or restorable refuge capabilities
- 3) Abundance on islands
- 4) Response to habitat management
- 5) Ability to represent a larger guild or group of species
- 6) Ability to represent (a) on-island ecological processes, (b) broader ecosystem processes, or (c) their importance in the maintenance or restoration of BIDEH

Ultimately, we made an informed decision on the number and type of priority ROC to select based on these filters while also considering the difficulty in managing these remote islands that are closed to public access. The results of the ROC scoring evaluation is summarized in Appendix F. Selected priority resources of concern for islands managed by Shiawassee NWR are found in Table 3.2.

Table 3.2. Selected priority ROCs and reasons for selection for MI Islands NWR: Lake Huron.

Habitat	ROC	Comments on Selection
Forest	Mesic Northern Forest	This community is vulnerable in Michigan to extirpation due to restricted range, relatively few occurrences, recent and widespread declines, and other factors. Michigan listed this community on their MI SWAP list. This community type represents biological diversity and integrity and supports a variety of species including the Bald Eagle. This community can be found on Thunder Bay, Sugar, and Big Charity Islands.
	Bald Eagle	The bald eagle is a federally protected bird. This species is common on all of the islands and is present year round. Bald Eagles prefer undisturbed areas with large, mature trees, near open water. As an apex predator, the Bald Eagle can be used as an indicator of environmental pollutants.

Habitat	ROC	Comments on Selection
Alvar/Shore	<ul style="list-style-type: none"> • Little Bluestem Alvar Grassland, • Alvar Nonvascular Pavement • Limestone Bedrock lakeshore 	Alvars and Limestone Bedrock Lakeshore are ecologically significant natural communities that are considered globally rare. These communities have very diverse plant communities that are distinctive from the bare shorelines and the dense vegetation of the herbaceous or shrub areas. These communities are present on Thunder Bay, Sugar, and Scarecrow Islands and represent biological diversity and integrity. These shorelines are important areas for colonial nesters and provide stopover and feeding areas for migratory birds.
	Pitcher's Thistle	Pitcher's thistle is listed as a state and federally threatened species. It grows only on shorelines or sand dunes of the Great Lakes. This shoreline plant requires open, windblown sand dunes or low, open beach ridges. Michigan has documented more occurrences of this thistle than any other state. Occurrence of this thistle has been documented on Big Charity Island.
	Dwarf Lake Iris	Dwarf lake iris is listed as a state and federally threatened species. The species only occurs in the Great Lakes region and is found on sand or in thin soil over limestone rich gravel or bedrock. This iris tolerates full sun to partial shade, but requires semi open habitats to flower. Fluctuating water levels play an important role in opening up new habitat for this species. Occurrence of this plant has been documented on Thunder Bay Island and it may also occur on Sugar Island.
	Great Blue Heron	The black-crowned night-heron, which was selected as a focal species in the 2007 JV Waterbird Habitat Conservation Strategy Plan is only occasionally found on these islands and therefore a more frequent nester, the great blue heron, was selected as our ROC. The great blue heron was included on the 2006 MI WAP list, but was removed from the 2015 MI WAP list due to the bird being found statewide and it is relatively common. However, this species is easily monitored and can be used as surrogate for the other colonial nesting wading birds that use similar foraging habitats and require or are tolerant of woody cover, including black-crowned night herons and great egrets. The great blue heron has been found nesting on Little Charity and Scarecrow Islands.
	Caspian Tern	The common tern, which was selected as a focal species in the 2007 JV Waterbird Habitat Conservation Strategy Plan, is only occasionally found on these islands and therefore a more frequent and abundant nester, the Caspian tern, was selected as our ROC. Caspian terns are also currently listed as threatened in Michigan. These terns are colonial nesters and require gravel shoreline communities. Caspian terns are abundant on Scarecrow and Little Charity Islands. The Caspian tern can be used as a surrogate to represent other colonial waterbirds such as herring gulls, ring-billed gulls, and common terns.

3.5. Relationship between Refuge Habitats and Priority Resources of Concern

To aid in management of Island habitats for the priority resources, we must know their specific habitat requirements. Table 3.3 summarizes the habitats and priority ROCs that are known to be present on each island. Table 3.4 summarizes the habitat composition, structure or habitat requirements of the selected priority ROCs. Those habitat requirements are often shared with other species. Therefore, each priority resource was chosen, in part, because managing for them would also benefit many of the other species on these islands. Some of those benefitting species are listed in Table 3.5.

Table 3.3. Summary of habitats and ROCs associated with MI Islands NWR: Lake Huron as of 2018.

Island	Acres ¹	Habitats ^{2,3} / ROCs
Scarecrow Island (Federal Wilderness Area)	8.96	<ul style="list-style-type: none"> • Little Bluestem Alvar Grassland • Alvar Nonvascular Pavement • Limestone Bedrock Lakeshore • Sand and Gravel Beach • Limestone Cobble Shore • Large colonial nesting waterbird area
Thunder Bay Island	121.70	<ul style="list-style-type: none"> • Mesic Northern Forest • Little Bluestem Alvar Grassland^{4,5} • Alvar Nonvascular Pavement^{4,5} • Limestone Bedrock Lakeshore^{4,5} • Sand and Gravel Beach • Limestone Cobble Shore⁵ • Dwarf Lake Iris • Bald Eagle • Historically used by colonial nesting waterbirds
Sugar Island	144.00	<ul style="list-style-type: none"> • Mesic Northern Forest • Little Bluestem Alvar Grassland • Alvar Nonvascular Pavement⁵ • Limestone Bedrock Lakeshore • Sand and Gravel Beach • Limestone Cobble Shore⁵ • Dwarf Lake Iris • Bald Eagle
Big Charity Island	223.42	<ul style="list-style-type: none"> • Mesic Northern Forest⁴ • Sand and Gravel Beach • Pitcher's Thistle • Bald Eagle
Little Charity Island	11.00	<ul style="list-style-type: none"> • Mesic Northern Forest (presently only Northern Hackberry remains)⁴ • Sand and Gravel Beach • Large colonial nesting waterbird area

¹ NWRS Mapper on FWSInsideMaps: [FWSInsideMaps](http://fwsinsidemaps.com). Reported acres were estimated using the Land Record System and the USFWS National Cadastral Database.

² Michigan Natural Features Inventory, <http://mnfi.anr.msu.edu/communities/index.cfm>

³ MI Habitat type maps, http://mnfi.anr.msu.edu/reports/2008-01-Distribution_Maps_of_Michigan's_Natural_Communities.pdf

⁴ Faber-Langendoen, D., editor. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. + appendix (705 pp.). Retrieved from <http://www.natureserve.org/library/plantcommappendix.pdf>

⁵ Forest Inventory: Reschke 1999

⁶USFWS 2013 GLI CCP

Table 3.4.: Priority Resources of Concern habitat requirements for MI Islands NWR: Lake Huron, as of 2018.

Priority Refuge Resource	Habitat Types	Key Habitat Relationships ¹			
		Vegetative Composition	Vegetative Structure	Patch/Territory Size	Special Considerations
Mesic Northern Forest	Forest	Moist to dry-mesic mixed hardwood forest.	Moist to dry-mesic sites, dominated by sugar maple (<i>Acer saccharum</i>) and American beech (<i>Fagus grandifolia</i>). Hemlock (<i>Tsuga canadensis</i>) and white pine (<i>Pinus strobus</i>) are canopy associates as well as yellow birch (<i>Betula alleghaniensis</i>), white ash (<i>Fraxinus americana</i>), basswood (<i>Tilia americana</i>), red oak (<i>Quercus rubra</i>), northern white-cedar (<i>Thuja occidentalis</i>). Ground and shrub layer is diverse in compositional variation.	N/A	Vulnerable to altered hydrology and invasive species.
Bald Eagle		Lakes, reservoirs, rivers, marshes, and coasts. Large mature coniferous or deciduous trees.	Mature forests with open canopy; adjacent to large bodies of water with suitable foraging opportunities.	0.5-2 km ² ; territorial during breeding season	Top avian predator
Little Bluestem Alvar Grassland	Alvar / Shore	Dominated by grasses and sedges, less than 50% of the ground surface is exposed limestone or dolostone bedrock	Shallow, loam soils, usually less than 10 cm deep over flat limestone dolostone bedrock. Dominant species are prairie dropseed (<i>Sporobolus heterolepis</i>), little bluestem, (<i>Schizachyrium scoparium</i>), or northern singlespike sedge (<i>Carex scirpoidea</i>).	Small to large patches, ranging in size from less than 5 acres to over 3000 acres.	Vulnerable to invasive species; trampling of vegetation, and altered hydrology.
Alvar Nonvascular Pavement		Flat limestone or dolostone pavement that is sparsely vegetated with moss and lichens.	Characteristic species are lichens and mosses such as cup lichen (<i>Cladonia pocillum</i>), blackthread lichen (<i>Placynthium nigrum</i>) and twisted moss (<i>Tortella tortuosa</i>). Herbs such as Virginia saxifrage (<i>Saxifraga virginensis</i>), hairy beardtongue (<i>Penstemon hirsutus</i>), Norwegian cinquefoil (<i>Potentilla norvegica</i>), and false pennyroyal (<i>Trichostema brachiatum</i>) also occur but make up less than 15% of groundcover.	Frequently occurs in small patches, < 1.25 acres, within other alvar communities.	

Priority Refuge Resource	Habitat Types	Key Habitat Relationships ¹			
		Vegetative Composition	Vegetative Structure	Patch/Territory Size	Special Considerations
Limestone Bedrock Lakeshore		Exposed flat limestone or dolostone bedrock lakeshores that are sparsely vegetated (2-20%).	This community is not considered alvar because of its dominance of forbs and different shoreline process (wave-washing and ice-scouring vs. an alternating wet and dry moisture regime). Sparsely vegetated bedrock has many cracks and crevices where plants grow. Common plants include, Baltic rush (<i>Juncus balticus</i>), silverweed (<i>Potentilla anserina</i>), balsam poplar (<i>Populus balsamifera</i>), Arkansas mint (<i>Calamintha arkansana</i>), shrubby cinquefoil (<i>Pentaphylloides floribunda</i>), panic grass (<i>Panicum lindheimeri</i>), eastern white cedar (<i>Thuja occidentalis</i>), tufted hair grass (<i>Deschampsia cespitosa</i>), bog violet (<i>Viola nephrophylla</i>), birdseye primrose (<i>Primula mistassinica</i>), and Kalm's lobelia (<i>Lobelia kalmii</i>).	Not given	Vulnerable to invasive species; trampling of vegetation, and altered hydrology.
Pitcher's Thistle		Endemic to beaches and grassland dunes of Lake Michigan, lake Superior, and Lake Huron	Found on large, intact, unforested, active dune systems.	N/A	Requires active sand dune processes to maintain early successional habitat; vulnerable to erosion when lake levels are high and invasive plants and insects.
Dwarf Lake Iris		Found in partly shaded or sheltered forest edges that are associated with shoreline coniferous forests dominated by northern white cedar and balsam fir.	Typically grows in shallow soil over moist calcareous sands, gravel and beach rubble.	N/A	Some form of disturbance is required to maintain forest openings, such as fluctuating water levels that open up new habitat; vulnerable to invasive plants and insects

Priority Refuge Resource	Habitat Types	Key Habitat Relationships ¹			
		Vegetative Composition	Vegetative Structure	Patch/Territory Size	Special Considerations
Great Blue Heron	Colonial Nesting Habitat	Found in both freshwater and saltwater habitats, also forage in grasslands and agricultural fields.	Require aquatic habitat for foraging and terrestrial vegetation for cover. Breeding habitat varies greatly. Nests in trees but will also nest on the ground, on bushes, or on artificial nest platforms. Nests are a platform of sticks in saucer shape lined with pine needles, moss, or dried grass.	Colonial breeders; pairs defend 2m nest territory; may also defend foraging territories	Social birds that nest in colonies but forage on their own or in loose flocks.
Caspian Tern		Nests in colonies on island beaches often near other colonial bird species.	Nests in open, sparsely vegetated areas. Nests are a scrape in ground and are lined with debris such as dried vegetation, small pebbles, or broken shells. Sometimes rimmed with sticks or shells.	Colonial breeders. Nest site territories are small (0.5–1.5 m in diameter) Territory size and nest spacing varies depending on local numbers, available space, and substrate.	Caspian terns are currently listed as threatened in Michigan. Population sizes are declining due to site disturbance, predator introduction, competition among other birds for nesting sites, and lake level fluctuations

¹Sources:

Poole, A., editor. 2005. The Birds of North America Online. Ithaca, NY: Cornell Laboratory of Ornithology. Retrieved from: <http://bna.birds.cornell.edu/bna>

Powell, H., editor. 2010. All about birds. Ithaca, NY: Cornell Laboratory of Ornithology. Retrieved from: <https://www.allaboutbirds.org>

Reschke, C., R. Reid, J. Jones, T. Feeney, and H. Potter. 1999. Conserving Great Lakes alvar: final technical report of the International Alvar Conservation Initiative. The Nature Conservancy, Chicago, IL. 241 pp.

U.S. Fish and Wildlife Service. 2002b. Pitcher's Thistle (*Cirsium pitcheri*) Recovery Plan. Fort Snelling, Minnesota. vii + 92 pp.

U.S. Fish and Wildlife Service. 2013b. Dwarf lake iris (*Iris lacustris*) Recovery Plan. Bloomington, Minnesota. vii + 75 pp.

Table 3.5. Priority resources of concern and other benefiting species for MI Islands NWR: Lake Huron as of 2018.

Resource of Concern	Life History Requirement	Habitat	Habitat Structure	Other Benefitting Resources
Mesic Northern Forest	N/A	Forest	Multi-layered canopy with windthrown canopy trees common. Ground and shrub layer is diverse but well developed.	Cavity nesters Neotropical migrants <ul style="list-style-type: none"> • black-throated blue warbler • black-throated green warbler • scarlet tanager • ovenbird
Bald Eagle	Entire life cycle		Mature forests with open canopy; adjacent to large bodies of water with suitable foraging opportunities.	
Little Bluestem Alvar Grassland	N/A	Alvar / Shore	Little Bluestem Alvar Grasslands can occur in small to large patches (<2 to >1214 ha). This community is an open canopy grassland with groundlayer dominated by grasses and sedges. Less than 50% of ground surface is exposed limestone or dolostone bedrock. Community occurs on shallow, loam soils, usually less than 10 cm deep and alternate between wet and dry periods.	Lake Huron tansy Lake Huron locust Houghton's goldenrod Colonial Waterbirds Shorebirds <ul style="list-style-type: none"> • Piping Plover • Upland Sandpiper Monarch
Alvar Nonvascular Pavement	N/A		Alvar Nonvascular Pavement occurs in small patches (<0.5 to >80 ha). This open canopy community consists of a mosaic of exposed, flat limestone or dolostone pavement covered with crustose and foliose lichens and sparsely vegetated patches of moss. Soils are lacking or exist only in rock crevices or under moss.	
Limestone Bedrock Lakeshore	N/A		Limestone Bedrock Lakeshore communities are found along the shores of the Great Lakes where exposed flat limestone or dolostone bedrock slopes gently into the lake. The sparsely vegetated bedrock has many cracks and crevices where plants grow. This community is not considered an alvar because shoreline processes influence the plant composition and structure and because of the dominance of forbs.	
Pitcher's Thistle	Entire life cycle		Shoreline plant found on open, windblown sand dunes or low, open beach ridges.	
Dwarf Lake Iris	Entire life cycle		Typically grows in shallow soil over moist calcareous sands, gravel and beach rubble.	
Great Blue Heron	Entire life cycle	Colonial nesting Habitats	Require aquatic habitat for foraging and terrestrial vegetation for cover. Breeding habitat varies greatly. Nests in trees but will also nest on the ground, on bushes, or on artificial nest platforms. Nests are a platform of sticks in saucer shape lined with pine needles, moss, or dried grass.	Black-crowned Night-heron Double-crested Cormorant Great Egret Great Blue Heron American White Pelican Herring Gull Ring-billed Gull Common Tern
Caspian Tern	Migration, nesting, brood rearing, foraging		Nests in open, sparsely vegetated areas. Nests are a scrape in ground and are lined with debris such as dried vegetation, small pebbles, or broken shells. Sometimes rimmed with sticks or shells.	

References:

Poole, A., editor. 2005. The Birds of North America Online. Ithaca, NY: Cornell Laboratory of Ornithology. Retrieved from: <http://bna.birds.cornell.edu/bna>
Powell, H., editor. 2010. All about birds. Ithaca, NY: Cornell Laboratory of Ornithology. Retrieved from: <https://www.allaboutbirds.org>
Reschke, C., R. Reid, J. Jones, T. Feeney, and H. Potter. 1999. Conserving Great Lakes alvar: final technical report of the International Alvar Conservation Initiative. The Nature Conservancy, Chicago, IL. 241 pp.

3.6. Priority Habitats and Relationship to Resources of Concern

Due to the remote location of the islands and because personnel and funding resources are limited, management activities are primarily directed toward invasive species management. However, to ensure that the most important resource needs are met, management of habitats must be prioritized. The habitat types within the refuges were prioritized based on information including current vegetation, management capability, and conservation needs of priority resources of concern.

Habitat types on the islands can be divided into three broad categories:

- Forest
- Alvar/Shore
- Transitional Habitat and/or Colonial Nesting Areas

Using the criteria presented in the Handbook (Taylor and Paveglio 2017), refuge habitats were categorized into Priority I and II Habitats using the following factors:

Priority I Habitats:

- Can be managed to provide the greatest conservation benefit to priority species, especially those specifically identified in the refuge purpose.
- Offer the greatest contribution to (1) maintenance/restoration of biological integrity, diversity, and environmental health; (2) represent important ecological and ecosystem processes not well represented within the landscape (including the broader ecoregion of which the refuge is a part) and; (3) address conservation needs of the Refuge System resources of concern.
- Habitat condition or other factors suggest an urgent need for active management.

Priority II Habitats

- Too limited in extent to make a meaningful difference.
- Outside the management authority or jurisdiction of the refuge.
- Does not require active management to maintain their present condition.

Table 3.6 lists the broad habitat categories according to the refuges priority for management and provides the reasons for the rankings and how they benefit the refuges' priority resources.

Table 3.6. Priority I and II habitats for MI Islands NWR: Lake Huron.

Priority I Habitat (High)	Reasons for Ranking and Comments
Alvar/Shore	BIDEH; represents important ecological and ecosystem processes not well represented within the landscape
Colonial Waterbird Nesting areas	Refuge purpose; BIDEH; directly benefits ROC's
Priority II Habitat (Low)	Reasons for Ranking and Comments
Mesic Northern Forest	Little to no active management; mostly focused on invasive species management and land protection

3.7. Conflict Resolution

Due to the diversity of goals, purposes, mandates, and conservation priorities of the National Wildlife Refuge System it is not unreasonable to expect conflicting management priorities at a specific refuge. Management conflicts are significantly reduced on these islands due to the remoteness and inaccessibility of the islands. Most of the Great Lakes islands have little or no opportunity to receive immigrants from the mainland, and therefore the species composition on these islands may reflect what was present when the islands were first formed, nearly 10,000 years ago (Myers et al. 2009). Maintaining the integrity of the historic habitats on these islands is a priority. However, the integrity of a rare or unique plant community will not be compromised for the benefit of one species or group. Those considerations are reflected in the objectives and strategies developed in this HMP (Chapter 4). The main conflict lies in determining whether or not to allow conditions to change through disturbance (natural processes) or to implement a management technique and attempt to keep conditions static. Most of the active management techniques on these islands is restricted to invasive species management and monitoring.

However, the conflict between the conservation of colonial nesting waterbirds, such as Double-crested Cormorant (DCCO) has been a very contentious issue for land managers throughout the Great Lakes. For island land managers the issue typically focuses on DCCO potential impacts to free swimming fish in the Great Lakes and/or the impact cormorants have on island vegetation. Free swimming fish in the Great Lakes are not a ROC for these islands and depredation permits in the Great Lakes can no longer be issued for the control of DCCO for the benefit of free swimming fish, therefore any DCCO management for free swimming fish will not be considered (USFWS 2017). Cormorants have altered vegetative communities on Little Charity and Scarecrow islands primarily through direct tree mortality and altering herbaceous layer through guano deposits, but this is a natural disturbance process for island systems. These openings create new nesting areas for other colonial nesting species and are one of the primary ecological drivers of this dynamic system. Furthermore, to fulfill the refuge purpose of these islands we must provide refuge and breeding habitat for all migratory birds and other wildlife.

Chapter 4: Habitat Goals, Objectives, and Strategies

4.1 Introduction

The 2013 Gravel Island, Green Bay, Harbor Island, Huron, and Michigan Islands NWR CCP (Great Lakes Islands CCP) was written to help ensure that management and administration of all of the Great Lakes Islands Refuges meet the mission of the Refuge System, the purpose for which the Refuges were established, and the goals for the Refuges. Therefore, the 2013 Great Lakes Islands CCP contains broad statements of the desired future conditions of the all the Great Lakes Islands and also provides separate objectives for each refuge. All of the 2013 CCP goals and objectives for the Great Lakes Islands were developed with the intention that HMPs would be written as step down plans in which objectives, goals and strategies would be further developed to support the goals and objectives of the CCP. A HMP was written for Harbor Island NWR, Huron NWR, and Michigan Islands NWR in 2015 (USFWS 2015b) by Seney NWR staff and in 2018 staff at Horicon NWR finalized an HMP for Green Bay and Gravel Island NWR (USFWS 2018). The focus of this HMP is on the remaining Great Lakes Islands which are part of the Michigan Islands NWR but are managed by Shiawassee NWR and presently include Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands. Any islands acquired after the approval of this HMP and are managed by Shiawassee NWR will also adhere to the goals and objectives outlined in this chapter.

Most refuge land on MI Islands NWR: Lake Huron is currently closed to the public and there is no public demand for access besides the occasional curious fisherman. However, Big Charity Island still has private parcels that include the lighthouse, which occasionally hosts visitors. All of the islands are surrounded by waters that are shallow and littered with large boulders and shallow reefs and therefore only very experienced boaters with small boats are able to access the islands. These islands are also far removed from Shiawassee NWR, which makes management of the islands more difficult. Consideration of safety issues precludes visitation of these islands except in ideal conditions and therefore, few extensive or intensive manipulative activities are expected to occur on these lands.

The goals, objectives, and strategies were developed for this HMP by reviewing, refining, and revising the 2013 Great Lakes Islands CCP overall goals and objectives and the objective and strategies that are specific to the Michigan Islands NWR (See Appendix D). During the development of this HMP, the CCP goals and objectives were reviewed to determine if they were still representative of existing Refuge conditions, current Service policies, and desired future management. CCP goals and objectives were also reviewed to determine if they meet the criteria defined in the Service's Writing Goals and Objectives Handbook (USFWS 2004). The handbook requires that objectives be written using the S.M.A.R.T. (specific, measurable, achievable, results-oriented, time fixed) criteria. The HMP objectives presented here are further refined and/or consolidated using the SMART criteria. Table 4.1 summarizes the objective amendments from the CCP to the HMP. The newly revised objectives provide improved specificity and bring objectives into compliance with Service policy.

Table 4.1. Crosswalk between the goals and objectives identified in the Great Lakes Islands CCP (Appendix D) and the objectives developed for MI Islands NWR: Lake Huron.

CCP Goals and Objectives	Change between CCP and HMP	HMP Goal or Objective	Rationale
Great Lakes CCP Overall Goals and Objectives			
<u>Ecosystem Goal</u>	Revised to combine into one overall goal that is specific to the islands managed by Shiawassee NWR	Habitat Management Goal	The CCP goal was written for all of the Great Lakes Islands. There was not an Ecosystem goal that was specific to the islands managed by Shiawassee NWR.
Ecosystem Objectives 1: Climate Change	Incorporated into all objectives	All	Incorporated into all HMP objectives. Secretarial order 3226 and 3289 requires that climate change effects be considered and analyzed when planning or decision making.
Ecosystem Objective 2: Island Acquisition	None	N/A	All HMP objectives will apply to any new land acquisition.
<u>Wildlife Goal</u>	Revised to combine into one goal that is specific to the islands managed by Shiawassee NWR	Habitat Management Goal	The CCP goal was written for all of the Great Lake Islands. There was not a Wildlife goal that was specific to the islands managed by Shiawassee NWR.
Wildlife Objective 1: Inventory and Monitoring	Updated to meet SMART criteria and made specific to Islands managed by Shiawassee NWR	<u>HMP Obj. 1:</u> Baseline habitat inventory <u>HMP Obj. 2:</u> Species and natural features inventory and monitoring	Inventory and monitoring is needed to better assess the needs of these islands. An Inventory and Monitoring Plan (IMP) will be developed as a step down plan to this HMP.
Wildlife Objective 2: Applied Research	Removed and included as strategies	N/A	Applied research is a strategy that should be used as needed to address issues/topics in the HMP.
Wildlife Objective 3: Protect Waterbird Colonies	Updated to meet SMART criteria and make specific to Islands managed by Shiawassee NWR	<u>HMP Obj. 3:</u> Colonial waterbirds	No ongoing double-crested cormorant management activities occur on the Islands managed by Shiawassee NWR.

CCP Goals and Objectives	Change between CCP and HMP	HMP Goal or Objective	Rationale
<u>Habitat Goal</u>	Revised to combine into one goal that is specific to the islands managed by Shiawassee NWR	Habitat Management Goal	The CCP goal was written for all of the Great Lakes Islands. There was not a Habitat goal that was specific to the islands managed by Shiawassee NWR.
CCP Objectives Specific to Michigan Islands NWR (Shiawassee)			
Ecosystem Objective 1: Preserve Great Lakes Alvar Communities on Thunder Bay and Sugar Islands	Updated to meet SMART criteria and to include all of the Michigan NWR islands managed by Shiawassee NWR	<u>HMP Obj. 4:</u> Alvar / Shore communities	Updated to include all islands that may contain these unique communities
Wildlife Objective 1: Maintain and Provide Nesting Habitat	Updated to meet SMART criteria and to include all of the Michigan NWR islands managed by Shiawassee NWR	<u>HMP Obj. 3:</u> Colonial waterbirds	Updated to include all islands that may provide nesting habitats
Habitat Objective 1: Preserve Pitcher's Thistle	Updated to meet SMART criteria	<u>HMP Obj. 5:</u> Pitcher's Thistle and Dwarf Lake Iris	Updated to include dwarf lake iris
Habitat Objective 2: Protect Sensitive Habitat by Reducing Invasive Plant Species	Removed from objectives and incorporated as a strategy in all habitat management objectives	N/A	Protection of sensitive plants by invasive species control is a strategy. Invasive species control can be used as a strategy for all habitat objectives.
Additions to HMP			
Wilderness	CCP did not include Wilderness Objective	<u>HMP Obj. 6:</u> Wilderness Objective	Added to HMP to meet <i>Wilderness Act</i> requirements for Scarecrow Island
Forests	CCP did not include objectives that addressed forest monitoring or management.	<u>HMP Obj. 7:</u> Northern Mesic Forests	An objective is needed to guide the monitoring and management of the forests that occur on the islands managed by Shiawassee NWR.

Management strategies identify the tools and techniques that can be used to achieve the habitat objectives outlined in this chapter. The management strategies identified for each habitat objective were selected by reviewing previous and current refuge practices, consultation with other refuges' biologists, and feasibility of implementing these strategies with the current resources and staff. Many factors, (i.e. accessibility, weather, staffing) will affect which strategies are implemented from year to year and will be reflected in Annual Habitat

Work Plans. Management strategies are provided in this chapter along with links to additional or supporting documents. As mentioned in previous chapters most of the active management techniques on these islands are restricted to invasive species management activities and effectiveness monitoring. Additional information regarding invasive species management tools and strategies are further defined in Appendix G.

4.2 HMP Goal, Objectives, and Management Strategies

Habitat Management Goal

Preserve and protect the biological diversity and integrity of native plant communities present on MI Islands NWR: Lake Huron in order to sustain high quality habitat for the benefit of migratory and colonial nesting birds, and other resident wildlife species.

HMP Objective 1: Baseline Habitat Inventory

Within ten years of HMP approval, conduct baseline inventories of habitat cover types and their associated acreage on MI Islands NWR: Lake Huron. An ecosystem classification approach (Barnes et al. 1982, Baker and Barnes 1998) will be used that investigates soil, physiography, hydrology, and vegetation to develop a hierarchical framework for management.

Rationale:

These islands are very remote and difficult to access. Most of the islands have not been inventoried nor has monitoring of resource trends or management effectiveness been consistent. A vegetation survey was conducted in 2005 on Scarecrow, Thunder Bay, Big Charity and Little Charity Islands and documents the plant species observed on those islands at that time (McAvinchey et al. 2005). See Appendix A, Table A.2 for list of species. Sugar Island, which was only recently acquired, was not included in that inventory. A follow up inventory of the plant species and communities on these islands and any additional islands acquired after approval of this HMP would be beneficial to future management. In addition, the development of a GIS vegetation cover map for all islands using a combination of aerial/satellite imagery and ground surveys is needed for all of the islands to assist in documenting present and future management and conservation efforts. When possible, we will work with partners to accomplish this objective on all islands managed by Shiawassee NWR.

Strategies:

- Conduct vegetation surveys on Scarecrow, Thunder Bay, Big Charity and Little Charity Islands and an initial (baseline) vegetation survey on Sugar Island and any newly acquired islands. Survey should document:
 - Habitat cover types on each island.
 - Acreage for each habitat cover type.
 - Comprehensive species inventory within each habitat cover type.
- Work with Michigan Natural Features Inventory, universities, and other Partners to conduct habitat and vegetation surveys and develop GIS vegetation cover maps on all of the islands managed by Shiawassee NWR.

- Develop GIS vegetation cover maps for all islands using aerial/satellite imagery and information from vegetation surveys.
- Before any proposed management is conducted on Scarecrow Island a [Minimum Requirements Analysis](#) will be performed.

HMP Objective 2: Species and natural features inventory and monitoring

Within five years of HMP approval, work with partners, such as USFWS Ecological Services Field Office, The Nature Conservancy, Michigan Natural Features Inventory, Thunder Bay Island Preservation society, state, and private agencies, to conduct a species and natural features inventory on the islands managed by Shiawassee NWR. Once all islands have been inventoried the islands will be monitored every three years to track the presence, abundance, population trends, and/or habitat associations of select biological resources. Species inventory and monitoring will include, but will not be limited to, Threatened and Endangered species, Region 3 Conservation Priority Species, colonial waterbirds, migratory birds, and other native species and unique communities associated with the Michigan Islands NWR.

Rationale:

Periodic monitoring of all species on the islands is important in order to monitor changes due to climate conditions and its influence on resource availability (Bateman et al. 2016). Aerial colonial nesting surveys are conducted annually on Scarecrow Island as part of the Great Lakes Colonial Waterbird Survey and ground surveys are conducted on Little Charity Island by Shiawassee NWR staff, but no other complete animal species inventories have been conducted on these islands. In 1911 and 1912 reports were written by N. A. Wood in which he describes the mammals and birds that were encountered on the Charity Islands (i.e. Big Charity, Little Charity, and Gull Islands) during the Mershon Expedition (Appendix B). Inventory and monitoring surveys that will document the presence, abundance, population trends, and/or habitat associations of select biological resources on all of the islands managed by Shiawassee NWR would serve as a benchmark for monitoring change over time and would guide future management.

Strategies:

- Write an Inventory and Monitoring step-down plan that includes surveys that will inventory and then monitor the species and natural features of these islands.
- Explore possibilities to conduct remote audio recordings for migrant birds and bats.
- Conduct invasive species inventories at least once every three years, but more frequently as budgets, travel, and personnel allow.
- Use applied research to address any questions that arise regarding resources of concern, T&E species or other issues such as invasive species management.
- Before any proposed survey or management is conducted on Scarecrow Island a [Minimum Requirements Analysis](#) will be performed.

HMP Objective 3: Colonial waterbirds

Annually, allow limited or no access to the islands managed by Shiawassee NWR in order to protect and maintain the fluctuating populations of colonial nesting waterbirds such as Caspian terns, common terns, double-crested cormorants, great blue herons, black-crowned night-herons, herring gulls, and ring-billed gulls. Annually survey the existing colonial nesting populations on Little Charity and Scarecrow Islands to contribute to the long-term monitoring effort of the Great Lakes Colonial Waterbird Survey. All other islands managed by Shiawassee NWR will be monitored every other year for any new colonial waterbird nesting activities.

Rationale:

Annual colonial waterbird surveys following the methods described by Cuthbert and Wires (2013) have been conducted on Little Charity and Scarecrow Islands since 2002. Ground surveys are conducted on Little Charity Island by Shiawassee NWR staff. Aerial surveys are conducted for Scarecrow Island to reduce nest disturbance following the guidance of the Michigan Islands NWR Wilderness Character Monitoring Report (O'Dell 2012; Gantz 2015; Gantz and Edwards 2017). Data collected from these surveys contribute the Great Lakes Colonial Waterbird Survey.

Little Charity and Scarecrow Islands provide important habitat to several species of nesting colonial waterbirds including double-crested cormorant, great blue heron, great egret, ring-billed gull, herring gull, Caspian tern, and sometimes the black-crowned night-heron and common tern. See Appendix C for annual colonial waterbird survey results. The Upper Mississippi River/Great Lakes Region Waterbird Conservation Strategy (Wires et al. 2010) includes Little Charity and Scarecrow Islands on its list of the most important sites for breeding colonial waterbirds in the United States Great Lakes. The Waterbird Conservation Plan lists population inventory and monitoring, habitat protection and management, and management of human disturbance as priority conservation actions for waterbirds (Wires et al. 2010).

To fulfill the original purpose of the Michigan Islands NWR it is important to preserve these breeding grounds for migratory birds, including colonial nesting waterbirds. The Upper Mississippi River and Great Lakes Region Joint Venture focal species for the dominant avian communities on the islands are black-crowned night-herons and common terns (Soulliere et al. 2007). However, these two species are limited in number on the islands of Lake Huron. Therefore, we chose great blue herons and the state threatened Caspian tern as the species that can best represent these guilds and act as surrogates for other colonial waterbird species on the Lake Huron islands.

Most waterbirds that nest on the islands nest on the ground and therefore are vulnerable to predation by other birds, lake level changes, and disturbances by humans if access is not limited. Therefore, the continuation of limited or no access to these islands is important to protecting these populations. In colonial nesting areas habitat management is mostly passive with the most effective strategy being the restriction of public access to these islands.

The islands are also susceptible to invasive species, such as *Phragmites* spp., and therefore invasive species control is needed to prevent nesting habitats from becoming overgrown by

Phragmites spp. or other rapidly spreading invasive species. However, invasive species control within the colonial nesting areas should not occur during the breeding season to limit disturbance (i.e., *Phragmites* treatment is geared toward late summer to early fall). In addition, Scarecrow Island is designated as a Wilderness area and therefore a Minimum Requirement Analysis will be conducted before any management can occur on this island.

Strategies:

- Continue annual surveys of nesting colonial waterbird colonies at Little Charity Island (ground survey) and Scarecrow Island (aerial survey). These surveys have been ongoing since 2002 and data collected contributes to the Great Lakes Colonial Waterbird Survey.
 - Annual surveys will follow the methods described by Cuthbert and Wires (2013).
- Every other year conduct reconnaissance trips to other islands to evaluate if colonial waterbirds have started nesting on those islands.
- Limit disturbances, such as public access, to colonial waterbird colonies to help maintain current nesting population levels of gull, tern, egret, and heron species.
- Protect sensitive colonial bird habitat by reducing invasive plant species cover to less than 5% of total area.
 - Early detection, rapid response (EDRR) methods will be used to determine when management actions are needed.
 - Use chemical and/or mechanical control techniques to control invasive species.
- Before any proposed management is conducted on Scarecrow Island a [Minimum Requirements Analysis](#) will be performed.

HMP Objective 4: Alvar / Shore Communities

Within five years of approval of this HMP, survey, monitor, and protect all Little Bluestem Alvar Grassland, Alvar Nonvascular Pavement, and Limestone Bedrock Lakeshore sites on Thunder Bay and Sugar Islands as well as any new sites discovered on the islands managed by Shiawassee NWR during baseline inventories.

Rationale:

Alvars and Limestone Bedrock Lakeshore are ecologically significant natural communities that are considered globally rare (Reschke et al. 1999). Approximately 15% of the Great Lakes alvar areas occur in Michigan. Therefore, the refuge has an opportunity to contribute to the conservation of these rare ecosystems that in turn support several rare and declining species, such as dwarf lake iris and pitcher's thistle (Reschke et al. 1999).

Due to their isolation, the alvar and shore communities of Great Lakes islands are often less disturbed than alvar and shore communities on the mainland (Kraus et al. 2009). These communities have very diverse plant communities that are distinctive from the bare shorelines and the dense vegetation of the herbaceous or shrub areas on the islands. The island

shorelines are also important areas for colonial nesters and provide stopover and feeding areas for migratory birds (Reschke et al. 1999).

Alvars and Limestone Bedrock Lakeshore communities are characterized by flat limestone and dolostone bedrock with shallow soils (Albert 2006; Comer et al. 1997). These communities are sensitive to any human disturbance and susceptible to invasive species that may be carried on to the island by humans or by lake currents, migratory birds and bats, or winds. Management of these communities is passive with the most effective strategy being the restriction of public access to these islands. Rapid detection of and response to the establishment of invasive species is also important but great care needs to be taken to not disturb the soils. Because invasive species, such as *Phragmites*, can also be transported to these islands via wind, water, and bird guano periodic inspections of known alvar and shore communities should be inspected for invasives and appropriate management applied.

Alvar communities have been documented on Thunder Bay Island (Reschke 1999) and according to landcover maps should also occur on other Lake Huron islands. These communities represent biological diversity and integrity and should be protected. According to International Alvar Conservation Initiative report (Reschke 1999) Thunder Bay Island was identified as one of the 34 multiple value alvar sites in need of immediate conservation action. Alvar communities should be mapped and protected and any other island managed by Shiawassee NWR should be inventoried to document presence of these communities. Because Scarecrow Island is designated as a Wilderness area a Minimum Requirement Analysis will be conducted before any management occurs on this island.

Strategies:

- Develop an Inventory and Monitoring Plan that would include surveys that documents these rare alvar and shore ecosystems and their associated flora and fauna. This survey would include:
 - Mapping of boundaries of alvar and shore sites and vegetative cover types.
 - An inventory of the plant species present within these habitats.
 - Procedures to measure current and future alvar and shore status and effectiveness of conservation strategies.
- Coordinate with the USFWS Ecological Services Field Office and other Partners to keep up-to-date records of the occurrence of these rare habitats on all of the islands managed by Shiawassee NWR.
- Limit disturbances, such as public access to these islands.
- Early detection, rapid response ([EDRR](#); DOI 2016) methods will be used to determine when management actions are needed to keep invasive plant species cover less than 5% of total area in these unique habitats.
 - 95% of area should be native species and open ground.
 - Use chemical and/or mechanical control techniques to control invasive species.

- Before any proposed management is conducted on Scarecrow Island a [Minimum Requirements Analysis](#) will be performed.

HMP Objective 5: Pitcher's Thistle and Dwarf Lake Iris

Annually protect and monitor pitcher's thistle and dwarf lake iris wherever they occur on the islands managed by Shiawassee NWR by restricting visitor use of the islands and by following the guidelines of the USFWS recovery plans that have been developed for these species. Inventorying and monitoring of these species will occur, at a minimum, every five years to assess status of current populations and check for new populations on the islands.

Rationale:

Pitcher's thistle is a state and federally listed threatened species which presently is known to occur on Big Charity Island. Management and recovery efforts for Pitcher's thistle will follow the guidelines outlined in [2012 Pitcher's Thistle Recovery Plan](#) (USFWS 2012). Dwarf lake iris is also a state and federally listed threatened species which is known to occur on Thunder Bay Island and may also occur on Sugar Island. Management and recovery efforts for the dwarf lake iris will follow the guidelines outlined in [2013 Dwarf Lake Iris Recovery Plan](#) (USFWS 2013b).

Although there is some documentation of the presence of these species on a few of the islands managed by Shiawassee NWR their population size, exact locations, and habitat conditions are not known. By inventorying and monitoring these species the refuge has an opportunity to contribute to their conservation. Both of these species are threatened by fragmentation, invasive species, and global warming (USFWS 2002b; 2013b). We know that fragmentation can decrease the likelihood of dispersal and invasive species can quickly crowd out native species. But it is unclear how these species will be affected by the alteration of shorelines and forest composition and/or distribution that may occur due to lake level or temperature changes (USFWS 2012; 2013b). Therefore, it is important to monitor any changes in populations in order to make management decisions related to their persistence.

Strategies:

- Develop an Inventory and Monitoring Plan that includes surveys that follow the recommendations of the pitcher's thistle and dwarf lake iris recovery plans including:
 - An assessment of pitcher's thistle's population size on Big Charity Island.
 - An assessment of dwarf lake iris' population size on Thunder Bay and Sugar Island.
 - An inventory of Scarecrow, Sugar, Little Charity Islands and any other islands managed by Shiawassee NWR to determine if populations of pitcher's thistle and/or dwarf lake iris exist on those islands.
 - Mapping of the locations of pitcher's thistle and dwarf lake iris.
 - An inventory of other species present within pitcher's thistle and/or dwarf lake iris habitats.

- Adding procedures that would measure current and future pitcher's thistle and dwarf lake iris status and effectiveness of conservation strategies.
- Inform and educate the public, recreationists, public land managers and private landowners regarding the identification and protection of pitcher's thistle and/or dwarf lake iris and add signage where these species exist.
- Coordinate with the USFWS Ecological Services Field Office and other Partners to document occurrences of pitcher's thistle and dwarf lake iris on all of the islands managed by Shiawassee NWR.
- Continue Pitcher's Thistle monitoring and evaluate effectiveness of augmenting population with greenhouse grown plants on Big Charity Island.
- Early detection, rapid response ([EDRR](#); DOI 2016) methods will be used to determine when management actions are needed to keep invasive plant species cover less than 5% of total area in pitcher's thistle and dwarf lake iris habitats.
 - Use chemical and/or mechanical control techniques to control invasive species.
- Before any proposed management is conducted on Scarecrow Island a [Minimum Requirements Analysis](#) will be performed.

HMP Objective 6: Wilderness Area (Scarecrow Island)

To protect and maintain the untrammeled, natural, and undeveloped qualities of Scarecrow Island, an annual Wilderness Character Monitoring evaluation will be conducted and entered into the [Wilderness Character Monitoring Database](#) using the measures outlined in the 2012 Michigan Islands NWR Wilderness Character Monitoring Report (O'Dell 2012) and the 2015 and 2017 addendums (Gantz 2015; Gantz and Edwards 2017). See Appendix H for measures attributed to Michigan Islands Wilderness Areas.

Rationale:

In 1970, Scarecrow Island was designated as a Federal Wilderness Area along with Pismire and Shoe Islands (managed by Seney NWR). In accordance with the Wilderness Act of 1964 the Michigan Islands NWR Wilderness Character Monitoring Report was written in 2012 and addendums modifying that report were written in 2015 and 2017 (USFWS 2012; 2015; 2017). Selected measures for Michigan Islands Wilderness were: 1) untrammeled quality, 2) natural quality, 3) undeveloped quality 4) Solitude or Primitive and Unconfined Recreation. Measure attributes and frequency of reporting is outlined in a table provided in Appendix H.

Presently, Scarecrow Island only consists of shrubs and dead trees, but is an important island for colonial nesting waterbirds. To reduce any disturbance to the island habitats or the nesting birds, annual aerial waterbird surveys instead of ground surveys are conducted every year. Habitats are passively managed through natural disturbance and lake fluctuations; and as needed, active invasive species management will be conducted to enhance habitat structure, composition, and regeneration. Before any proposed management is conducted on Scarecrow Island a Minimum Requirements Analysis will be performed.

Strategies:

- Any activities conducted on Scarecrow Island will follow measures outlined in the 2012 Michigan Islands NWR Wilderness Character Monitoring Report (ServCat Record #: [24720](#)) and the 2015 and 2017 addendums.
 - A [Minimum Requirements Analysis](#) will be performed before any proposed management is conducted on Scarecrow Island.

HMP Objective 7: Northern Mesic Forests

Annually, maintain the existing forests that occur on the islands managed by Shiawassee NWR in order to support the needs of priority and migratory bird species, threatened and endangered species, and resident wildlife.

Rationale:

Michigan lists Northern Mesic Forests as a community that is vulnerable to extirpation due to restricted range, relatively few occurrences, recent and widespread declines, and other factors (MDNR 2010) such as invasive species. Occasionally rapid assessments of invasive species have been conducted on Big Charity, Little Charity, Scarecrow, Sugar, and Thunder Bay Islands. However, these assessments should be conducted every other year to control and manage invasive species before they become established.

Northern Mesic Forests represent biological diversity and integrity and has the ability to support a variety of species, including the bald eagle. Bald eagles have been seen on most of the islands and there are known nests on Big Charity Island. This habitat is also important for cavity nesters and neotropical migrants. However, no surveys have been conducted recently to document what species use these communities. Northern Mesic forest blocks can be found on Thunder Bay, Sugar, and Big Charity Islands. Any management and restoration efforts should focus on promoting ecological integrity of the forest.

Strategies:

- Develop an Inventory and Monitoring Plan that would include procedures that would measure current and future status of forests and the effectiveness of conservation strategies.
 - Forest Invasives Adaptive Management (FIAM; Booker et al. 2017) strategies will be used in large forest blocks to conduct forest inventory and monitoring.
 - The expertise of Michigan Natural Features Inventory and/or local universities will be invited to assist in inventories of these forests.
- Early detection, rapid response ([EDRR](#); DOI 2016) methods will be used to determine when management actions are needed to keep invasive plant species cover less than 5% of total area forest habitats.
 - Use chemical and/or mechanical control techniques to control invasive species.
 - Before any proposed management is conducted on Scarecrow Island a [Minimum Requirements Analysis](#) will be performed.

Literature Cited

Albert, D. A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. Gen. Tech. Rep. NC-178. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Jamestown, ND: Northern Prairie Wildlife Research Center Online.

Albert, D. A. 2006. Natural community abstract for alvar. Michigan Natural Features Inventory, Lansing, MI. 10 pp. Retrieved from: <https://mnfi.anr.msu.edu/abstracts/ecology/Alvar.pdf>

Baker, M. E., and B. V. Barnes. 1998. Landscape ecosystem diversity of river floodplains in northwestern Lower Michigan, USA. Canadian Journal of Forest Research 28: 1405-1418.

Barnes, B. V., K. S. Pregitzer, T. A. Spies, and V. H. Spooner. 1982. Ecological forest site classification. Journal of Forestry 80: 493-498.

Bateman, B.L., A. M. Pidgeon, V. C. Radeloff, C. H. Flather, J. VanDerWal, H. R. Akcakaya, W. E. Thogmartin, T. P. Albright, S. J. Vavrus, and P. J. Heglund. 2016. Potential breeding distributions of U.S. birds predicted with both short-term variability and long-term average climate data. Ecological Applications 26: 2720-2731.

Booker J., S. M. Blomquist, D. D. Wood, A. C. McColpin, V. M. Hunt, D. B. Lesmeister, E. V. Lonsdorf, K. Mangan, B. Pendley, and B. A. Walker. 2017. Regional Protocol Framework for the Inventory and Effectiveness Monitoring of Invasive Plants in Forests, U.S. Fish and Wildlife Service, Midwest Region, National Wildlife Refuge System, Division of Natural Resources and Conservation Planning, Bloomington, MN.

Comer, P. J., D. L. Cuthrell, D. A. Albert, and M. R. Penskar. 1997. Natural community abstract for limestone bedrock lakeshore. Michigan Natural Features Inventory, Lansing, MI. 5 pp. Retrieved from: https://mnfi.anr.msu.edu/abstracts/ecology/Limestone_bedrock_lakeshore.pdf

Cuthbert, F. J. and L. R. Wires. 2013. The fourth decadal U.S. Great Lakes colonial waterbird survey (2007-2010): Results and recommendations to improve the scientific basis for conservation and management. Final Report to U.S. Fish and Wildlife Service, Region 3, Bloomington, MN.

[DOI] The U.S. Department of the Interior. 2016. Safeguarding America's lands and waters from invasive species: A national framework for early detection and rapid response, Washington D.C., 55p. Retrieved from: <https://www.doi.gov/sites/doi.gov/files/National%20EDRR%20Framework.pdf>

Eagle, A. C., E. M. Hay-Chmielewski, K. T. Cleveland, A. L. Derosier, M. E. Herbert, and R. A. Rustem, eds. 2005. Michigan's Wildlife Action Plan. Michigan Department of Natural Resources. Lansing, Michigan. 1592 pp. Retrieved from: <http://www.michigan.gov/dnrwildlifeactionplan>

[EPA] Environmental Protection Agency. 2015. Great Lakes Facts and Figures. Retrieved from: <http://www.epa.gov/greatlakes/great-lakes-facts-and-figures>

Gantz M. 2015. Michigan Islands NWR Wilderness Character Monitoring Summary: Addendum. US Fish and Wildlife Service, Midwest Region, Minneapolis, MN

Gantz M. and M. Edwards. 2017. Michigan Islands NWR Wilderness Character Monitoring Summary: Addendum. US Fish and Wildlife Service, Midwest Region, Minneapolis, MN

[GLISA] Great Lakes Integrated Science and Assessment. 2014. Fact Sheet – Climate Change in the Great Lakes Region. Retrieved from: http://glisa.umich.edu/media/files/GLISA_climate_change_summary.pdf

Knutson, M. G., G. Butcher, J. Fitzgerald, and J. Shieldcastle. 2001. Partners in Flight Bird Conservation Plan for The Upper Great Lakes Plain (Physiographic Area 16). USGS Upper Midwest Environmental Sciences Center in cooperation with Partners in Flight. La Crosse, Wisconsin. Retrieved from: <https://www.partnersinflight.org/wp-content/uploads/2017/02/PA-16-Upper-Great-Lakes.pdf>

Kraus D. B. Henson and D. Ewert. 2009. Biodiversity and conservation of Lake Huron's islands, Aquatic Ecosystem Health & Management, 12:1, 90-100, Retrieved from: <http://dx.doi.org/10.1080/14634980802715225>

Matteson, S. K. Kreitingner, G. Bartelt, G. Butcher, D. Sample, and T. Will. 2009. Partners in Flight Bird Conservation Plan for the Boreal Hardwood Transition (Bird Conservation Region 12 — U.S. Portion). Version 1.0. Partners in Flight. Retrieved from: <https://www.partnersinflight.org/wp-content/uploads/2017/03/BCR-12-US-Plan.pdf>

McAvinchey R. J., C. R. Hays, B. A. Horney and B. J. Wrona. 2005. Coastal Management Program Grant Vegetative Survey of Great Lakes Islands, Final Project Report.

[MDNR] Michigan Department of Natural Resources. 2010. Michigan's Natural Communities. Retrieved from: <https://mnfi.anr.msu.edu/pub/abstracts.cfm>

[MDNR] Michigan Department of Natural Resources. 2015. Michigan's Wildlife Action Plan. Lansing, MI. Retrieved from: http://www.michigan.gov/dnr/0,4570,7-153-10370_30909---,00.html

[MICRA] Mississippi Interstate Cooperative Resource Association. 2009. Interjurisdictional Fishes of the Mississippi River Basin. Retrieved from: <http://www.micrarivers.org>

[MSUE] Michigan State University Extension. 2013. Michigan Natural Features Inventory, Michigan's Rare Species Explorer. Retrieved from: <http://mnfi.anr.msu.edu/explorer/results.cfm>

Newman, B. J. 2011. Water Resource Inventory and Assessment (WRIA) - Shiawassee National Wildlife Refuge. US Fish and Wildlife Service, Midwest Region, Minneapolis, MN

O'Dell S. 2012. Michigan Islands Wilderness: A Report on Wilderness Character Monitoring. US Fish and Wildlife Service, Midwest Region, Bloomington, MN

Partners in Amphibian and Reptile conservation [PARC]. 2011. Midwest PARC Species List. Retrieved from: <http://www.mwparc.org/region/#species>

Potter, B. A., R. J. Gates, G. J. Soulliere, R. P. Russell, D. A. Granfors, and D. N. Ewert. 2007a. Upper Mississippi River and Great Lakes Region Joint Venture Shorebird Habitat Conservation Strategy. U. S. Fish and Wildlife Service, Fort Snelling, MN. 101pp.

Potter, B. A., G. J. Soulliere, D. N. Ewert, M. G. Knutson, W. E. Thogmartin, J. S. Castrale, and M. J. Roell. 2007b. Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, MN. 124pp.

Reschke, C., R. Reid, J. Jones, T. Feeney, and H. Potter. 1999. Conserving Great Lakes alvars. Final technical report of the International Alvar Conservation Initiative. The Nature Conservancy, Great Lakes Program.

Reznicek A. A., E. G. Voss, and B. S. Walters. 2011. Michigan Flora Online. University of Michigan. Retrieved from: <http://michiganflora.net>

Rosenberg, K. V., D. Pashley, B. Andres, P. J. Blancher, G. S. Butcher, W. C. Hunter, D. Mehlman, A. O. Panjabi, M. Parr, G. Wallace, and D. Wiedenfeld. 2014. The State of the Birds 2014 Watch List. North American Bird Conservation Initiative, U.S. Committee. Washington, D.C. 4 pages. Retrieved from: http://www.stateofthebirds.org/2014/habitats/2014%20SotB%20Watch%20List_FINAL.pdf

Rosenberg K. V., J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J. D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J. J. Giocomo, R. H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, T. Will. 2016. Partners in Flight Landbird Conservation Plan: 2016 Revision for Canada and Continental United States. Partners in Flight Science Committee. 119 pp. Retrieved from: <https://www.partnersinflight.org/resources/the-plan/>

Salas, D. and M. Prankus. 2015. ROCSTAR: Resources of Concern Selection Tool for Americas Refuges User Guide. Cardno Engineering and Environmental Services Division. Fitchburg, Wisconsin.

Soulé, M. 1991. Conservation: Tactics for a constant crisis. Science 253: 744-50.

Soulé, J. D., 1993. Biodiversity of Michigan's Great Lakes islands. Knowledge, threats and protection. p. 11–26. Report to Michigan Department of Natural Resources, Land and Water Management Division, Coastal Zone Management Program. Michigan Natural Features Inventory Report #1993-10.

Soulliere, G. J., B. A. Potter, J. M. Coluccy, R. C. Gatti., C. L. Roy, D. R. Luukkonen, P. W. Brown, and M. W. Eichholz. 2007a. Upper Mississippi River and Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Soulliere, G. J., B. A. Potter, D. J. Holm, D. A. Granfors, M. J. Monfils, S. J. Lewis, and W. E. Thogmartin. 2007b. Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, MN. 68pp.

Taylor J. D. and F. L. Paveglio. 2017. Identifying Refuge Resources of Concern and Management Priorities: A Handbook. U.S. Fish and Wildlife Service, Washington, DC.

[UMRGLR JV] Upper Mississippi River and Great Lakes Region Joint Venture Implementation Plan. 2007. (Compiled by G. J. Soulliere and B. A. Potter). U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA. Retrieved from: <http://www.uppermissgreatlakesjv.org/Plans.htm>)

[USFWS] U.S. Fish and Wildlife Service. 1999. Fulfilling the promise: the National Wildlife Refuge System. Arlington, VA: U.S. Fish and Wildlife Service, Division of Refuges.

[USFWS] U.S. Fish and Wildlife Service. 2002a. Fish and Wildlife Resource Conservation Priorities, Region 3. 32 pp. Retrieved from:
<http://www.fws.gov/midwest/News/documents/priority.pdf>

[USFWS] U.S. Fish and Wildlife Service. 2002b. Pitcher's Thistle (*Cirsium pitcheri*) Recovery Plan. Fort Snelling, Minnesota. vii + 92 pp.

[USFWS] U.S. Fish and Wildlife Service. 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp. Retrieved from: <http://www.fws.gov/migratorybirds/>

[USFWS] U.S. Fish and Wildlife Service. 2011. FY2012- FY2016 Focal Species. Retrieved from: <https://www.fws.gov/migratorybirds/pdf/management/focalspecies.pdf>

[USFWS] U.S. Fish and Wildlife Service. 2012. Midwest Birds of Concern, Retrieved from: <http://www.fws.gov/midwest/midwestbird/concern.html>

[USFWS] U.S. Fish and Wildlife Service. 2013a. Gravel Island, Green Bay, Harbor Island, Huron, and Michigan Islands National Wildlife Refuge Comprehensive Conservation Plan.

[USFWS] U.S. Fish and Wildlife Service. 2013b. Dwarf lake iris (*Iris lacustris*) Recovery Plan. Bloomington, Minnesota. vii + 75 pp

[USFWS] U.S. Fish and Wildlife Service. 2014. Selecting surrogate species for Strategic Habitat Conservation in the Upper Midwest Great Lakes geography. Bloomington, MN: Powers, N., Brouder, M., Blomquist, S., Potter, B., Dingledine, J., Deloria, C., Soulliere, G., Kerr, T., Steiger-Meister, K. Retrieved from:
<https://www.fws.gov/midwest/science/surrogatespecies/documents/UMGLSurrogatesSpeciesTechnicalReportFINAL2014.pdf>

[USFWS] U. S. Fish and Wildlife Service. 2015a. Endangered, Threatened, Proposed and Candidate Species in the Upper Midwest (Region 3). Retrieved from:
<http://www.fws.gov/midwest/endangered/lists/ethpr.html>

[USFWS] U. S. Fish and Wildlife Service. 2015b. Habitat Management Plan for Harbor Island NWR, Huron NWR, Michigan Islands NWR. US Fish and Wildlife Service, Midwest Region, Minneapolis, MN.

[USFWS] U. S. Fish and Wildlife Service. 2017. Environmental Assessment for Issuing Depredation Permits for Double-crested Cormorant Management. U.S. Fish and Wildlife Service, Division of Migratory Bird Management. Retrieved from:
<https://www.fws.gov/birds/management/managed-species/double-crested-cormorants.php>

[USFWS] U. S. Fish and Wildlife Service. 2018. Green Bay and Gravel Island National Wildlife Refuges Habitat Management Plan. US Fish and Wildlife Service, Midwest Region, Minneapolis, MN.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. “Chip” Weseloh, R. P. Russell, and F. J. Cuthbert. 2010. Upper Mississippi River/Great Lakes Region Waterbird Conservation Strategy. A plan associated with the Waterbird Conservation for the Americas Initiative. Final Report submitted to the U. S. Fish and Wildlife Service, Fort Snelling, MN.

Wood, N. A. 1911a. Results of the Mershon Expedition to the Charity Islands, Lake Huron: Mammals, Thirteenth Report of the Michigan Academy of Science 1911 (1911): 131–134.

Wood, N. A. 1911b. The results of the Mershon Expedition to the Charity Islands, Lake Heron, Birds. Wilson Bulletin. 23 (2):78-114.

Wood, N. A. The Breeding Birds of the Charity Islands, with Additional Notes on the Migrants, Fourteenth Report of the Michigan Academy of Science 1912 (1912): 178–188.

Xerces Society. n.d. Red List of Butterflies and Moths. Retrieved from:
<http://www.xerces.org/red-list-of-butterflies-and-moths-sorted/>

Appendix A: Plant Lists

Table A.1. Vegetation survey results from the 1991 survey on [Big] Charity Island's West shore.

Charity Island W Shore Surveyed in 1991. FQA typed up by Higman: 9/19/17				
Au Gres				
Arenac				
Michigan				
USA				
FQA DB Region:	Michigan			
FQA DB Publication Year:	2014			
FQA DB Description:	Reznicek et al.			
Practitioner:	Goff, Glenn			
Conservatism-Based Metrics:			Physiognomy Metrics:	
Total Mean C:	3.1		Tree:	19 12.50%
Native Mean C:	3.9		Shrub:	15 9.90%
Total FQI:	38.2		Vine:	8 5.30%
Native FQI:	42.7		Forb:	67 44.10%
Adjusted FQI:	34.7		Grass:	19 12.50%
% C value 0:	26.3		Sedge:	13 8.60%
% C value 1-3:	34.9		Rush:	6 3.90%
% C value 4-6:	27.0		Fern:	5 3.30%
% C value 7-10:	11.8		Bryophyte:	0 0%
Native Tree Mean C:	2.8			
Native Shrub Mean C:	4.0		Duration Metrics:	
Native Herbaceous Mean C:	4.1		Annual:	23 15.10%
			Perennial:	121 79.60%
Species Richness:			Biennial:	8 5.30%
Total Species:	152		Native Annual:	14 9.20%
Native Species:	120	78.90%	Native Perennial:	103 67.80%
Non-native Species:	32	21.10%	Native Biennial:	3 2%
Species Wetness:				
Mean Wetness:	0.2			
Native Mean Wetness:	-0.3			

Species Documented:

Scientific Name	Common Name	Native?	C	W	Physiog.	Duration
<i>Acer negundo</i>	box-elder	native	0	0	tree	perennial
<i>Acer rubrum</i>	red maple	native	1	0	tree	perennial
<i>Acer saccharum</i>	sugar maple	native	5	3	tree	perennial
<i>Agalinis purpurea</i>	purple false foxglove	native	7	-3	forb	annual

Scientific Name	Common Name	Native?	C	W	Physiog.	Duration
<i>Agrostis stolonifera</i>	creeping bent	non-nat	0	-3	grass	perennial
<i>Ammophila breviligulata</i>	marram grass	native	10	5	grass	perennial
<i>Anemone virginiana</i>	thimbleweed	native	3	3	forb	perennial
<i>Arctostaphylos uva-ursi</i>	bearberry	native	8	5	shrub	perennial
<i>Artemisia campestris</i>	wormwood	native	5	5	forb	biennial
<i>Asclepias incarnata</i>	swamp milkweed	native	6	-5	forb	perennial
<i>Asclepias syriaca</i>	common milkweed	native	1	5	forb	perennial
<i>Betula papyrifera</i>	paper birch	native	2	3	tree	perennial
<i>Bidens connata</i>	purple-stemmed tickseed	native	5	-3	forb	annual
<i>Bidens frondosa</i>	common beggar-ticks	native	1	-3	forb	annual
<i>Boehmeria cylindrica</i>	false nettle	native	5	-5	forb	perennial
<i>Bromus pubescens</i>	Canada brome	native	5	3	grass	perennial
<i>Cakile edentula</i>	sea-rocket	native	5	3	forb	annual
<i>Calamagrostis canadensis</i>	blue-joint	native	3	-5	grass	perennial
<i>Calamovilfa longifolia</i>	sand reed grass	native	10	5	grass	perennial
<i>Carex annectens</i>	sedge	native	1	-3	sedge	perennial
<i>Carex bebbii</i>	sedge	native	4	-5	sedge	perennial
<i>Carex comosa</i>	sedge	native	5	-5	sedge	perennial
<i>Carex cristatella</i>	sedge	native	3	-3	sedge	perennial
<i>Carex lacustris</i>	sedge	native	6	-5	sedge	perennial
<i>Carex pellita; c. lanuginosa</i>	sedge	native	2	-5	sedge	perennial
<i>Carex pensylvanica</i>	sedge	native	4	5	sedge	perennial
<i>Carex viridula</i>	sedge	native	4	-5	sedge	perennial
<i>Celastrus scandens</i>	American bittersweet	native	3	3	vine	perennial
<i>Centaurea stoebe; (C. maculosa)</i>	spotted knapweed	non-nat	0	5	forb	biennial
<i>Chenopodium album</i>	lambs-quarters	non-nat	0	3	forb	annual
<i>Cirsium arvense</i>	Canada thistle	non-nat	0	3	forb	perennial
<i>Cirsium vulgare</i>	bull thistle	non-nat	0	3	forb	biennial
<i>Citrullus lanatus</i>	watermelon	non-nat	0	5	vine	annual
<i>Comandra umbellata</i>	bastard-toadflax	native	5	3	forb	perennial
<i>Conyza canadensis</i>	horseweed	native	0	3	forb	annual
<i>Cornus amomum</i>	silky dogwood	native	2	-3	shrub	perennial
<i>Cornus sericea; C. stolonifera</i>	red-osier	native	2	-3	shrub	perennial
<i>Crocanthemum bicknellii (Helianthemum bicknellii)</i>	frostweed	native	10	5	forb	perennial
<i>Cycloloma atriplicifolium</i>	winged pigweed	non-nat	0	3	forb	annual
<i>Cyperus bipartitus; C. rivularis</i>	brook nut sedge	native	3	-3	sedge	annual
<i>Cyperus odoratus</i>	umbrella sedge	native	3	-5	sedge	annual
<i>Dichanthelium boreale; Panicum boreale</i>	northern panic grass	native	7	0	grass	perennial
<i>Dichanthelium lindheimeri; (Panicum lindheimeri)</i>	panic grass	native	8	-5	grass	perennial

Scientific Name	Common Name	Native?	C	W	Physiog.	Duration
<i>Doellingeria umbellata</i> ; (<i>Aster umbellatus</i>)	flat-topped white aster	native	5	-3	forb	perennial
<i>Echinochloa crusgalli</i>	barnyard grass	non-nat	0	0	grass	annual
<i>Elymus canadensis</i>	Canada wild rye	native	5	3	grass	perennial
<i>Elymus lanceolatus</i> ; <i>Agropyron dasystachyum</i>	wheat grass	native	10	3	grass	perennial
<i>Elymus repens</i> ; <i>agropyron r.</i>	quack grass	non-nat	0	3	grass	perennial
<i>Epilobium ciliatum</i>	willow-herb	native	3	-3	forb	perennial
<i>Epilobium hirsutum</i>	great hairy willow-herb	non-nat	0	-3	forb	perennial
<i>Equisetum arvense</i>	common horsetail	native	0	0	fern	perennial
<i>Equisetum hyemale</i>	scouring rush	native	2	0	fern	perennial
<i>Equisetum scirpoides</i>	dwarf scouring rush	native	7	0	fern	perennial
<i>Equisetum variegatum</i>	variegated scouring rush	native	6	-3	fern	perennial
<i>Erucastrum gallicum</i>	dog mustard	non-nat	0	3	forb	annual
<i>Eupatorium perfoliatum</i>	boneset	native	4	-3	forb	perennial
<i>Euphorbia maculata</i>	spotted spurge	native	0	3	forb	annual
<i>Euphorbia virgata</i> ; <i>e. esula</i>	leafy spurge	non-nat	0	5	forb	perennial
<i>Euthamia graminifolia</i>	grass-leaved goldenrod	native	3	0	forb	perennial
<i>Fallopia convolvulus</i> ; <i>polygonum convolvulus</i>	false buckwheat	non-nat	0	3	vine	annual
<i>Fragaria virginiana</i>	wild strawberry	native	2	3	forb	perennial
<i>Fraxinus americana</i>	white ash	native	5	3	tree	perennial
<i>Fraxinus pennsylvanica</i>	red ash	native	2	-3	tree	perennial
<i>Geranium robertianum</i>	herb robert	native	3	3	forb	annual
<i>Helianthus strumosus</i>	pale-leaved sunflower	native	4	5	forb	perennial
<i>Impatiens capensis</i>	spotted touch-me-not	native	2	-3	forb	annual
<i>Juncus alpinoarticulatus</i> ; (<i>Juncus alpinus</i>)	rush	native	5	-5	rush	perennial
<i>Juncus articulatus</i>	jointed rush	native	3	-5	rush	perennial
<i>Juncus balticus</i>	rush	native	4	-5	rush	perennial
<i>Juncus brachycephalus</i>	rush	native	7	-5	rush	perennial
<i>Juncus effusus</i>	soft-stemmed rush	native	3	-5	rush	perennial
<i>Juncus nodosus</i>	joint rush	native	5	-5	rush	perennial
<i>Juniperus communis</i>	common or ground juniper	native	4	3	shrub	perennial
<i>Juniperus horizontalis</i>	creeping juniper	native	10	3	shrub	perennial
<i>Lactuca canadensis</i>	tall lettuce	native	2	3	forb	biennial
<i>Lathyrus japonicus</i>	beach pea	native	10	3	vine	perennial
<i>Leersia oryzoides</i>	cut grass	native	3	-5	grass	perennial
<i>Ligustrum vulgare</i>	common privet	non-nat	0	3	shrub	perennial
<i>Lithospermum canescens</i>	hoary puccoon	native	10	5	forb	perennial
<i>Lobelia kalmii</i>	bog lobelia	native	10	-5	forb	perennial

Scientific Name	Common Name	Native?	C	W	Physiog.	Duration
<i>Lycopus americanus</i>	common water horehound	native	2	-5	forb	perennial
<i>Maianthemum canadense</i>	Canada mayflower	native	4	3	forb	perennial
<i>Maianthemum stellatum</i> ; (<i>Smilacina stellata</i>)	starry false solomon-seal	native	5	0	forb	perennial
<i>Medicago lupulina</i>	black medick	non-nat	0	3	forb	annual
<i>Melilotus albus</i>	white sweet-clover	non-nat	0	3	forb	biennial
<i>Mentha canadensis</i> ; (<i>M. arvensis</i>)	wild mint	native	3	-3	forb	perennial
<i>Oenothera biennis</i>	common evening-primrose	native	2	3	forb	biennial
<i>Panicum capillare</i>	witch grass	native	0	0	grass	annual
<i>Panicum virgatum</i>	switch grass	native	4	0	grass	perennial
<i>Parthenocissus quinquefolia</i>	Virginia creeper	native	5	3	vine	perennial
<i>Persicaria lapathifolia</i> ; (<i>Polygonum lapathifolia</i>)	nodding smartweed	native	0	-3	forb	annual
<i>Persicaria maculosa</i> ; (<i>Polygonum persicaria</i>)	lady's-thumb	non-nat	0	0	forb	annual
<i>Phalaris arundinacea</i>	reed canary grass	native	0	-3	grass	perennial
<i>Phragmites australis</i> var. <i>australis</i>	reed	non-nat	0	-3	grass	perennial
<i>Physostegia virginiana</i>	false dragonhead	native	8	-3	forb	perennial
<i>Pinus strobus</i>	white pine	native	3	3	tree	perennial
<i>Poa compressa</i>	Canada bluegrass	non-nat	0	3	grass	perennial
<i>Polygonatum pubescens</i>	downy solomon seal	native	5	5	forb	perennial
<i>Polygonella articulata</i>	jointweed	native	8	5	forb	annual
<i>Populus balsamifera</i>	balsam poplar	native	2	-3	tree	perennial
<i>Populus deltoides</i>	cottonwood	native	1	0	tree	perennial
<i>Populus grandidentata</i>	big-tooth aspen	native	4	3	tree	perennial
<i>Populus nigra</i>	lombardy poplar	non-nat	0	5	tree	perennial
<i>Populus tremuloides</i>	quaking aspen	native	1	0	tree	perennial
<i>Potamogeton gramineus</i>	pondweed	native	5	-5	forb	perennial
<i>Potentilla anserina</i>	silverweed	native	5	-3	forb	perennial
<i>Prunus pensylvanica</i>	pin cherry	native	3	3	tree	perennial
<i>Prunus pumila</i>	sand cherry	native	8	5	shrub	perennial
<i>Prunus serotina</i>	wild black cherry	native	2	3	tree	perennial
<i>Prunus virginiana</i>	choke cherry	native	2	3	shrub	perennial
<i>Pteridium aquilinum</i>	bracken fern	native	0	3	fern	perennial
<i>Quercus rubra</i>	red oak	native	5	3	tree	perennial
<i>Rhus typhina</i>	staghorn sumac	native	2	3	shrub	perennial
<i>Rosa blanda</i>	wild rose	native	3	3	shrub	perennial
<i>Rubus flagellaris</i>	northern dewberry	native	1	3	shrub	perennial
<i>Rumex acetosella</i>	sheep sorrel	non-nat	0	3	forb	perennial
<i>Rumex crispus</i>	curly dock	non-nat	0	0	forb	perennial

Scientific Name	Common Name	Native?	C	W	Physiog.	Duration
<i>Salix bebbiana</i>	Bebb's willow	native	1	-3	shrub	perennial
<i>Salix exigua</i>	sandbar willow	native	1	-3	shrub	perennial
<i>Salix fragilis</i>	crack willow	non-nat	0	0	tree	perennial
<i>Salix lucida</i>	shining willow	native	3	-3	shrub	perennial
<i>Salix myricoides</i>	blueleaf willow	native	9	-3	shrub	perennial
<i>Saponaria officinalis</i>	bouncing bet	non-nat	0	3	forb	perennial
<i>Schoenoplectus acutus; Scirpus acutus</i>	hardstem bulrush	native	5	-5	sedge	perennial
<i>Schoenoplectus pungens; Scirpus americanus</i>	threesquare	native	5	-5	sedge	perennial
<i>Scirpus cyperinus</i>	wool-grass	native	5	-5	sedge	perennial
<i>Scutellaria lateriflora</i>	mad-dog skullcap	native	5	-5	forb	perennial
<i>Solanum dulcamara</i>	bittersweet nightshade	non-nat	0	0	vine	perennial
<i>Solanum ptychanthum</i>	black nightshade	native	1	3	forb	annual
<i>Solidago altissima</i>	tall goldenrod	native	1	3	forb	perennial
<i>Solidago caesia</i>	bluestem goldenrod	native	6	3	forb	perennial
<i>Solidago hispida</i>	hairy goldenrod	native	3	5	forb	perennial
<i>Solidago nemoralis</i>	old-field goldenrod	native	2	5	forb	perennial
<i>Sonchus arvensis; (S. uliginosus)</i>	perennial sow-thistle	non-nat	0	3	forb	perennial
<i>Spartina pectinata</i>	cordgrass	native	5	-3	grass	perennial
<i>Sporobolus cryptandrus</i>	sand dropseed	native	3	3	grass	perennial
<i>Symphyotrichum lanceolatum; (Aster lanceolatum)</i>	panicked aster	native	2	-3	forb	perennial
<i>Symphyotrichum novae-angliae; Aster novae-angliae)</i>	New England aster	native	3	-3	forb	perennial
<i>Symphyotrichum pilosum; (Aster pilosum)</i>	hairy aster	native	1	3	forb	perennial
<i>Taraxacum officinale</i>	common dandelion	non-nat	0	3	forb	perennial
<i>Teucrium canadense</i>	wood-sage	native	4	-3	forb	perennial
<i>Thalictrum dasycarpum</i>	purple meadow-rue	native	3	-3	forb	perennial
<i>Thuja occidentalis</i>	arbor vitae	native	4	-3	tree	perennial
<i>Tilia americana</i>	basswood	native	5	3	tree	perennial
<i>Toxicodendron radicans</i>	poison-ivy	native	2	0	vine	perennial
<i>Tragopogon pratensis</i>	common goats beard	non-nat	0	5	forb	biennial
<i>Typha angustifolia</i>	narrow-leaved cat-tail	non-nat	0	-5	forb	perennial
<i>Typha latifolia</i>	broad-leaved cat-tail	native	1	-5	forb	perennial
<i>Ulmus pumila</i>	Siberian elm	non-nat	0	3	tree	perennial
<i>Verbascum thapsus</i>	common mullein	non-nat	0	5	forb	biennial
<i>Vitis riparia</i>	river-bank grape	native	3	0	vine	perennial
<i>Xanthium strumarium</i>	common cocklebur	non-nat	0	0	forb	annual

Table A.2. In McAvinchey et al. 2005, Appendix 4: Plant species list for Thunder Bay, Scarecrow, Big Charity and Little Charity Islands. Sugar Island was not included in this inventory.

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
Trees and Shrubs						
<i>Taxus canadensis</i>	Yew	Taxaceae	X			
<i>Larix laricina</i>	Tamarack	Pinaceae	X			
<i>Pinus resinosa</i>	Red Pine	Pinaceae			X	
<i>Pinus strobus</i>	White Pine	Pinaceae	X		X	
<i>Abies balsamea</i>	Balsam Fir	Pinaceae	X			
<i>Thuja occidentalis</i>	Northern White-cedar	Cupressaceae	X		X	
<i>Juniperus communis</i> var. <i>depressa</i>	Ground Juniper	Cupressaceae			X	
<i>Picea glauca</i>	White Spruce	Pinaceae	X			
<i>Salix myricoides</i>	Blueleaf Willow	Salicaceae			X	
<i>Salix bebbii</i>	Bebb Willow	Salicaceae			X	
<i>Salix cordata</i>	Heartleaf Willow	Salicaceae			X	
<i>Salix eriocephala</i>	Diamond Willow	Salicaceae	X			
<i>Salix</i> sp.	Willow	Salicaceae	X			X
<i>Populus balsamifera</i>	Balsam Poplar	Salicaceae	X	X	X	
<i>Populus deltoids</i>	Eastern Cottonwood	Salicaceae			X	X
<i>Populus grandidentata</i>	Bigtooth Aspen	Salicaceae			X	
<i>Populus tremuloides</i>	Quaking Aspen	Salicaceae	X	X	X	
<i>Fagus grandifolia</i>	American Beech	Fagaceae			X	
<i>Quercus rubra</i>	Northern Red Oak	Fagaceae	X		X	
<i>Quercus velutina</i>	Black Oak	Fagaceae			X	
<i>Quercus ellipsoidalis</i>	Northern Pin Oak	Fagaceae			X	
<i>Celtis occidentalis</i>	Hackberry	Ulmaceae				X
<i>Alnus incana</i> ssp. <i>rugosa</i>	Speckled Alder	Betulaceae			X	
<i>Betula papyrifera</i>	Paper Birch	Betulaceae	X	X	X	
<i>Ostrya virginiana</i>	Hop-hornbeam; Ironwood	Betulaceae			X	

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
<i>Tilia americana</i>	Basswood	Tiliaceae	X		X	
<i>Sheperdia canadensis</i>	Buffaloberry	Eleagnaceae	X			
<i>Rhus typhina</i>	Staghorn Sumac	Anacardiaceae	X			
<i>Ribes cynosbati</i>	Eastern Prickly Gooseberry	Grossulariaceae	X			
<i>Ribes hirtellum</i>	Swamp Gooseberry	Grossulariaceae	X			
<i>Ribes americanum</i>	American Black Currant	Grossulariaceae	X			
<i>Hamamelis virginiana</i>	Witch-hazel	Hamamelidaceae			X	
<i>Rubus allegheniensis</i>	Allegheny Blackberry	Rosaceae			X	
<i>Rubus idaeus</i>	American Red Raspberry	Rosaceae	X		X	
<i>Rosa carolina</i>	Carolina Rose	Rosaceae	X			
<i>Rosa palustris</i>	Swamp Rose	Rosaceae			X	
<i>Amelanchier arborea</i>	Common Serviceberry	Rosaceae	X		X	
<i>Crataegus sp.</i>	Hawthorn	Rosaceae			X	
<i>Prunus serotina</i>	Black Cherry	Rosaceae	X		X	
<i>Prunus virginiana</i>	Chokecherry	Rosaceae			X	
<i>Physocarpus opulifolius</i>	Common Ninebark	Rosaceae	X			
<i>Potentilla fruticosa</i>	Shrubby Cinquefoil	Rosaceae	X			
<i>Nemopanthus mucronatus</i>	Catberry	Aquifoliaceae			X	
<i>Ilex verticillata</i>	Common Winterberry	Aquifoliaceae			X	
<i>Acer saccharum</i>	Sugar Maple	Aceraceae			X	
<i>Acer rubrum</i>	Red Maple	Aceraceae	X		X	
<i>Acer saccharinum</i>	Silver Maple	Aceraceae	X		X	
<i>Acer spicatum</i>	Mountain Maple	Aceraceae	X			
<i>Acer pensylvanicum</i>	Striped Maple	Aceraceae	X			
<i>Cornus alternifolia</i>	Alternate-leaf Dogwood	Cornaceae	X		X	
<i>Cornus sericea</i>	Red-osier Dogwood	Cornaceae	X	X		
<i>Cornus racemosa</i>	Gray Dogwood	Cornaceae	X		X	
<i>Cornus rugosa</i>	Roundleaf Dogwood	Cornaceae	X			

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
<i>Vaccinium corymbosum</i>	Highbush Blackberry	Ericaceae			X	
<i>Sambucus racemosa</i>	Red-berried Elder	Caprifoliaceae	X		X	
<i>Lonicera dioica</i>	Limber Honeysuckle	Caprifoliaceae			X	
<i>Lonicera diervilla</i>	Northern Bush-honeysuckle	Caprifoliaceae	X		X	
<i>Lonicera hirsute</i>	Hairy Honeysuckle	Caprifoliaceae	X			
<i>Lonicera oblongifolia</i>	Swamp Fly Honeysuckle	Caprifoliaceae	X			
<i>Sambucus canadensis</i>	Common Elder	Caprifoliaceae		X		
<i>Viburnum acerifolium</i>	Mapleleaf Viburnum	Caprifoliaceae	X			
<i>Viburnum lentago</i>	Nannyberry	Caprifoliaceae			X	

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
Horsetails, Ferns, Forbs, Small Shrubs and Vines						
<i>Equisetum hyemale</i>	Scouring Rush Horsetail	Equisetaceae			X	
<i>Equisetum pratense</i>	Meadow Horsetail		X		X	
<i>Botrychium virginianum</i>	Rattlesnake Fern	Ophioglossaceae	X			
<i>Osmunda regalis</i>	Royal Fern	Osmundaceae			X	
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>	Eastern Bracken Fern	Dennstaedtiaceae	X		X	
<i>Onoclea sensibilis</i>	Sensitive Fern	Dryopteridaceae			X	
<i>Dryopteris spinulosa</i>	Spinulose Wood Fern	Dryopteridaceae			X	
<i>Dryopteris spinulosa</i> var. <i>fructuosa</i>	Fruitful Wood Fern	Dryopteridaceae	X			
<i>Dryopteris intermedia</i>	Intermediate Wood Fern	Dryopteridaceae	X			
<i>Athyrium filix-femina</i>	Lady Fern	Dryopteridaceae			X	
<i>Pellaea atropurpurea</i>	Purple Cliffbrake	Pteridaceae			X	
<i>Thelypteris palustris</i>	Eastern Marsh Fern	Thelypteridaceae			X	
<i>Urtica dioica</i>	Stinging Nettle	Urticaceae		X		X
<i>Boehmeria cylindrica</i>	Small-spike False Nettle	Urticaceae			X	
<i>Rumex crispus</i>	Sourdock; Curly Dock	Polygonaceae		X		
<i>Polygonum scandens</i>	Climbing False Buckwheat	Polygonaceae		X		
<i>Polygonum sp.</i>	Knotweed	Polygonaceae		X		
<i>Chenopodium album</i>	Lambsquarters; Pigweed	Chenopodiaceae		X		
<i>Amaranthus retroflexus</i>	Redroot Amaranth	Amaranthaceae		X		
<i>Stellaria media</i>	Common Chickweed	Caryophyllaceae				X
<i>Cerastium fontanum</i>	Common Mouse-ear Chickweed	Caryophyllaceae	X			
<i>Aquilegia canadensis</i>	Red Columbine	Ranunculaceae	X			
<i>Thalictrum dioicum</i>	Early Meadow-rue	Ranunculaceae	X		X	
<i>Actaea pachypoda</i>	White Baneberry	Ranunculaceae			X	

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
<i>Actaea rubra</i>	Red Baneberry	Ranunculaceae	X			
<i>Hepatica acutiloba</i>	Sharp-lobed Hepatica	Ranunculaceae			X	
<i>Ranunculus acris</i>	Tall Buttercup	Ranunculaceae	X			
<i>Anemone quinquefolia</i>	Nightcaps	Ranunculaceae			X	
<i>Anemone canadensis</i>	Canada Anemone	Ranunculaceae	X			
<i>Berberis sp.</i>	Barberry	Berberidaceae			X	
<i>Erucastrum gallicum</i>	Common Dog Mustard	Brassicaceae			X	
<i>Barbarea vulgaris</i>	Garden Yellow Rocket	Brassicaceae	X			
<i>Erysimum cheiranthoides</i>	Wormseed Wallflower or Mustard	Brassicaceae		X		
<i>Sedum acre</i>	Goldmoss or Mossy Stonecrop	Crassulaceae	X			
<i>Mitella nuda</i>	Naked Miterwort	Saxifragaceae	X			
<i>Rubus pubescens</i>	Dwarf Red Blackberry	Rosaceae			X	
<i>Rosa sp.</i>	Rose	Rosaceae			X	
<i>Fragaria virginiana</i>	Wild Strawberry	Rosaceae	X	X		X
<i>Potentilla norvegica</i>	Rough or Norwegian Cinquefoil	Rosaceae		X		
<i>Potentilla anserina</i>	Silverweed	Rosaceae	X	X	X	
<i>Geum canadense</i>	White Avens	Rosaceae	X		X	
<i>Geum sp.</i>	Avens	Rosaceae	X			
<i>Trifolium dubium</i>	Little Hop Clover	Fabaceae	X			
<i>Melilotus officinalis</i>	Yellow Sweet-clover	Fabaceae		X		
<i>Lupinus perennis</i>	Wild Lupine	Fabaceae			X	
<i>Lathyrus palustris</i>	Marsh Pea	Fabaceae	X			
<i>Lotus corniculatus</i>	Birdfoot Trefoil	Fabaceae		X		
<i>Geranium robertianum</i>	Herb-Robert	Geraniaceae	X		X	
<i>Geranium maculatum</i>	Spotted Geranium	Geraniaceae	X		X	
<i>Geranium sp.</i>	Geranium	Geraniaceae			X	
<i>Polygala paucifolia</i>	Fringed Polygala	Polygalaceae	X			
<i>Toxicodendron radicans</i>	Poison Ivy	Anacardiaceae	X		X	

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
<i>Celastrus scandens</i>	American Bittersweet	Celastraceae			X	
<i>Impatiens capensis</i>	Jewelweed; Touch-me-not	Balsaminaceae	X	X		
<i>Parthenocissus quinquefolia</i>	Virginia Creeper	Vitaceae			X	
<i>Vitis sp.</i>	Wild Grape	Vitaceae			X	
<i>Hypericum Kalmianum</i>	Kalm St. Johnswort	Guttiferae (Clusiaceae)	X		X	
<i>Hypericum perforatum</i>	Common St. Johnswort	Guttiferae	X			
<i>Hypericum sp.</i>	St. Johnswort	Guttiferae	X			
<i>Viola pubescens</i>	Downy Yellow Violet	Violaceae			X	
<i>Viola sororia</i>	Common Blue Violet	Violaceae			X	
<i>Viola conspersa</i>	American Dog Violet	Violaceae	X			
<i>Lythrum salicaria</i>	Purple Loosestrife	Lythraceae	X	X		
<i>Circaea sp.</i>	Enchanter's Nightshade	Onagraceae			X	
<i>Epilobium angustifolium</i>	Fireweed	Onagraceae		X		
<i>Epilobium coloratum</i>	Purpleleaf Willowherb	Onagraceae		X		
<i>Epilobium sp.</i>	Willowherb	Onagraceae		X		
<i>Aralia nudicaulis</i>	Wild Sarsaparilla	Araliaceae	X		X	
<i>Sanicula canadensis</i>	Canadian Black Snakeroot	Umbelliferae (Apiaceae)			X	
<i>Osmorhiza longistylis</i>	Longstyle Sweetroot	Umbelliferae			X	
<i>Osmorhiza claytonia</i>	Clayton's Sweetroot	Umbelliferae	X		X	
<i>Heracleum maximum</i>	Common Cow-parsnip	Umbelliferae	X			
<i>Pyrola rotundifolia</i>	Wintergreen	Pyrolaceae			X	
<i>Pyrola sp.</i>	Wintergreen	Pyrolaceae			X	
<i>Vaccinium angustifolium</i>	Lowbush Blueberry	Ericaceae	X		X	
<i>Vaccinium sp.</i>	Blueberry	Ericaceae			X	
<i>Gaultheria procumbens</i>	Eastern Teaberry; Wintergreen	Ericaceae			X	
<i>Arctostaphylos uva-ursi</i>	Kinnikinnick; Bearberry	Ericaceae	X		X	

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
<i>Trientalis borealis</i>	Starflower	Primulaceae	X		X	
<i>Asclepias incarnate</i>	Swamp Milkweed	Asclepiadaceae			X	
<i>Asclepias syriaca</i>	Common Milkweed	Asclepiadaceae	X	X	X	
<i>Borago sp.</i>	Borage	Boraginaceae	X			
<i>Myosotis scorpioides</i>	True Forget-me-not	Boraginaceae	X			
<i>Myosotis laxa</i>	Bay Forget-me-not	Boraginaceae	X			
<i>Cynoglossum virginianum var. boreale</i>	Wild Comfrey	Boraginaceae	X			
<i>Verbena hastate</i>	Blue or Swamp Vervain	Verbenaceae		X		
<i>Lycopus americanus</i>	American Water-horehound	Labiatae (Lamiaceae)	X		X	
<i>Prunella sp.</i>	Self-heal	Labiatae	X			
<i>Clinopodium vulgare</i>	Wild-basil; Dog-mint	Labiatae	X			
<i>Solanum dulcamara</i>	Climbing Nightshade	Solanaceae		X		
<i>Verbascum thapsus</i>	Mullein; Flannel Plant	Scrophulariaceae	X	X		
<i>Galium aparine</i>	Sticky Willy	Rubiaceae	X		X	
<i>Galium triflorum</i>	Fragrant Bedstraw	Rubiaceae			X	
<i>Lonicera oblongifolia</i>	Swamp Fly Honeysuckle	Caprifoliaceae	X		X	
<i>Lonicera japonica</i>	Japanese Honeysuckle	Caprifoliaceae			X	
<i>Lonicera sempervirens</i>	Trumpet Honeysuckle	Caprifoliaceae	X		X	
<i>Linnaea borealis</i>	Twinflower	Caprifoliaceae	X			
<i>Solidago sp.</i>	Goldenrod	Asteraceae	X		X	X
<i>Taraxacum officinale</i>	Common Dandelion	Asteraceae	X			
<i>Tragopogon sp.</i>	Goat's-beard	Asteraceae	X			
<i>Hieracium piloselloides</i>	Tall Hawkweed	Asteraceae			X	
<i>Hieracium aurantiacum</i>	Orange Hawkweed	Asteraceae	X			
<i>Chrysanthemum leucanthemum</i>	Oxe-eye Daisy	Asteraceae	X			
<i>Achillea millefolium</i>	Common Yarrow; Milfoil	Asteraceae	X			

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
<i>Artemesia biennis</i>	Biennial Wormwood	Asteraceae		X		
<i>Ambrosia artemesifolia</i>	Annual Ragweed	Asteraceae		X		
<i>Arctium minus</i>	Lesser Burdock	Asteraceae	X	X		
<i>Lactuca biennis</i>	Tall Blue Lettuce	Asteraceae			X	
<i>Eupatorium perfoliatum</i>	Common Boneset	Asteraceae	X	X	X	
<i>Euthamia graminifolia</i>	Flat-topped, Grass-leaved or Bushy Goldenrod	Asteraceae		X	X	
<i>Senecio pauperculus</i>	Northern Ragwort	Asteraceae	X			
<i>Solidago canadensis</i> var. <i>scabra</i>	Canada Goldenrod	Asteraceae			X	
<i>Solidago nemoralis</i>	Gray Goldenrod	Asteraceae		X	X	
<i>Solidago hispida</i>	Hairy Goldenrod	Asteraceae		X		
<i>Solidago canadensis</i>	Canada Goldenrod	Asteraceae	X			
<i>Erigeron strigosus</i>	Daisy or Prairie Fleabane	Asteraceae	X		X	
<i>Erigeron philadelphicus</i>	Common or Philadelphia Fleabane	Asteraceae		X		
<i>Carduus acanthoides</i>	Spiny Plumeless Thistle	Asteraceae		X		
<i>Cirsium arvense</i>	Canada Thistle	Asteraceae		X		X
<i>Cirsium vulgare</i>	Bull Thistle	Asteraceae	X			
<i>Antennaria howellii</i> ssp. <i>canadensis</i>	Canadian Pussytoes	Asteraceae	X			

SPECIES	COMMON NAME	FAMILY	ISLAND			
			Thunder Bay	Scarecrow	Big Charity	Little Charity
Monocots: Grasses, Sedges, Rushes, Lilies, Orchids						
<i>Triglochin maritimum</i>	Seaside Arrowgrass	Juncaginaceae	X			
<i>Phragmites australis</i>	Giant Reed	Gramineae Tribe Poeae	X			
<i>Phragmites sp.</i>	Giant Reed	Tribe Poeae			X	
<i>Poa compressa</i>	Canada Bluegrass	Tribe Poeae	X		X	
<i>Poa palustris</i>	Fowl Meadowgrass	Tribe Poeae	X			
<i>Phleum pretense</i>	Timothy	Tribe Poeae	X			
<i>Calamagrostis canadensis</i>	Bluejoint Grass	Tribe Poeae	X			
<i>Carex pensylvanica</i>	Pennsylvania Sedge	Cyperaceae			X	
<i>Carex viridula</i>	Little Green Sedge	Cyperaceae			X	
<i>Carex deweyana</i>	Dewey's Sedge	Cyperaceae	X			
<i>Carex stricta</i>	Upright Sedge	Cyperaceae	X			
<i>Carex pedunculata</i>	Long-stalk Sedge	Cyperaceae	X			
<i>Carex aquatilis</i>	Water Sedge	Cyperaceae	X			
<i>Carex hystericina</i>	Bottlebrush Sedge	Cyperaceae	X			
<i>Cares schweinitzii</i>	Schweinitz's Sedge	Cyperaceae		X		
<i>Carex sp.</i>	Sedge	Cyperaceae			X	
<i>Eleocharis acicularis</i>	Needle Spikerush	Cyperaceae			X	
<i>Eleocharis elliptica</i>	Flatstem Spikerush	Cyperaceae	X		X	
<i>Eleocharis sp.</i>	Spikerush	Cyperaceae	X			
<i>Cladium mariscoides</i>	Smooth Sawgrass	Cyperaceae	X			
<i>Juncus balticus</i>	Baltic Rush	Juncaceae	X		X	
<i>Juncus dudleyi</i>	Dudley's Rush	Juncaceae			X	
<i>Juncus effusus</i>	Common Rush	Juncaceae	X	X	X	
<i>Smilax ecirrata</i>	Upright Carrion-flower	Liliaceae			X	
<i>Polygonatum sp.</i>	Solomon-seal	Liliaceae	X		X	

[illegible]

Appendix B: 1910 Mershon Expedition: Mammals and Birds

Results of 1910 Mershon expedition to the Charity Islands (Big Charity, Little Charity, and Gull Island; Wood 1911 a, b). Most of the work was done on Big Charity Island. Only a few observations occurred on Little Charity Island (+) and observations on Gull Island are not included in these tables. In 1911 the author returned the Charity Islands during the breeding season and observed eight additional bird species and documented additional breeding records (Wood 1912). Additional observations recorded in 1912 have been added to the Table B.2.

Table B.1. Mammals (Wood 1911a)

Common Name (name in report)	Scientific Name
Red fox	<i>Vulpes vulpes</i>
Snowshoe hare (American hare, Varying hare)	<i>Lepus americanus</i>
Eastern cottontail (Cottontail) ⁺	<i>Sylvilagus floridanus</i>
Eastern small-footed Myotis (Say's brown bat)	<i>Myotis leibii</i>
Silver-haired bat	<i>Lasionycteris noctivagans</i>
Eastern Red Bat (Red bat)	<i>Lasiurus borealis</i>
Muskrat ¹	<i>Ondatra zibethicus</i>
Raccoon ²	<i>Procyon lotor</i>
Eastern fox squirrel (Fox squirrel) ³	<i>Sciurus niger</i>

⁺Also observed on Little Charity Island

¹ only one seen on BCI

² introduced on BCI in 1907

³ introduced on BCI in 1896; all perished by 1903

Table B.2. Birds (Wood 1911b; 1912)

Common Name (name in report)	Scientific Name
Horned Grebe ⁺	<i>Podiceps auritus</i>
Pied-billed Grebe ⁺	<i>Podilymbus podiceps</i>
Common Loon	<i>Gavia immer</i>
Herring Gull ^{***}	<i>Larus argentatus</i>
Ring-billed Gull	<i>Larus delawarensis</i>
Bonaparte's Gull	<i>Chroicocephalus philadelphia</i>
Common Tern [*]	<i>Sterna hirundo</i>
Double-crested Cormorant	<i>Phalacrocorax auritus</i>
Common Merganser [*]	<i>Mergus merganser</i>
Red-breasted Merganser	<i>Mergus serrator</i>
Hooded Merganser	<i>Lophodytes cucullatus</i>
Mallard	<i>Anas platyrhynchos</i>
American Black Duck [*]	<i>Anas rubripes</i>
Green-winged Teal	<i>Anas crecca</i>
Blue-winged Teal	<i>Anas discors</i>

Common Name (name in report)	Scientific Name
Northern Pintail	<i>Anas acuta</i>
Wood Duck	<i>Aix sponsa</i>
Redhead	<i>Aythya americana</i>
Canvasback	<i>Aythya valisineria</i>
Greater Scaup	<i>Aythya marila</i>
Lesser Scaup	<i>Aythya affinis</i>
Common Goldeneye	<i>Bucephala clangula</i>
Bufflehead	<i>Bucephala albeola</i>
Long-tailed Duck (Old Squaw)	<i>Clangula hyemalis</i>
Canada Goose	<i>Branta canadensis</i>
White-winged Scoter	<i>Melanitta fusca</i>
Tundra Swan (Whistling Swan)	<i>Cygnus columbianus</i>
American Bittern	<i>Botaurus lentiginosus</i>
Great Blue Heron*	<i>Ardea herodias</i>
Green Heron	<i>Butorides virescens</i>
Virginia Rail	<i>Rallus limicola</i>
Sora	<i>Porzana carolina</i>
American Woodcock*	<i>Scolopax minor</i>
Wilson's Snipe	<i>Gallinago delicata</i>
Red Knot	<i>Calidris canutus</i>
Pectoral Sandpiper	<i>Calidris melanotos</i>
Baird's Sandpiper	<i>Calidris bairdii</i>
Least Sandpiper	<i>Calidris minutilla</i>
Semipalmated Sandpiper	<i>Calidris pusilla</i>
Dunlin (Red-backed Sandpiper)	<i>Calidris alpina</i>
Sanderling	<i>Calidris alba</i>
Great Yellowlegs	<i>Tringa melanoleuca</i>
Lesser Yellowlegs	<i>Tringa flavipes</i>
Solitary Sandpiper	<i>Tringa solitaria</i>
Spotted Sandpiper*	<i>Actitis macularius</i>
Black-bellied Plover	<i>Pluvialis squatarola</i>
Golden Plover	<i>Pluvialis dominica</i>
Killdeer*	<i>Charadrius vociferus</i>
Semipalmated Plover	<i>Charadrius semipalmatus</i>
Piping Plover*	<i>Charadrius melodus</i>
Ruddy Turnstone	<i>Arenaria interpres</i>
Mourning Dove	<i>Zenaida macroura</i>
Northern Harrier (Marsh hawk)	<i>Circus cyaneus</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Red-tailed Hawk	<i>Buteo jamaicensis</i>
Bald Eagle*	<i>Haliaeetus leucocephalus</i>
Peregrine Falcon (Duck Hawk)	<i>Falco peregrinus</i>

Common Name (name in report)	Scientific Name
Merlin (Pigeon Hawk)	<i>Falco columbarius</i>
American Kestrel (Sparrow Hawk)	<i>Falco sparverius</i>
Osprey	<i>Pandion haliaetus</i>
Long-eared Owl	<i>Asio otus</i>
Short-eared Owl	<i>Asio flammeus</i>
Great Horned Owl	<i>Bubo virginianus</i>
Snowy Owl	<i>Bubo scandiacus</i>
Yellow-billed Cuckoo*	<i>Coccyzus americanus</i>
Black-billed Cuckoo*	<i>Coccyzus erythrophthalmus</i>
Belted Kingfisher*	<i>Megaceryle alcyon</i>
Hairy Woodpecker*	<i>Picoides villosus</i>
Downy Woodpecker*	<i>Picoides pubescens</i>
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>
Red-headed Woodpecker*	<i>Melanerpes erythrocephalus</i>
Northern Flicker*	<i>Colaptes auratus</i>
Eastern Whip-poor-will	<i>Antrostomus vociferus</i>
Common Nighthawk	<i>Chordeiles minor</i>
Chimney Swift*	<i>Chaetura pelagica</i>
Ruby-throated Hummingbird	<i>Archilochus colubris</i>
Eastern Kingbird*	<i>Tyrannus tyrannus</i>
Great Crested Flycatcher*	<i>Myiarchus crinitus</i>
Eastern Phoebe	<i>Sayornis phoebe</i>
Olive-sided Flycatcher	<i>Contopus cooperi</i>
Eastern Wood-Pewee*	<i>Contopus virens</i>
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>
Alder Flycatcher	<i>Empidonax alnorum</i>
Least Flycatcher*	<i>Empidonax minimus</i>
Horned Lark	<i>Eremophila alpestris</i>
Blue Jay*	<i>Cyanocitta cristata</i>
American Crow*	<i>Corvus brachyrhynchos</i>
Bobolink	<i>Dolichonyx oryzivorus</i>
Brown-headed Cowbird	<i>Molothrus ater</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Eastern Meadowlark	<i>Sturnella magna</i>
Baltimore Oriole	<i>Icterus galbula</i>
Rusty Blackbird ⁺	<i>Euphagus carolinus</i>
Common Grackle (Bronzed Grackle)	<i>Quiscalus quiscula</i>
Evening Grosbeak	<i>Coccothraustes vespertinus</i>
Pine Grosbeak	<i>Pinicola enucleator</i>
Purple Finch*	<i>Haemorhous purpureus</i>
Crossbill	<i>Loxia spp.</i>
American Goldfinch*	<i>Spinus tristis</i>
Snow Bunting (Snowflake)	<i>Plectrophenax nivalis</i>

Common Name (name in report)	Scientific Name
Lapland Longspur ⁺	<i>Calcarius lapponicus</i>
Vesper Sparrow ^{***}	<i>Pooecetes gramineus</i>
Savanna Sparrow	<i>Passerculus sandwichensis</i>
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>
White-throated Sparrow	<i>Zonotrichia albicollis</i>
American Tree Sparrow	<i>Spizelloides arborea</i>
Chipping Sparrow ^{***}	<i>Spizella passerina</i>
Field Sparrow ^{**}	<i>Spizella pusilla</i>
Dark-eyed Junco (Slate-colored Junco)	<i>Junco hyemalis</i>
Song Sparrow ^{**}	<i>Melospiza melodia</i>
Lincoln's Sparrow	<i>Melospiza lincolnii</i>
Swamp Sparrow [*]	<i>Melospiza georgiana</i>
Fox Sparrow	<i>Passerella iliaca</i>
House Sparrow (English Sparrow)	<i>Passer domesticus</i>
Eastern Towhee ⁺	<i>Pipilo erythrophthalmus</i>
Indigo Bunting ^{***}	<i>Passerina cyanea</i>
Scarlet Tanager	<i>Piranga olivacea</i>
Purple Martin ⁺	<i>Progne subis</i>
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>
Barn Swallow ^{***}	<i>Hirundo rustica</i>
Tree Swallow	<i>Tachycineta bicolor</i>
Bank Swallow	<i>Riparia riparia</i>
Cedar Waxwing [*]	<i>Bombicilla cedrorum</i>
Northern Shrike	<i>Lanius excubitor</i>
Red-eyed Vireo [*]	<i>Vireo olivaceus</i>
Warbling Vireo [*]	<i>Vireo gilvus</i>
Yellow-throated Vireo	<i>Vireo flavifrons</i>
Blue-headed Vireo ⁺	<i>Vireo solitarius</i>
Black-and-white Warbler	<i>Mniotilta varia</i>
Golden-winged Warbler	<i>Vermivora chrysoptera</i>
Nashville Warbler	<i>Oreothlypis ruficapilla</i>
Orange-crowned Warbler	<i>Oreothlypis celata</i>
Northern Parula	<i>Setophaga americana</i>
Cape May Warbler	<i>Setophaga tigrina</i>
Yellow Warbler [*]	<i>Setophaga petechia</i>
Black-throated Blue Warbler	<i>Setophaga caerulescens</i>
Yellow-rumped Warbler (Myrtle Warbler)	<i>Setophaga coronata</i>
Magnolia Warbler	<i>Setophaga magnolia</i>
Chestnut-sided Warbler	<i>Setophaga pensylvanica</i>
Bay-breasted Warbler	<i>Setophaga castanea</i>
Blackpoll Warbler	<i>Setophaga striata</i>
Blackburnian Warbler	<i>Setophaga fusca</i>

Common Name (name in report)	Scientific Name
Black-throated Green Warbler	<i>Setophaga virens</i>
Palm Warbler	<i>Setophaga palmarum</i>
Prairie Warbler	<i>Setophaga discolor</i>
Ovenbird	<i>Seiurus aurocapilla</i>
Northern Waterthrush (Grinnell's Water-thrush)	<i>Parkesia noveboracensis</i>
Connecticut Warbler	<i>Oporornis agilis</i>
Wilson's Warbler	<i>Cardellina pusilla</i>
Canada Warbler	<i>Cardellina canadensis</i>
American Redstart*	<i>Setophaga ruticilla</i>
American Pipit	<i>Anthus rubescens</i>
Gray Catbird**	<i>Dumetella carolinensis</i>
Carolina Wren	<i>Thryothorus ludovicianus</i>
Brown Thrasher	<i>Toxostoma rufum</i>
House Wren	<i>Troglodytes aedon</i>
Winter Wren	<i>Troglodytes hiemalis</i>
Marsh Wren (Short-billed Marsh Wren)	<i>Cistothorus palustris</i>
Brown Creeper	<i>Certhia americana</i>
White-breasted Nuthatch*	<i>Sitta carolinensis</i>
Red-breasted Nuthatch	<i>Sitta canadensis</i>
Black-capped Chickadee*	<i>Poecile atricapillus</i>
Golden-crowned Kinglet	<i>Regulus satrapa</i>
Ruby-crowned Kinglet	<i>Regulus calendula</i>
Veery	<i>Catharus fuscescens</i>
Gray-cheeked Thrush	<i>Catharus minimus</i>
Swainson's Thrush (Olive-backed Thrush)	<i>Catharus ustulatus</i>
Hermit Thrush	<i>Catharus guttatus</i>
American Robin*	<i>Turdus migratorius</i>
Eastern Bluebird	<i>Sialia sialis</i>

*Also observed on Little Charity Island

*Bred on Big Charity Island

** Bred on Big Charity and Little Charity Island

Appendix C: Colonial Waterbird Survey Results

Annually, colonial waterbird nesting surveys are conducted on Little Charity Island and aerial colonial waterbird nesting surveys are conducted on Scarecrow Island. Table C.1 contains the results of the colonial ground surveys on Little Charity Island and Table C.2 contains the results of the aerial colonial waterbird surveys on Scarecrow Island.

Table C.1. Little Charity Island colonial waterbird nesting survey results, 1997, 2002-2017.

Year	Double-crested cormorant	Herring gull	Great blue heron	Great egret	Unknown (Egret or Heron)	Mute swan	Black-crowned night heron	Caspian tern	Ring-billed gull
1997	438	1289	75	94	-	-	-	54	-
2002	2011	1004	14	70	-	-	-	-	54
2003	1192	388	7	56	-	-	-	-	76
2004	1388	1906	25	29	-	-	-	-	364
2005	1604	656	15	49	-	-	-	-	-
2006	2278	963	21	35	-	-	-	-	-
2007	1345	345	27	16	-	-	2	-	-
2008*	1886	NA	NA	NA	NA	NA	NA	NA	NA
2009	2419	-	54	38	-	3	-	-	-
2010	2715	737	-	-	-	-	-	-	-
2011	2387	1674	4	6	10	2	0	0	0
2012	2446	2520	20	46	0	3	0	0	0
2013	1717	1864	29	69	0	3	4	0	0
2014	2342	1862	6	142	0	0	0	0	0
2015	2639	1717	20	30	0	0	0	107	0
2016**	2121	1703	98	26	5	0	0	75	0
2017	No Survey conducted								

*Only DCCO were counted in 2008.

**Most of the 2016 survey crew was new (first time ever doing a colonial waterbird survey). Consequently, there were 75 Caspian Tern nests that were misidentified as Herring Gull nests. Dr. Keith Grassman (Calvin College) was on the island the day after the survey and documented 75 CATE nests. Therefore, the Herring Gull number was adjusted from 1,778 to 1,703 to account for the 75 nests that were counted as Herring Gull nests. In addition, the confidence in the Great Blue Heron and Great Egret numbers is low due to the new survey crew and most of the adults were not sitting on the nests. As a result, the Great Blue Heron number may be slightly higher and the Great Egret number may be lower than the actual number that nested.

Table C.2. Scarecrow Island aerial colonial waterbird nesting survey results, 1997-2017.

Year	Double-crested cormorants	Herring gulls	Ring-billed gulls	Caspian terns	Common terns	Great blue heron	Black crowned night heron	Great black-backed gull	Mallard	Canada Goose
1997	677	-	-	-	-	-	-	-	-	-
1998	-	384	-	-	-	-	-	1	-	-
1999	No Survey conducted									
2000	No Survey conducted									
2001	No Survey conducted									
2002	1890	350	113	-	-	1	2	-	-	-
2003	1935	90	35	9	-	2	-	-	-	-
2004	1343	-	-	-	-	2	-	-	-	-
2005	1563	117	210	81	-	1	1	-	-	-
2006	1370	162	234	80	-	-	1	-	-	-
2007	425	356	2	124	4	-	2	-	-	-
2008	No Survey conducted									
2009	No Survey conducted									
2010	No Survey conducted									
2011	199	805	99	101	-	-	-	-	-	-
2012	165	857	164	101	-	-	-	-	10	-
2013	167	1030	102	130	-	-	-	-	10	1
2014	No Survey conducted									
2015	204	574	0	108	-	-	-	-	-	-
2016*	305	NA	NA	NA	NA	NA	NA	NA	NA	NA
2017	269	904	0	0	0	0	0	0	0	0

*Only DCCO were counted in 2016.

Appendix D: CCP Goals and Objectives

*Note: The text provided in this appendix is taken directly from the **Gravel Island, Green Bay, Harbor Island, Huron, and Michigan Islands National Wildlife Refuges Comprehensive Conservation Plan and Land Protection Plan (USFWS 2013a)**. These goals and objectives are provided here for reference. The HMP goals and objectives provided in Chapter 4 are consistent with the vision and direction provided in the 2013 GLI CCP.*

CCP Goals and Objectives Common to all Great Lakes Islands Refuges

Ecosystem Goal

Protect and maintain natural ecological communities to promote a healthy functioning ecosystem and identify future scenarios for Great Lakes islands ecosystems.

Ecosystem Objectives 1: Climate Change

Within five years of CCP approval, identify potential impacts of the projected climate changes on both abiotic and biotic components of the Great Lakes island ecosystem and communicate these issues to the public.

Ecosystem Objective 2: Island Acquisition

Through the life of the plan, protect highly threatened Great Lakes island habitat that is either underrepresented and unique; or critical for threatened and endangered species, focal colonial waterbird species, or birds of conservation concern for Region 3 of the Service.

Wildlife Goal

Protect, restore and maintain a natural diversity of fish and wildlife native to the Great Lakes, with an emphasis on Service Resource Conservation Priority Species.

Wildlife Objective 1: Inventory and Monitoring

Within five years of CCP approval, implement a monitoring program to track the presence, abundance, population trends, and/or habitat associations of select resources including but not limited to Region 3 Conservation Priority Species, habitats, communities and ecosystems (e.g., Great Lakes islands' habitat). Resources to be monitored are identified under the island's specific objectives or in forthcoming step-down plans. As the need arises, implement research to answer questions that have been raised regarding the management of resources and other issues.

Wildlife Objective 2: Applied Research

During the life of the CCP, promote applied research aimed at answering wildlife-, habitat-, community-, and ecosystem-based questions without compromising wildlife, visitor, and wilderness values.

Wildlife Objective 3: Protect Waterbird Colonies

During the life of the CCP, limit disturbance to colonial waterbird colonies in order to maintain current nesting population levels of gull, tern, egret, and heron species.

Habitat Goal

Perpetuate the biological diversity and integrity of native plant communities to sustain high quality habitat for migratory birds, fish, and endangered species.

CCP Objectives Specific to Michigan Islands NWR (Shiawassee)

Ecosystem Objective 1: Preserve Great Lakes Alvar Communities on Thunder Bay and Sugar Islands

Throughout the life of the CCP, maintain and protect all alvar sites on Thunder Bay and Sugar Islands through proactive monitoring and aggressive control of non-indigenous invasive plants and animals.

Wildlife Objective 1: Maintain and Provide Nesting Habitat

Throughout the life of the CCP, maintain and provide nesting habitat on Little Charity and Scarecrow Islands favorable to colonial nesting waterbirds, including Region 3 Conservation Priority Species: Black-crowned Night-Heron and Common Tern.

Habitat Objective 1: Preserve Pitcher's Thistle

Preserve Pitcher's thistle on Big Charity Island and dwarf lake Iris on Thunder Bay and Sugar Islands.

Habitat Objective 2: Protect Sensitive Habitat by Reducing Invasive Plant Species

By 2020, protect sensitive colonial bird habitat by reducing the area infested with target invasive plant species on Scarecrow and Big Charity Islands (e.g., common buckthorn, phragmites, reed canarygrass) by 50 percent from the documented 2011 levels and eliminate new infestations of these and other highly invasive species as they occur.

Appendix E: ROCSTAR Comprehensive list of species for Great Lakes Islands NWR

The following table is a comprehensive list of species generated from the Great Lakes Islands (GLI) ROCSTAR (Resources of Concern Selection Tool for America's Refuges; Salas and Pranckus 2015) Any species known to occur or that could reasonably occur on any of the island refuges within the Great Lakes *and* was included in any of the resources consulted was added to the comprehensive list. Key ecosystems were also added. The ROCSTAR comprehensive list for the Great Lakes Islands is a large list and includes species and ecosystems for all of the islands within the Great Lakes. This list also includes a number of species that are unlikely to occur on the small islands that are managed by Shiawassee NWR. Please see section 3.4 for description of the selection process used to select the Resources of Concern (ROC). The original GLI ROCSTAR was modified for this appendix to include only species and plans specific to Michigan and Lake Huron. Fish and mussels were also removed from this comprehensive list. Please see the ServCat record [70762](#) for original and complete GLI ROCSTAR.

This large excel table is only included in the PDF of version of this report.

Common Name	Scientific Name	Group/Order	Broad Habitat	GL Bird Habitat, COP 2013 Appendix D	Species Documented in Range	Fed T&E 2013	MI State T & E, 2013	MI SWAP, 2006	BCC 12 BCC	FWS RB BCC 2012	FWS FY2012- FY2016 Focal Species	Reg. Conserv. Prior., List GRI, 2002	PIF 16 Upper Great Lakes Plain, 2001	PIF 20, Boreal Hardwood Trans., BCR 12: 2009	UNMRGL IV A/Bird Implementation Plan, 2007	UNMRGL IV Priority Spp Landbird 2007	UNMRGL IV/BCR 12 Priority Spp Shorebird 2007	UNMRGL IV/BCR 12 Priority Spp Waterbirds 2007	UNMRGL IV/BCR 12 Priority Spp	ABC Watchlist 2007		UMNGL Surrogate Spp 2014	Great Lakes Fish (interjurisdictional) Species	PARC	Xerces	
Chestnut-sided Warbler	<i>Setophaga pensylvanica</i>	Landbird	For, Rip, Shr	FE (m)	X									X (rs) M												
Yellow Warbler	<i>Setophaga petechia</i>	Landbird	Rip, Shr	FE (b)	X																					
Pine Warbler	<i>Setophaga pinus</i>	Landbird	For	MF (m)	X																	Forest				
American Redstart	<i>Setophaga ruticilla</i>	Landbird	For	FE/W (b)	X																					
Blackpoll Warbler	<i>Setophaga striata</i>	Landbird	For, Shr	MF (m)	X																					
Cape May Warbler	<i>Setophaga tigrina</i>	Landbird	For	MF (m)	X							GRL			(f, h)	X (f)										
Black-throated Green Warbler	<i>Setophaga virens</i>	Landbird	For	MF (b)	X																					
Golden-winged warbler	<i>Vermivora chrysoptera</i>	Landbird	Shr	MF/FE (m)	X			X	X	X (f)	f	GRL	X (I)	X (rc)	M	X (f)	X (f)				Red		Shrubland			
Blue-winged Warbler	<i>Vermivora cyanoptera</i>	Landbird	For, Shr		X			X		X		GRL	X (I)			X (f)					Yellow					
Tennessee warbler	<i>Vermivora peregrina</i>	Landbird	For	MF/FE (m)	X																					
Nashville Warbler	<i>Vermivora ruficapilla</i>	Landbird	For	FE (m,b)	X									X L												
Ruffed grouse	<i>Bonasa umbellus</i>	Landbird	For, Shr		X									X (rs) M												
Spruce Grouse	<i>Falcipennis canadensis</i>	Landbird	For		X, MI (UP & nLP)		SC	X																		
Wild Turkey	<i>Meleagris gallopavo</i>	Landbird	For, Shr		X																					
Ring-necked Pheasant	<i>Phasianus colchicus</i>	Landbird	Gra		X																					
Sharp-tailed Grouse	<i>Tympanuchus phasianellus</i>	Landbird	Gra		X, MI (all UP)		SC	X																		
Northern Flicker	<i>Colaptes auratus</i>	Landbird	For, Gra, Sav	MF/GM (m,b)	X			X		X		GRL		X (rc) M								Grassland				
Pileated Woodpecker	<i>Dryocopus pileatus</i>	Landbird	For	MF	X																					
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	Landbird	For	MF	X																					
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	Landbird	For, Gra, Sav	MF	X			X	X	X		GRL	X (I)	X (rc) M	X (f)	X (f)					Yellow					
Black-backed Woodpecker	<i>Picoides arcticus</i>	Landbird	For		X, MI (UP & nLP)		SC	X																		
Downy Woodpecker	<i>Picoides pubescens</i>	Landbird	For	MF (b)	X																					
Three-toed woodpecker	<i>Picoides tridactylus</i>	Landbird	For		X																					
Hairy Woodpecker	<i>Picoides villosus</i>	Landbird	For	MF (b)	X																					
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	Landbird	For	FE/MF (m)	X									X (rs)												
Ruby-crowned Kinglet	<i>Regulus calendula</i>	Landbird	For	MF/FE (m)	X			X																		
Golden-crowned Kinglet	<i>Regulus satrapa</i>	Landbird	For, Shr	MF/FE (m)	X																					
Red-breasted Nuthatch	<i>Sitta canadensis</i>	Landbird	For	MF	X																					
White-breasted Nuthatch	<i>Sitta carolinensis</i>	Landbird	For	MF (b)	X																					
Northern Saw-whet Owl	<i>Aegollus acadicus</i>	Landbird	For		X																					
Boreal Owl	<i>Aegolius funereus</i>	Landbird	For		X																					
Short-eared Owl	<i>Asio flammeus</i>	Landbird	Gra		X, MI (UP & nLP)		E	X		X		GRL	X (IIC)		X	X										
Long-eared Owl	<i>Asio otus</i>	Landbird	For, Gra		X, MI (UP & nLP)		T	X				GRL														
Great Horned Owl	<i>Bubo virginianus</i>	Landbird	For, Gra	FE (b)	X																					
Barred Owl	<i>Falco sparverius</i>	Landbird	For, Gra		X																					
Snowy Owl	<i>Nyctea scandiaca</i>	Landbird	Gra		X																					
Eastern Screech Owl	<i>Otus asio</i>	Landbird	For		X																					
European Starling	<i>Sturnus vulgaris</i>	Landbird	Dev, Gra, Shr	FE/GM (b)	X																					
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	Landbird	For	MF (m)	X																					
Scarlet Tanager	<i>Piranga olivacea</i>	Landbird	For	FE/MF (b)	X																					
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	Landbird	For, Gra	FE (m,b)	X																					
Marsh Wren	<i>Cistothorus palustris</i>	Landbird	Pal	W	X		SC	X		X			X (IIC)													
Sedge Wren	<i>Cistothorus platensis</i>	Landbird	Pal	W (b)	X			X		X		GRL	X (IIC)	X (rs) M												
Carolina Wren	<i>Thryothorus ludovicianus</i>	Landbird	For, Shr																							
House Wren	<i>Troglodytes aedon</i>	Landbird	Dev, For, Shr	FE (b)	X																					
Winter Wren	<i>Troglodytes troglodytes</i>	Landbird	For, Rip	W (b)	X																					
Veery	<i>Catharus fuscescens</i>	Landbird	For	MF (b)	X									X (rc, rs)	(f, h)	X (f)										
Hermit Thrush	<i>Catharus guttatus</i>	Landbird	For	MF (m,b)	X																					
Gray-cheeked Thrush	<i>Catharus minimus</i>	Landbird	For, Shr	MF (m)	X																					
Swainson's Thrush	<i>Catharus ustulatus</i>	Landbird	For	MF (m)	X																					
Wood Thrush	<i>Hylocichla mustelina</i>	Landbird	For		X			X	X	X	f	GRL	X (IIC)	X (rc)	X (f)	X (f)					Yellow		Forest			
Eastern Bluebird	<i>Sialia sialis</i>	Landbird	Gra, Shr	GM (b)	X																					
American Robin	<i>Turdus migratorius</i>	Landbird	Dev, For, Gra	MF/FE (m,b)	X																					
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	Landbird		MF (b)	X																					
Olive-sided Flycatcher	<i>Contopus cooperi</i>	Landbird	For		X			X	X	X		GRL		X (rc) M	X (f)	X (f)					Yellow					
Eastern Wood-pewee	<i>Contopus virens</i>	Landbird	For	MF (b)	X																					
Alder Flycatcher	<i>Empidonax alnorum</i>	Landbird	For, Rip	FE	X																					
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	Landbird	For, Rip		X																					
Least Flycatcher	<i>Empidonax minimus</i>	Landbird	For	FE (b)	X			X						X (rs) M												
Willow Flycatcher	<i>Empidonax traillii</i>	Landbird	Pal, Shr	FE (b)	X					X				X L	X (f)						Yellow (SW sp)					
Acadian Flycatcher	<i>Empidonax virescens</i>	Landbird	For, Rip					X	X	X		GRL	X (I)													

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Great-crested Flycatcher	<i>Myiarchus crinitus</i>	Landbird	For, Rip		X																			
Eastern Phoebe	<i>Sayornis phoebe</i>	Landbird	Dev, For, Shr	MF (b)	X																			
Eastern Kingbird	<i>Tyrannus tyrannus</i>	Landbird	Rip, Shr	FE (b)	X			X																
Western Kingbird	<i>Tyrannus verticalis</i>	Landbird	Gra, Rip, Shr		X																			
Barn Owl	<i>Tyto alba</i>	Landbird	Gra, Rip, Shr		X, MI (all UP)		E	X																
Bell's Vireo	<i>Vireo bellii</i>	Landbird	Dev, For, Gra						X			GRL	X (I)		X	X				Red				
Yellow-throated Vireo	<i>Vireo flavifrons</i>	Landbird	Gra, Shr	MF (b)	X								X											
Warbling Vireo	<i>Vireo gilvus</i>	Landbird	For		X																			
White-eyed Vireo	<i>Vireo griseus</i>	Landbird	For					X					X											
Red-eyed Vireo	<i>Vireo olivaceus</i>	Landbird	Shr	MF/FE (b)	X																			
Philadelphia Vireo	<i>Vireo philadelphicus</i>	Landbird	For		X																			
Blue-headed Vireo	<i>Vireo solitarius</i>	Landbird	For	MF	X																			
Piping Plover (Great Plains pop.)	<i>Charadrius melodus</i>	Shorebird	Bar			T	E	X		E		GRL									Beach and Open Coast			
Piping Plover (Great Lakes pop.)	<i>Charadrius melodus</i>	Shorebird	Bar		X, MI (UP & nLP)	E	E	X		E		GRL	X (I)		X(f)		M/B (f), 4							
Semipalmated Plover	<i>Charadrius semipalmatus</i>	Shorebird	Pal	SB (m)	X												m, 4			Yellow				
Killdeer	<i>Charadrius vociferus</i>	Shorebird	Gra, Pal	RS (b)	X			X								(f, h)	M/B (f), 5							
American Golden Plover	<i>Pluvialis dominica</i>	Shorebird	Gra		X											X(f)	m (f), 4							
Black-bellied Plover	<i>Pluvialis squatarola</i>	Shorebird	Pal		X												M, 4							
American Avocet	<i>Recurvirostra americana</i>	Shorebird	Pal		X												M							
Spotted Sandpiper	<i>Actitis macularius</i>	Shorebird	Pal	RS/SB (m)	X			X									M/B, 4							
Ruddy Turnstone	<i>Arenaria interpres</i>	Shorebird	Pal		X										X (c)		M, 4							
Upland Sandpiper	<i>Bartromia longicauda</i>	Shorebird	Gra		X			X	X	X	f	GRL	X (I)		X(f)	X (f)	M/b (f), 3				Grassland			
Sanderling	<i>Calidris alba</i>	Shorebird	Pal		X										X (f, c)		M (f), 4			Yellow				
Dunlin	<i>Calidris alpina</i>	Shorebird	Pal	SB (m)	X						f				(f, h)		m (f), 4							
Baird's Sandpiper	<i>Calidris bairdii</i>	Shorebird	Pal		X												M, 4							
Red Knot (roselaari ssp.)	<i>Calidris canutus roselaari</i>	Shorebird	Pal		X					X	f				X		m, 3			Yellow				
Red Knot (rufa ssp.)	<i>Calidris canutus rufa</i>	Shorebird	Pal		X	PT			X (nb, c)	X	f				X		m, 3			Yellow				
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	Shorebird	Pal		X												M, 4			Yellow				
Stilt Sandpiper	<i>Calidris himantopus</i>	Shorebird	Pal		X							GRL					m, 4			Yellow				
Western Sandpiper	<i>Calidris mauri</i>	Shorebird	Pal														m, 3			Yellow				
Pectoral Sandpiper	<i>Calidris melanotos</i>	Shorebird	Pal		X												M, 4			Red				
Least Sandpiper	<i>Calidris minutilla</i>	Shorebird	Pal		X												M, 5							
Semi-palmated Sandpiper	<i>Calidris pusilla</i>	Shorebird	Pal		X				X		f						M, 4							
Wilson's Snipe	<i>Gallinago delicata</i>	Shorebird	Pal		X			X							(f, h)		M/B (f), 4							
Short-billed Dowitcher	<i>Limnodromus griseus</i>	Shorebird	Pal	(m)	X				X (nb)	X		GRL			X(f)		m (f), 4							
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	Shorebird	Pal		X												m, 5							
Marbled Godwit	<i>Limosa fedoa</i>	Shorebird	Pal						X (nb)	X (f)	f	GRL			X		m, 3			Yellow				
Hudsonian Godwit	<i>Limosa haemastica</i>	Shorebird	Gra, Pal						X (nb)	X	f	GRL			X		M, 4			Yellow				
Long-billed Curlew	<i>Numenius americanus</i>	Shorebird	Pal								f									Yellow				
Eskimo Curlew	<i>Numenius borealis</i>	Shorebird	Pal																					
Whimbrel	<i>Numenius phaeopus</i>	Shorebird	Pal	SB	X				X (nb)	X		GRL			X		m, 3							
Red-necked Phalarope	<i>Phalaropus lobatus</i>	Shorebird	Pal														M, 3							
Wilson's Phalarope	<i>Phalaropus tricolor</i>	Shorebird	Pal		X, MI (all UP)		SC	X				GRL	X (I)		X(f)		M/b (f), 4							
American Woodcock	<i>Scolopax minor</i>	Shorebird	Gra, For, Shr	MF/FE (b)	X			X			f	GRL	X, IIIB		X(f)	X (f)	M/B (f), 4				Shrubland			
Lesser Yellowlegs	<i>Tringa flavipes</i>	Shorebird	Pal	RS (m)	X					X							M, 5							
Greater Yellowlegs	<i>Tringa melanoleuca</i>	Shorebird	Pal	RS (m)	X							GRL					M, 5							
Willet	<i>Tringa semipalmata</i>	Shorebird	Pal		X												m, 3							
Solitary Sandpiper	<i>Tringa solitaria</i>	Shorebird	Pal		X				X (nb)	X					X (c)		M/b 4							
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	Shorebird	Pal						X (nb)	X	f	GRL			X		m, 4			Red				
Great Egret	<i>Ardea alba</i>	Waterbird	Pal	RS/MF (b)	X													b/m						
Great Blue Heron	<i>Ardea herodias</i>	Waterbird	Pal, Rip	RS/MF (b)	X			X										B/w						
American Bittern	<i>Botaurus lentiginosus</i>	Waterbird	Pal		X, MI (UP & nLP)		SC	X	X	X		GRL			X			B						
Cattle Egret	<i>Bubulcus ibis</i>	Waterbird	Dev, Gra		X													b/m						
Green Heron	<i>Butorides virescens</i>	Waterbird	Pal, Rip		X			X										B						
Snowy Egret	<i>Egretta thula</i>	Waterbird	Pal		X																			
Least Bittern	<i>Ixobrychus exilis</i>	Waterbird	Pal		X, MI (UP & nLP)		T	X		X		GRL			X									
Yellow-crowned Night-heron	<i>Nyctanassa violacea</i>	Waterbird	Pal		X										X			b/m						
Black-crowned Night-heron	<i>Nycticorax nycticorax</i>	Waterbird	Pal, Rip	RS/MF (b)	X		SC	X		X		GRL			X(f)			b/w						
Common Loon	<i>Gavia immer</i>	Waterbird	Lac	OW (m)	X		T	X				GRL						B/m			Lacustrine			
Red-throated Loon	<i>Gavia stellata</i>	Waterbird	Lac, Riv		X													M						
Whooping Crane	<i>Grus americana</i>	Waterbird	Pal		X	E				E		GRL	X (I)		X				Red					

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Hooded Merganser	<i>Lophodytes cucullatus</i>	Waterfowl	Lac, Pal, Rip, Riv	OW (m)	X								X						b/n					
White-winged Scoter	<i>Melanitta fusca</i>	Waterfowl	Lac		X														N					
Black Scoter	<i>Melanitta nigra</i>	Waterfowl	Lac		X														N					
Surf Scoter	<i>Melanitta perspicillata</i>	Waterfowl	Lac		X														N					
Common Merganser	<i>Mergus merganser</i>	Waterfowl	Lac, Riv	OW (m)	X														b					
Red-breasted Merganser	<i>Mergus serrator</i>	Waterfowl	Lac, Riv	OW/RS (b)	X																			
Ruddy Duck	<i>Oxyura jamaicensis</i>	Waterfowl	Lac, Pal, Riv		X															B/n				
American Bison	<i>Bison bison</i>	Artiodactyla			X																			
Moose	<i>Alces americanus</i>	Artiodactyla			X, MI (all UP)		SC	X																
Elk or Wapiti	<i>Cervus elaphus</i>	Artiodactyla			X																			
White-tailed deer	<i>Odocoileus virginianus</i>	Artiodactyla			X																			
Coyote	<i>Canis latrans</i>	Carnivora			X																			
Gray wolf	<i>Canis lupus</i>	Carnivora			X, WI & MI	E	SC	X				GRL												
Gray fox	<i>Urocyon cinereoargenteus</i>	Carnivora			X																			
Red fox	<i>Vulpes vulpes</i>	Carnivora			X																			
Puma / Cougar / Mountain Lion	<i>Felis concolor</i>	Carnivora			X, MI (wUP)		E	X																
Canada Lynx	<i>Lynx canadensis</i>	Carnivora			X, MI (all UP)	T	E	X				GRL												
Bobcat	<i>Lynx rufus</i>	Carnivora			X																			
Mountain Lion	<i>Puma concolor</i>	Carnivora			X																			
Striped skunk	<i>Mephitis mephitis</i>	Carnivora			X																			
Wolverine, Eastern pop.	<i>Gulo gulo</i>	Carnivora			X																			
River Otter	<i>Lontra canadensis</i>	Carnivora			X																			
American Marten	<i>Martes americana</i>	Carnivora			X			X																
Fisher	<i>Martes pennanti</i>	Carnivora			X																			
Ermine	<i>Mustela erminea</i>	Carnivora			X																			
Long-tailed weasel	<i>Mustela frenata</i>	Carnivora			X																			
Black-footed Ferret	<i>Mustela nigripes</i>	Carnivora			X																			
Least Weasel	<i>Mustela nivalis</i>	Carnivora			X			X																
Mink	<i>Mustela vison</i>	Carnivora			X																			
American Badger	<i>Taxidea taxus</i>	Carnivora			X																			
Raccoon	<i>Procyon lotor</i>	Carnivora			X																			
Black Bear	<i>Ursus americanus</i>	Carnivora			X																			
Big Brown Bat	<i>Eptesicus fuscus</i>	Chiroptera			X, WI																			
Silver-haired Bat	<i>Lasiorycteris noctivagans</i>	Chiroptera			X			X																
Eastern Red Bat	<i>Lasiurus borealis</i>	Chiroptera			X			X																
Hoary Bat	<i>Lasiurus cinereus</i>	Chiroptera			X			X																
Little Brown Myotis	<i>Myotis lucifugus</i>	Chiroptera			X, WI																			
Northern Long-eared Bat	<i>Myotis septentrionalis</i>	Chiroptera			X, WI	PE		X																
Indiana Bat	<i>Myotis sodalis</i>	Chiroptera			X, MI (UP & nLP)	E	E	X				GRL												
Evening Bat	<i>Nycticeius humeralis</i>	Chiroptera			X, MI (wUP)		T	X																
Eastern Pipistrelle	<i>Perimyotis subflavus</i>	Chiroptera			X, WI & MI		SC	X																
Virginia Opossum	<i>Didelphis virginiana</i>	Didelphimorphia			X																			
Snowshoe hare	<i>Lepus americanus</i>	Lagomorpha			X																			
Eastern cottontail	<i>Sylvilagus floridanus</i>	Lagomorpha			X																			
Beaver	<i>Castor canadensis</i>	Rodentia			X																			
Muskrat	<i>Ondatra zibethicus</i>	Rodentia			X																			
Deermouse	<i>Peromyscus maniculatus</i>	Rodentia			X			X																
Prairie Vole	<i>Microtus ochrogaster</i>	Rodentia			X, MI (wUP)		E	X																
Woodland Vole / Pine Vole	<i>Microtus pinetorum</i>	Rodentia			X, MI (UP & nLP)		SC	X																
Woodland jumping mouse	<i>Napaeozapus insignis</i>	Rodentia			X, WI			X																
Northern flying squirrel	<i>Glaucomys sabrinus</i>	Rodentia			X, WI & MI		SC	X																
Eastern gray squirrel	<i>Sciurus carolinensis</i>	Rodentia			X																			
Eastern fox squirrel	<i>Sciurus niger</i>	Rodentia			X																			
Least Chipmunk	<i>Tamias minimus</i>	Rodentia			X			X																
Red Squirrel	<i>Tamiasciurus hudsonicus</i>	Rodentia			X																			
Least Shrew	<i>Cryptotis parva</i>	Soricomorpha			X, MI (wUP)		T	X																
Smoky shrew	<i>Sorex fumeus</i>	Soricomorpha			X, MI (all UP)		T	X																
Water Shrew	<i>Sorex palustris</i>	Soricomorpha			X, WI			X																
Blanchard's Cricket Frog	<i>Acris blanchardi</i>	Amphibian	Aqu, Pal		X, MI (UP & nLP)		T	X																
Northern Cricket Frog	<i>Acris crepitans</i>	Amphibian	Pal, Rip		X, WI																			
Gray Treefrog	<i>Hyla versicolor</i>	Amphibian	Aqu, For, Pal		X																			D

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Gorgone checkerspot	<i>Chlosyne gorgone</i>	Lepidoptera	Bar, Gra, Sav		X, MI (UP & nLP)		SC	X																
Tawny Crescent	<i>Phyciodes batesii</i>	Lepidoptera	Gra		X, MI (UP & nLP)		SC	X																
Regal fritillary	<i>Speyeria idalia</i>	Lepidoptera	Gra, Sav		X, MI (UP & nLP)		E	X																V
Mitchell's satyr butterfly	<i>Neonympha mitchellii mitchellii</i>	Lepidoptera	Gra		X, MI (wUP)	E	E	X				GRL												CI
Pipeline swallowtail	<i>Battus philenor</i>	Lepidoptera	Gra		X, MI (wUP)		SC	X																
Chryxus Arctic	<i>Oeneis chryxus</i>	Lepidoptera	Bar, Gra		X, WI																			
Macoun's arctic	<i>Oeneis macounii</i>	Lepidoptera	Gra		X, MI (wUP)		SC	X																
Large marble	<i>Euchloe ausonides</i>	Lepidoptera	Gra		X, MI (wUP)		SC	X																
West Virginia White	<i>Pieris virginensis</i>	Lepidoptera	Gra		X, WI																			
Swamp metalmark	<i>Calephelis mutica</i>	Lepidoptera	Gra, Pal		X, WI & MI		SC	X																
Pine imperial moth	<i>Eacles imperialis pini</i>	Lepidoptera	Bar, For		X, MI (wUP)		SC	X																
Barrens buckmoth	<i>Hemileuca maia</i>	Lepidoptera	Bar, Gra, Pal, Sav		X, MI (UP & nLP)		SC	X																
Yellow-banded day-sphinx	<i>Proserpinus flavofasciata</i>	Lepidoptera	For		X, MI (wUP)		SC	X																
Gold moth	<i>Basilodes pepita</i>	Lepidoptera	For, Pal		X, MI (wUP)		SC	X																
Boreal brachionyncha	<i>Brachionyncha borealis</i>	Lepidoptera	Bar, For		X, MI (UP & nLP)		SC	X																
Monarch Butterfly*	<i>Danaus plexippus</i>	Lepidoptera	Gra		X	Review 2016															Grassland			
Phyllira Tiger Moth	<i>Grammia phyllira</i>	Lepidoptera	Bar		X, WI																			
Small heterocampa	<i>Heterocampa subrotata</i>	Lepidoptera	For, Pal, Shr		X, MI (wUP)		SC	X																
Doll's merolonche	<i>Merolonche dolli</i>	Lepidoptera	Bar		X, MI (UP & nLP)		SC	X																
Hoary comma	<i>Polygonia gracilis</i>	Lepidoptera	For, Rip		X, MI (all UP)		SC	X																
Pink swallow	<i>Psectraglaea camasa</i>	Lepidoptera			X, WI																			
Sprague's pygarctia	<i>Pygarctia spraguei</i>	Lepidoptera	Bar, For, Gra, Sav		X, MI (UP & nLP)		SC	X																
Mottled Darner	<i>Aeshna clepsydra</i>	Odonata	Aqu, Pal		X, WI																			
Smokey rubyspot	<i>Hetaerina titia</i>	Odonata	Aqu, Pal		X, MI (wUP)		SC	X																
Delta-spotted Spiketail	<i>Cordulegaster diastatops</i>	Odonata	Aqu, Pal		X, WI																			
Tiger spiketail	<i>Cordulegaster erronea</i>	Odonata	Aqu, Pal		X, MI (UP & nLP)		SC	X																
Lemon-faced Emerald	<i>Somatochlora ensigera</i>	Odonata	Aqu, Pal		X, WI																			
Forcinate Emerald	<i>Somatochlora forcipata</i>	Odonata	Aqu, Pal		X, WI																			
Hine's emerald dragonfly	<i>Somatochlora hineana</i>	Odonata	Aqu, Pal		X, WI & MI	E	E	X				GRL												
Incurvate Emerald	<i>Somatochlora incurvata</i>	Odonata	Aqu, Pal		X, MI (all UP)		SC	X																
Ebony boghaunter	<i>Williamsonia fletcheri</i>	Odonata	Aqu, Pal		X, MI (UP & nLP)		SC	X																
Ringed boghaunter	<i>Williamsonia lintneri</i>	Odonata	Aqu, Pal		X, MI (all UP)		SC	X																
Pronghorned Clubtail	<i>Gomphus graslinellus</i>	Odonata	Aqu, Pal		X, WI																			
Splendid clubtail	<i>Gomphus lineatifrons</i>	Odonata	Aqu, Pal		X, MI (UP & nLP)		SC	X																
Rapids Clubtail	<i>Gomphus quadricolor</i>	Odonata	Aqu, Pal		X, MI (UP & nLP)		SC	X																
Extra-striped snaketail	<i>Ophiogomphus anomalus</i>	Odonata	Aqu, Riv		X, WI		SC	X																
Pygmy snaketail	<i>Ophiogomphus howei</i>	Odonata	Aqu, Pal		X, MI (wUP)		T	X																
Riverine snaketail	<i>Stylurus amnicola</i>	Odonata	Aqu, Pal		X, MI (all UP)		SC	X																
Laura's snaketail	<i>Stylurus laurae</i>	Odonata	Aqu, Pal		X, MI (UP & nLP)		SC	X																
Elusive snaketail	<i>Stylurus notatus</i>	Odonata	Aqu, Pal		X, MI (wUP)		SC	X																
Russet-tipped clubtail	<i>Stylurus plagiatus</i>	Odonata	Aqu, Pal		X, MI (wUP)		SC	X																
Grey petaltail	<i>Tachopteryx thoreyi</i>	Odonata	Aqu, Pal		X, MI (wUP)		T	X																
Swamp Darner	<i>Epiaeschna heros</i>	Odonata	Aqu, Pal		X, WI																			
Slaty Skimmer	<i>Libellula incesta</i>	Odonata	Aqu, Pal		X, WI																			
Davis's shield-bearer	<i>Atlantiscus davis</i>	Orthoptera			X, MI (wUP)		SC																	
Clear-winged Grasshopper	<i>Camnula pellucida</i>	Orthoptera	Gra		X, WI																			
Blue-legged Grasshopper	<i>Melanoplus flavidus</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Bog conehead	<i>Neoconocephalus lyristes</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Conehead grasshopper	<i>Neoconocephalus retusus</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Tamarack tree cricket	<i>Oecanthus laricis</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Pinetree cricket	<i>Oecanthus pini</i>	Orthoptera	Gra		X, MI (UP & nLP)		SC																	
Red-faced meadow katydid	<i>Orchelimum concinnum</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Delicate Meadow Katydid	<i>Orchelimum delicatum</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Spotted-winged Grasshopper	<i>Orphulella pelidna</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Hoosier locust	<i>Paroxya hoosieri</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Atlantic-coast locust	<i>Psinidia fenestralis</i>	Orthoptera	Gra		X, MI (wUP)		SC																	
Black-striped Katydid	<i>Scuddereria fasciata</i>	Orthoptera	Gra		X, MI (UP & nLP)		SC																	
Lake Huron locust	<i>Trimerotropis huroniana</i>	Orthoptera	Gra		X, WI & MI		T																	
Quadrate Salifly	<i>Haploperla orpha</i>	Plecoptera	Aqu		X, WI																			
A caddisfly	<i>Limnephilus pallens</i>	Trichoptera	Aqu		X, MI (wUP)		SC																	
A Long-horned Casemaker Caddisfly	<i>Trienodes nox</i>	Trichoptera	Aqu		X, WI																			

[illegible]

[illegible]

Common Name	Scientific Name	Group/Order	Broad Habitat	GL Bird Habitat, CCP 2013 Appendix D	Species Documented in Range	Fed T&E 2013	MI State T &E, 2013	MI SWAP, 2006	BCR 12 BCC	FWS R3 BCC 2012	FWS FV2012- FV2016 Focal Species	Reg. Conserv. Prior. List GRL, 2002	PIF 16 Upper Great Lakes Plan, 2001	PIF 20, Boreal Hardwood Trans, BCR 12; 2009	UMRGLR JV AT/Bird Implementation Plan, 2002	UMRGLR JV Priority Spp Landbird 2007	UMRGLR JV/BCR 12 Priority Spp Shorebird 2007	UMRGLR JV/BCR 12 Priority Spp Waterbirds 2007	UMRGLR JV/BCR 12 Priority Spp	ABC Watchlist 2007	UMGL Surogate Spp 2014	Great Lakes Fish (interjurisdictional) Species	PARC	Xerces
Foster mantleslug	<i>Pallifera fosteri</i>	Snail	For, Gra		X, MI (wUP)		T	X																
Dentate Supercoil	<i>Paravitrea multidentata</i>	Snail			X, WI																			
Carolina mantleslug	<i>Philomycus carolinianus</i>	Snail	For, Gra, Pal		X, MI (UP & nLP)	SC		X																
Great Lakes physa	<i>Physella magnalacustris</i>	Snail			X, MI (UP & nLP)	SC																		
Broadshoulder physa	<i>Physella parkeri</i>	Snail			X, MI (wUP)	T																		
Eastern flat-whorl	<i>Planogyra asteriscus</i>	Snail	For, Pal, Shr		X, WI & MI	SC		X																
Acorn ramshorn	<i>Planorbella multivolvis</i>	Snail	Pal		X, MI (wUP)	E		X																
An aquatic snail (no common name)	<i>Planorbella smithi</i>	Snail	Pal		X, MI (UP & nLP)	E		X																
Brown walker	<i>Pomatopsis cincinnatiensis</i>	Snail	For, Pal		X, MI (UP & nLP)	SC		X																
Widespread column	<i>Pupilla muscorum</i>	Snail	Bar, For, Gra, Pal		X, MI (all UP)	SC		X																
Gravel pyrg	<i>Pyrgulopsis letsoni</i>	Snail	Bar, For, Pal		X, MI (wUP)	SC		X																
Deepwater pondsnail	<i>Stagnicola contracta</i>	Snail	Pal		X, MI (UP & nLP)	E		X																
Petoskey pondsnail	<i>Stagnicola petoskeyensis</i>	Snail	For, Pal, Shr		X, MI (UP & nLP)	E		X																
Coldwater pondsnail	<i>Stagnicola woodruffi</i>	Snail			X, MI (wUP)	SC																		
Ribbed Striate	<i>Striatura exigua</i>	Snail			X, WI																			
Black Striate	<i>Striatura ferrea</i>	Snail			X, WI																			
Median striate	<i>Striatura meridionalis</i>	Snail	For, Gra, Pal		X, MI (wUP)	SC																		
A land snail (no common name)	<i>Vallonia gracilicosta albula</i>	Snail	Bar, For, Gra		X, MI (all UP)	E		X																
Trumpet vallonia	<i>Vallonia parvula</i>	Snail	Bar, For, Gra		X, MI (wUP)	SC																		
Purplecap valvata	<i>Valvata perdepressa</i>	Snail			X, MI (wUP)	SC																		
Flanged Valvata	<i>Valvata winnebagoensis</i>	Snail			X, MI (wUP)	SC																		
Pyramid dome	<i>Ventridens intertextus</i>	Snail	For, Gra		X, MI (wUP)	SC																		
Flat dome	<i>Ventridens suppressus</i>	Snail	For, Gra		X, MI (wUP)	SC																		
Delicate vertigo	<i>Vertigo bollesiana</i>	Snail	Bar		X, MI (all UP)	T		X				GRL												
Crested vertigo	<i>Vertigo cristata</i>	Snail	Bar		X, WI & MI	SC		X				GRL												
Tapered vertigo	<i>Vertigo elatior</i>	Snail	Bar, For, Pal		X, WI & MI	SC		X																
Midwest Pleistocene Vertigo	<i>Vertigo hubrichti</i>	Snail	Bar		X, MI (all UP)	E		X																
A land snail (no common name)	<i>Vertigo modesta modesta</i>	Snail	Bar		X, MI (wUP)	E																		
A land snail (no common name)	<i>Vertigo modesta parietalis</i>	Snail	Bar		X, MI (wUP)	E		X																
Six-whorl Vertigo	<i>Vertigo morsei</i>	Snail	Pal		X, WI & MI	E		X																
Deep-throat vertigo	<i>Vertigo nylanderi</i>	Snail	Bar, Pal		X, WI & MI	E		X																
Mystery Vertigo	<i>Vertigo paradoxa</i>	Snail	Bar, For, Gra, Pal		X, WI & MI	SC		X				GRL												
Crested vertigo	<i>Vertigo pygmaea</i>	Snail	Bar, For, Pal		X, MI (all UP)	SC		X																
Honey vertigo	<i>Vertigo tridentata</i>	Snail	Bar, Gra		X, WI & MI	SC																		
Transparent Vitrine Snail	<i>Vitrina angelicae</i>	Snail			X, WI																			
Velvet wedge	<i>Xolotrema denotata</i>	Snail	For, Gra, Pal		X, MI (wUP)	SC		X																
Boreal Top	<i>Zoogenetes harpa</i>	Snail			X, WI																			

Appendix F: ROCSTAR: Resources of Concern Selection Tool for Americas Refuges

ROCSTAR: Resources of Concern Selection Tool for Americas Refuges

From the Handbook: Now you must selectively reduce this table to those species and plant communities that will be managed to fulfill obligations to refuge purposes, Refuge System resources of concern, and biological integrity, diversity, and environmental health...We suggest using the following filters to help you select the appropriate focal resources: site capabilities, limiting factors, response to management or restoration, best science, and professional judgment. Also consider ecological or ecosystem processes within the refuge and surrounding landscape and importance for the maintenance and restoration of biological integrity, diversity, and environmental health when selecting focal resources.

Step 5. Identify Priority Refuge Resources of Concern

1. Select guilds and/or groups or community types of significance that utilize the broad habitat type noted within the BIDEH table (Step 3).
2. For each broad habitat type representing BIDEH within Step 3, select a number of "potential priority refuge ROC's" that help achieve refuge purpose AND rank moderate to high in regional priority rankings.
3. Select initial "potential priority refuge ROC's" from each group, guild, or significant community type to populate the scoring matrix below.
4. Score filters for each species and/or community based on available data, literature, professional judgment, and scoring definitions on the tab titled "Scoring Definitions and Scales".
5. Evaluate scoring to narrow down and select priority refuge ROC's. Be sure to consider the varying needs of different guilds, time of year, habitat availability, and biological capabilities. Select numerous species or guilds as necessary to evaluate future management and monitoring.

* Assumes that the filter of Refuge and Trust resources (Steps 1 and 2 have been applied. Can be done tracked in Step 4.
Comprehensive ROC)

Color Key

=Fed T&E	=both Fed and state T&E
=state T&E or SC	=all 3: Fed and state T&E and surrogates
=GLI surrogates	=State and GLI Surr

1. Forest

Species - Forest	Ratio of priority rankings or listings in Federal, State, or regional plans	Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)	Abundance on Refuge (See scoring scale B)	Responds well to habitat management? (See scoring scale C)	Ability to represent a larger guild or group of species? (See scoring scale D)	Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)	Scoring
Mammals							
Indiana Bat	5	3	1	1	3	5	3.10
Evening Bat	3	1	1	1	3	5	2.30
Eastern Pipistrelle	3	1	1	1	3	5	2.30
Herps							
Eastern Massasauga	7	3	1	3	7	7	4.70
Kirtland's Snake	3	1	1	3	5	5	2.90
Wood Turtle	5	3	1	3	3	7	3.70
Smallmouth salamander	5	1	1	1	3	7	3.00
Landbirds							
Kentucky Warbler	5	3	1	3	7	7	4.30
Kirtland's Warbler	7	1	1	1	7	10	4.45
Henslow's Sparrow	10	1	1	1	7	10	5.05
Eastern Meadowlark	3	1	1	1	7	10	3.65
Brown Thrasher	3	7	7	5	5	5	5.30
Canada Warbler	7	7	7	5	7	7	6.70
Golden-winged warbler	7	7	7	5	10	10	7.60

Species - Forest	Ratio of priority rankings or listings in Federal, State, or regional plans	Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)	Abundance on Refuge (See scoring scale B)	Responds well to habitat management? (See scoring scale C)	Ability to represent a larger guild or group of species? (See scoring scale D)	Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)	Scoring
Wood Thrush	7	7	7	5	5	5	6.10
Louisiana Waterthrush	5	7	7	5	7	7	6.30
Prothonotary Warbler	7	3	7	3	10	10	6.50
Cerulean Warbler	7	3	7	3	10	10	6.50
Sprague's Pipit	1	1	1	1	5	7	2.50
Red-shouldered Hawk	5	7	7	5	5	7	6.00
Bald Eagle	5	10	10	5	5	3	6.45
Le Conte's Sparrow	3	1	1	1	5	3	2.30
Shorebirds							
Upland Sandpiper	7	1	1	1	7	7	4.00
American Woodcock	5	5	7	3	7	7	5.60
<i>Weight</i>	<i>0.2</i>	<i>0.2</i>	<i>0.15</i>	<i>0.15</i>	<i>0.15</i>	<i>0.15</i>	<i>1.00</i>

1. Alvar/Shore

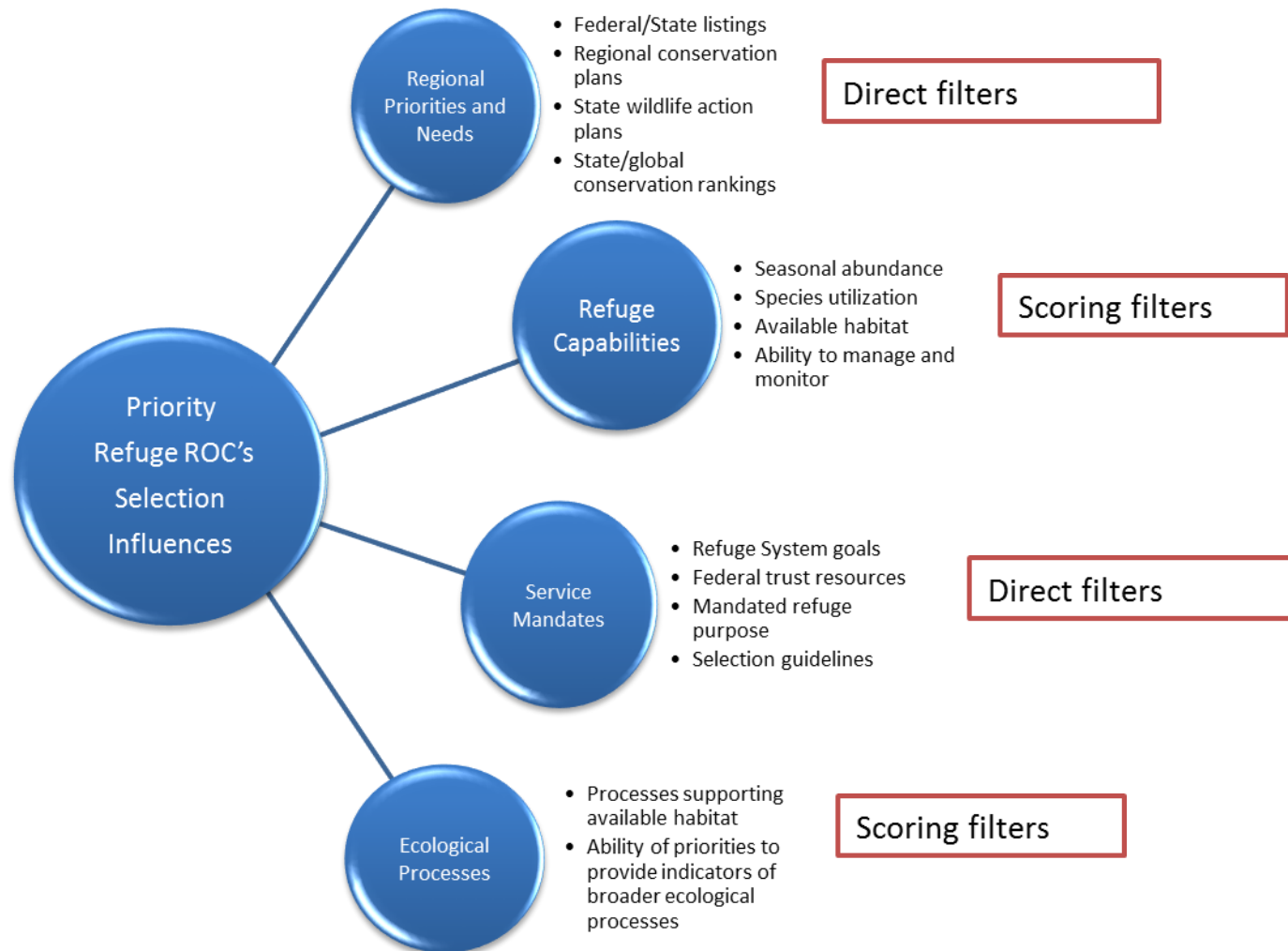
Species - Alvar/shore	Ratio of priority rankings or listings in Federal, State, or regional plans	Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)	Abundance on Refuge (See scoring scale B)	Responds well to habitat management ? (See scoring scale C)	Ability to represent a larger guild or group of species? (See scoring scale D)	Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)	Scoring
Plants							
Houghton's goldenrod	5	3	1	3	3	3	3.10
Eastern Prairie Fringed Orchid	10	1	1	3	10	10	5.80
Pitcher's thistle	5	10	5	7	10	10	7.80
Dwarf Lake Iris	5	10	5	3	7	7	6.30
Michigan monkey-flower	3	1	1	3	3	3	2.30
American hart's-tongue fern	3	1	1	3	3	3	2.30
Lakeside daisy	3	1	1	3	3	3	2.30
Insects							
Hine's emerald dragonfly	7	3	1	1	7	7	4.40
Persius Duskywing	7	3	1	1	3	3	3.20
Herps							
Copperbelly Watersnake	5	1	1	1	7	7	3.60
Six-lined Racerunner	5	1	1	1	3	3	2.40
Eastern Fox snake	5	7	5	3	7	7	5.70
Gray Ratsnake	5	3	1	1	3	3	2.80
Queensnake	7	1	1	1	3	3	2.80
Spotted Turtle	5	3	1	3	5	3	3.40
Blanding's Turtle	5	3	1	3	5	5	3.70
Blanchard's Cricket Frog	5	1	1	1	3	3	2.40
Shorebirds							
Piping Plover (Great Lakes pop.)	7	3	1	3	7	5	4.40
Wilson's Phalarope	5	3	3	3	3	3	3.40

Species - Alvar/shore	Ratio of priority rankings or listings in Federal, State, or regional plans	Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)	Abundance on Refuge (See scoring scale B)	Responds well to habitat management ? (See scoring scale C)	Ability to represent a larger guild or group of species? (See scoring scale D)	Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)	Scoring
Waterbirds							
Whooping Crane	3	1	1	1	3	3	2.00
Roseate tern	1	1	1	3	3	3	1.90
Common Loon	3	7	5	3	3	3	4.10
Black Tern	7	1	1	1	7	7	4.00
Common Tern	7	10	1	3	10	10	7.00
Caspian Tern	3	10	5	3	10	10	6.80
Forster's Tern	3	5	3	3	7	7	4.60
American Bittern	5	5	3	3	7	7	5.00
Black-crowned Night-heron	3	10	5	7	7	5	6.20
Great Blue Heron	1	10	10	7	5	5	6.25
Yellow Rail	7	3	1	1	7	7	4.40
King Rail	7	1	1	1	7	7	4.00
Common Gallinule (Moorhen)	3	3	1	1	5	5	3.00
Waterfowl							
Wood Duck	3	5	3	5	5	5	4.30
Blue-winged Teal	3	7	5	5	5	5	5.00
Mallard	3	7	10	5	3	3	5.15
Lesser Scaup	3	1	3	3	5	5	3.20
Trumpeter Swan	5	5	3	3	3	5	4.10
<i>Weight</i>	<i>0.2</i>	<i>0.2</i>	<i>0.15</i>	<i>0.15</i>	<i>0.15</i>	<i>0.15</i>	<i>1.00</i>

Summary of Filter Scoring Criteria* and Determining Factors Used in Value Assignments

Scoring Criteria	# of priority rankings or listings in Federal, State, or regional plans	Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)	Abundance on Refuge (See scoring scale B)	Responds well to habitat management? (See scoring scale C)	Ability to represent a larger guild or group of species? (See scoring scale D)	Ability to represent (a) on-refuge ecological processes, (b) broader ecosystem processes, or (c) their importance in the maintenance or restoration of BIDEH? (See scoring scale E)
Summary of determining factors and likely information sources.	Based on summary listings in the Potential ROC list developed for the refuge.	Based on knowledge of refuge habitats and conditions required for migratory and/or breeding habitat preferences found in literature.	Based on abundance and breeding listings in the Potential ROC list developed for the refuge.	Based on knowledge of refuge habitats and conditions required for migratory and/or breeding habitat preferences found in literature.	Based on knowledge of other birds of similar guilds and habitat requirements based on professional judgment or in literature.	Based on knowledge of species relation to ecological processes that support refuge habitats (soils, hydrology, disturbance regimes), broader ecosystem processes (watershed impacts, climate change), or the importance of the species in evaluating the maintenance or restoration of BIDEH based on professional judgment or in literature.

*Based on filters described in Step 5: Identify Priority Refuge Resources of Concern, pages 18-19 of Identifying ROC's Handbook.



Conservation Plan List Ratio of Inclusion

0.8 - 1.0	10
0.6 - 0.79	7
0.4 - 0.59	5
.2 - 0.39	3
0.0 - 0.19	1

Scoring Scale A - Assign values based on literature review, professional judgment, and definitions provided.

Strongly Able	10	Current refuge habitat(s) provide a variety of forage, breeding, and migratory requirements during all or part of the species life history.
Somewhat Able	7	Current refuge habitat(s) (or conditions <u>practically</u> restored or enhanced) provide some forage, breeding, and migratory requirements during all or part of the species life history.
Limited Ability	5	Current refuge habitat(s) provide occasional or limited forage, breeding, and migratory requirements during a portion of the species life history. Significant restoration or enhancement would be necessary to increase supporting habitat ability.
Inconclusive/Uncertain	3	Current literature available or working knowledge of species poses a significant degree of uncertainty in terms of the refuge habitat(s) ability to provide forage, breeding, and migratory requirements during all or part of the species life history.
Clearly Unable	1	Current literature available and/or working knowledge of species indicates that refuge habitat(s) have limited or no ability to provide substantial forage, breeding, and migratory requirements during all or part of the species life history.

Scoring Scale B - Assign values based on refuge I&M records and professional judgment.

Birds		Fish, Plants, Herps, and Other Native Wildlife	
Common throughout breeding season	10	Common throughout refuge	10
Common during migration only	7	Common along portions of refuge	7
Occasional during breeding	5	Occasional/Uncommon throughout refuge	5
Occasional during migration	3	Occasional/Uncommon along portions of refuge	3
Uncommon/rare	1	Rare or no local records.	1

Scoring Scale C - Assign values based on literature review, professional judgment, and definitions provided.

Strongly Able	10	Species is documented or (based on professional judgment) is known to respond positively to habitat management**. Suitable habitat management actions are practical for the refuge to implement and can be monitored easily.
Somewhat Able	7	Species response to management** actions is less documented, but (based on professional judgment) is likely to respond positively to habitat management. Suitable habitat management actions are practical for the refuge to implement, but may require additional or detailed I&M efforts to ensure response is documented.
Limited Ability	5	Species response to management** actions is less documented and (based on professional judgment) is less likely to respond positively to habitat management. Species may have generalist habitat requirements or be difficult to evaluate with I&M. Suitable habitat management actions are either difficult for the refuge to implement, or monitor a direct response.
Inconclusive/Uncertain	3	Species response is not clearly documented and (based on refuge I&M or professional judgment) is uncertain as to whether it can have a reliable response to habitat management**.
Clearly Unable	1	Species response to management** actions is documented or (based on professional judgment) is not likely to respond positively to habitat management. Species may have generalist habitat requirements or be difficult to evaluate with I&M. Suitable habitat management actions are either difficult for the refuge to implement, or monitor a direct response.

** Management may include preservation, protection, restoration, enhancement, or other specific conservation measures taken to sustain a particular habitat or species requirement.

Scoring Scale D - Assign values based on literature review, professional judgment, and definitions provided.

Strongly Able	10	Species is documented or (based on refuge I&M or professional judgment) likely to represent (focal, umbrella, indicator, or keystone) other species. Species known to share a suite of habitat requirements with other species, guilds, or groups utilizing the refuge.
Somewhat Able	7	Species is not clearly documented, but (based on refuge I&M or professional judgment) may potentially represent (focal, umbrella, indicator, or keystone) other species. Species likely shares a suite of habitat requirements with other species, guilds, or groups utilizing the refuge.
Limited Ability	5	Species is not clearly documented and (based on refuge I&M or professional judgment) is less likely to represent (focal, umbrella, indicator, or keystone) other species. Species is either a) very specific, or b) a generalist in terms of habitat requirements related to other species, guilds, or groups utilizing the refuge.
Inconclusive/Uncertain	3	Species is not clearly documented and (based on refuge I&M or professional judgment) is uncertain as to whether it can represent (focal, umbrella, indicator, or keystone) other species.
Clearly Unable	1	Species is documented (or based on refuge I&M or professional judgment) to be unable represent (focal, umbrella, indicator, or keystone) other species. Due to a lack of similar guilds or groups available or very specific habitat requirements.

Scoring Scale E - Assign values based on literature review, professional judgment, and definitions provided.

Strongly Able	10	Species is documented or (based on refuge I&M or professional judgment) likely to strongly act as an indicator of both: on-refuge ecological processes AND broader landscape ecosystem processes.
Somewhat Able	7	Species is documented or (based on refuge I&M or professional judgment) likely to strongly act as an indicator of either: on-refuge ecological processes OR broader landscape ecosystem processes.
Limited Ability	5	Species is documented or (based on refuge I&M or professional judgment) somewhat likely to act as an indicator of either: on-refuge ecological processes OR broader landscape ecosystem processes.
Inconclusive/Uncertain	3	Species is documented or (based on refuge I&M or professional judgment) less likely or uncertain to act as an indicator of either: on-refuge ecological processes OR broader landscape ecosystem processes.
Clearly Unable	1	Species is documented or (based on refuge I&M or professional judgment) not likely to act as an indicator of either: on-refuge ecological processes OR broader landscape ecosystem processes.

Appendix G: Invasive Species Habitat Management Strategies

The following appendix identifies the management tools or strategies used for invasive species management that could be utilized by managers to achieve the habitat objectives outlined in Chapter 4. These strategies were identified through literature review, consultation with other biologists, and feasibility of utilization on the remote islands managed by Shiawassee NWR. The information in this appendix should be used as a reference when making invasive species management decisions. Many techniques mentioned in Chapter 4 were based on resources already available online and the links are provided here. These online resources should be referenced for further information and direction when applying these strategies.

Prevention Strategies

Actions to prevent invasive species introductions into and within a region are far more cost effective and environmentally desirable than actions undertaken after invasive species establishment (Leung et al. 2002). In addition to Service staff actively treating and controlling invasive species, there are other areas in which invasive species management strategies can be considered or incorporated into habitat management:

Working with Partners

Working with partners is one of the most effective way to manage invasive species on a refuge. Control efforts on the refuge will have little long-term impact if the surrounding lands and waters are infested with invasive species. The Refuge is currently partnering with Partners for Fish and Wildlife program, Huron Pines RC&D, The Nature Conservancy (TNC), and Michigan Natural Features Inventory on *Phragmites spp.* species management on the islands.

Working with partners on invasive species management is important to USFWS. A detailed summary of invasive species related partnerships and funding sources is available online at <http://www.fws.gov/invasives/partnerships.html>. Where possible, refuge habitat management should consider the support available through partnerships and resources listed here.

Incorporate Invasive Species Prevention in All Habitat Management Activities

Field activities for habitat management can introduce invasive species and create disturbances favorable to species introductions. Some considerations for prevention include:

- Minimize ground disturbance and restore disturbed areas.
- Require mulch, sand, gravel, dirt, and other construction materials to be certified as free of noxious weed seeds.
- Avoid stockpiles of weed-infested materials.
- Inspect vehicles, machinery, and gear (hand tools, clothing, hats, socks, shoes, gloves, jackets, etc.) before and after conducting activities
- Remove any contaminated material (plants, animals, and mud) from personal gear in a

designated area

- Clean and sanitize sensitive equipment every time it has been exposed to substrates that may harbor invasive species or use dedicated field gear for each site with unique invasive species risks.
- When loaning equipment or vehicles, make an expectation that the equipment is loaned out clean and returned clean.
- Where possible, take reasonable steps to avoid transit through areas of high density, or small isolated populations of invasive species.
- Minimize the number of entry points to a project site.

Invasive Species Management

Controlling and managing invasive species is a strategy for maintaining the biological integrity and diversity of all habitats when prevention has failed. In 2015, NWRS invasive species representatives (strike team, invasive species, and IPM coordinators) from all eight regions and headquarters jointly refined a conceptual model depicting the phases of strategic and adaptive invasive plant management (Figure G.1.). The model was first developed by Region 8 to help focus regional support for invasive plant management. Although focused on invasive plants, the model can be applied in theory to other taxa. In general, the model outlines an iterative approach of invasive species management that includes prioritization, inventorying, management, and monitoring.

Potential management strategies for prioritizing control efforts for established invasive species and controlling invasive species are generally described in the sections below. Prior to the initiation of invasive species control efforts, the refuge manager must understand the biology of the species to be controlled. When invasive species become established, a number of resources are available to assist refuge managers with selecting species-specific strategies for invasive species management. Some good sources of management information include:

- National Invasive Species Information Center: <http://invasivespeciesinfo.gov/index.shtml>
- Center for Invasive Species and Ecosystem Health: <http://www.invasive.org/>
- USGS Invasive Species Program: <http://biology.usgs.gov/invasive/>
- Midwest Invasive Plant Network (MIPN): <http://mipn.org/>
- Weeds Gone Wild: <http://www.nps.gov/plants/alien/index.htm>

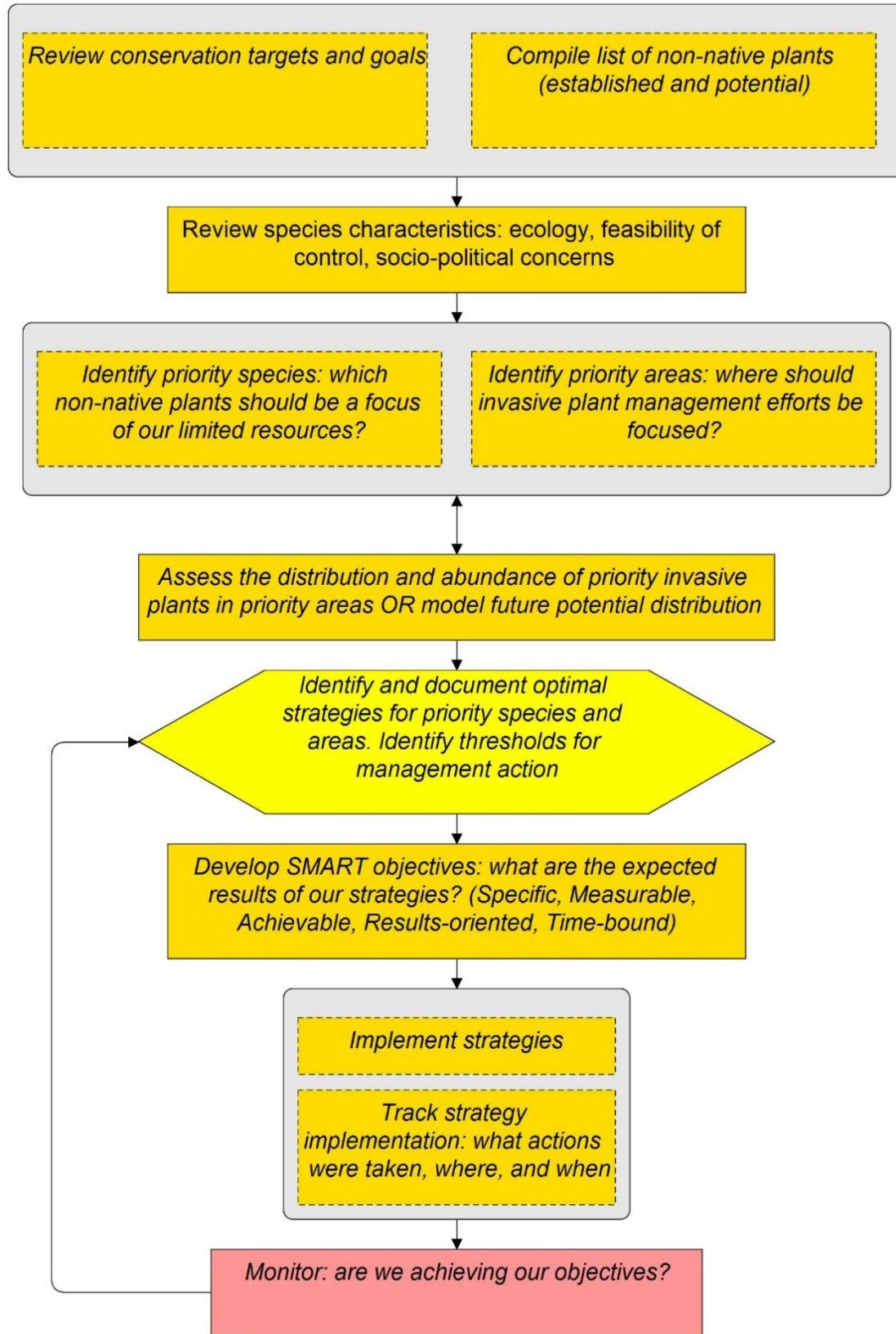


Figure G.1. Phases of strategic and adaptive invasive plant management

Early Detection and Rapid Response (EDRR)

Where prevention is not possible, early detection and rapid response is the next best strategy for new invasions. The Department of Interior put out a general framework for EDRR efforts last year (DOI 2016).

- See: <https://www.doi.gov/sites/doi.gov/files/National%20EDRR%20Framework.pdf>

This approach to invasive species control is based on the well-documented phases of invasion (Rawlins et al. 2011 and depicted in Figure 2 below), with the goal of recognizing invasions in their early phase and eradicating infestations before they grow too large to eradicate. Success will depend, in part, on participation by all refuge staff, researchers, and volunteers to report and respond to invasions.

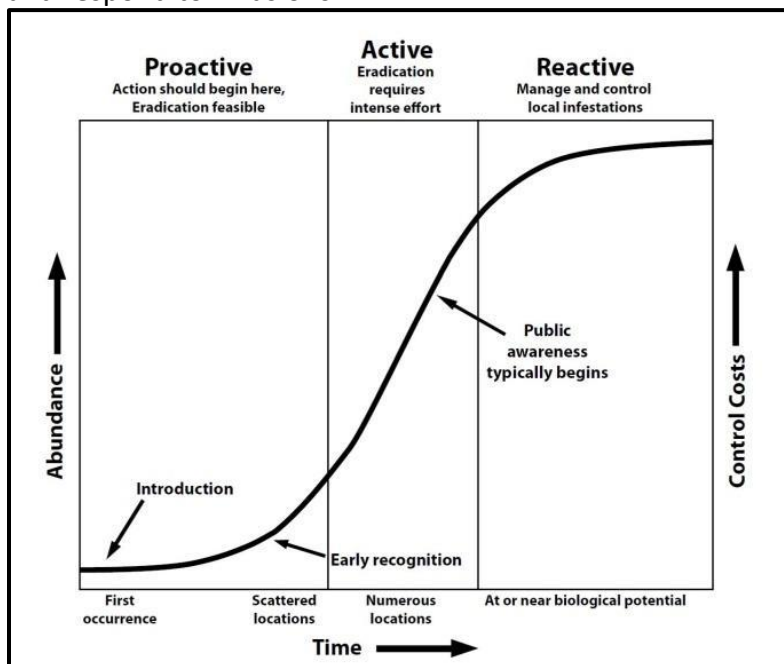


Figure G.2. Phases of invasive species invasion and control (from Rawlins et al. 2011).

Tools and resources for early detection and distribution mapping have been developed and are readily available online from a number of sources. One such source of information includes EDDMapS (Early Detection and Distribution Mapping System) developed by The University of Georgia - Center for Invasive Species and Ecosystem Health. This site includes mapping tools, species distribution maps, and other spatial datasets that inform invasive species distribution:

- EDDMapS: <https://www.eddmaps.org/>

When small infestations are spotted, they should be eradicated as soon as possible. The site must then be monitored for several years to ensure the control was effective.

Prioritizing Invasive Species Control Efforts

The first step in prioritizing invasive species control efforts is to set clear management objectives and then compare a suite of management alternatives against those objectives. Once measurable objectives and management alternatives have been selected then prioritization can occur.

There are a number of ranking tools to assist land managers with the daunting task of prioritizing their invasive plant control efforts. The *Fulfilling the Promise* National Invasive Species Management Strategy Team recommends using the following order of priority to determine appropriate actions:

1. Smallest scale of infestation
2. Poses greatest threat to land management objectives
3. Greatest ease of control.

The following ranking systems are available for prioritizing invasive plant species control:

- Morse, L.E., J.M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An Invasive Species Assessment Protocol: Evaluating Non-Native Plants for Their Impact on Biodiversity. Version 1. NatureServe, Arlington, Virginia. Available online at: <http://www.natureserve.org/library/invasiveSpeciesAssessmentProtocol.pdf>
- Hiebert, R.D. and J. Stubbendieck. 1993. Handbook for Ranking Exotic Plants for Management and Control. National Park Service. Natural Resources Report NPS/NRMWRO/NRR-93/08. Denver, Colorado. Available online at: http://especies-envahissantes-outremer.fr/pdf/methode_hierarchisation_hiebert.pdf
- APRS Implementation Team. 2000. Alien plants ranking system version 5.1. Jamestown, ND: Northern Prairie Wildlife Research Center Online. (Version 30SEP2002).
- Zimmerman, C., M. Jordan, G. Sargis, H. Smith, K. Schwager. 2011. An Invasive Plant Management Decision Tool. Version 1.1. The Nature Conservancy, Arlington, Virginia. Available online at: http://greatlakesresilience.org/sites/default/files/library_reference_2011_TheNatureConservancy_IPMDAT.pdf

Categories of treatment control are adapted from guidance outlined in The Nature Conservancy's Invasive Plant Management Decision Analysis Tool Report (Zimmerman et al. 2011). This recommended approach contains three potential control options: eradication, containment, and suppression.

- Eradication attempts to eliminate all individuals and the seed bank from an area with the low likelihood of needing to address the species again in the future.
- A containment/reduction approach prevents infestations of invasive species from spreading to uninfested areas and (where possible) seeks to reduce population sizes to a level suitable for eradication.
- Suppression attempts to reduce an invasive plant population in size, abundance, and/or reproductive output below the threshold needed to maintain a species or ecological process.

“Eradication is considered successful when no plants are recovered from the initial infested area for three consecutive years” (Zimmerman et al. 2011). Eradication is practical only for small-scale infestations, generally identified in the introduction phase. Rejmánek and Pitcairn (2002) recommend infestations of < 1 ha (2.47 acres) be considered for eradication in California.

According to Zimmerman et al. (2011), containment may involve methods that prevent reproduction and dispersal, treating the perimeter of a large infestation, and/or eliminating small satellite infestations. “Containment is most effective with species that spread slowly, move short distances, and for which effective barriers can be established” (Hulme 2006). Reduction seeks to eliminate any occurrences within the area and/or prevent the invasive species from spreading into the project area from the surrounding landscape. Similar techniques and management thresholds are at work for either focus of this approach.

The timeframe of a suppression effort may vary depending on the invasive plant and desired conservation outcome. Zimmerman et al. (2011) cites several examples where suppression is best suited:

1. Areas targeted for planting desired species in order to establish and become competitive.
2. Interim competition pressure on desired species needs to be reduced so that they may persist.
3. Areas where suppression helps maintain conditions for rare or listed species.

Restore Altered Habitats and Reintroduce Native Plants

Restoration is critically important because the conditions responsible for the initial invasion will expose the site to a resurgence of the invasive species, as well as a secondary invasion of one or more different species. Furthermore, restoration of a disturbed area before the initial invasion may preclude the need for further control efforts. The goal is to conserve and promote natural processes that will inherently suppress potential pest populations (DOI 2007).

If funding or personnel are not available to restore highly disturbed areas in a timely manner, consider planting a cover crop for several years to stabilize the site prior to reintroducing native plants. This will prevent more invasive seeds from entering the environment until the site can be restored. Native plants can then be established by direct seeding or planting with less competition from invasives in the seed bank. When practical, local genotypes of native species should be used.

Biological Control

Biological control is the use of animals or disease organisms that feed upon or parasitize the invasive species target. Usually, the control agent is imported from the invasive species’ home country, and artificially high numbers of the control agent are fostered and maintained. There are also “conservation” or “augmentation” biological control methods where populations of biological agents already in the environment (usually native) are maintained or enhanced to

target an invasive species. The advantages of this method are that it avoids the use of chemicals and can provide relatively inexpensive and permanent control over large areas. Appropriate control agents do not exist for all invasive species. Petitions must be submitted to, and approved by, the USDA Technical Advisory Group on weed biological control before any proposed biological control agent can be released in the United States.

Detailed discussion of the application and impacts of biological controls on Service lands is available at:

<http://www.fws.gov/invasives/staffTrainingModule/methods/biological/impacts.html>

Physical Control

Physical (also referred to as mechanical or manual) removal of invasive organisms can be effective against some herbaceous plants, shrubs and saplings, and aquatic organisms. This is particularly effective for plants that are annuals or have a taproot. Care should be taken to minimize soil disturbance to prevent creating conditions ideal for weed seed germination. Repeated cutting over a growing period is needed for effective control of many invasive plant species. Care should be taken to properly remove and dispose of any plant parts that can re-sprout. Treatments should be timed to prevent seed set and re-sprouting. The following methods are available: hand-pulling, pulling with hand tools (weed wrench, etc.), mowing, brush-hogging, weed-eating, stabbing (cutting roots while leaving in place), girdling (removing cambium layer), mulching, tilling, smothering (black plastic or other), and flooding.

Mowing can be used to reduce plant height and deplete energy reserves of invasive and robust plants. Repeated mowing within a growing season is often necessary to successfully control invasive plants. This can be logistically difficult in a habitat that is managed for various resources of concern. However, mowing can be effective when combined with other strategies, such as chemical treatment, spring flooding, and disking. Timing of mowing should be scheduled to maximize above ground energy reserves and to prevent seed dispersal (late summer). Mowing may also increase plant diversity by creating space (light) for other species to germinate.

The advantages of mechanical treatment are low cost for equipment and supplies and minimal damage to neighboring plants and the environment. The disadvantages are higher costs for labor and inability to control large areas. For many invasive species, mechanical treatments alone are not effective, especially for mature plants or well-established plants. Mechanical treatments are most effective when combined with herbicide treatments (e.g. girdle and herbicide treatment).

Detailed discussion of the application and impacts of physical controls on Service lands is available at:

<http://www.fws.gov/invasives/staffTrainingModule/methods/physical/impacts.html>

Herbicides

Invasive and robust plants in impoundments can be managed using herbicides approved for use in wetlands. Methods of application include spot-treatment using back pack or ATV mounted

sprayer, or aerial application. Spot-treated is more targeted (avoiding neighboring plants), but can be very labor intensive when treating large areas. Aerial application is less labor-intensive, but is not as target-specific, and requires extensive planning to execute. Herbicides are applied during various times of the growing season depending on plant species and overall goal. For long term control, herbicide application is typically combined with other methods, such as mowing, burning, and flooding.

There are a wide variety of chemicals that are toxic to plant and animal species. They may work in different ways and be very target specific, or affect a wide range of species. Herbicides may be “pre-emergent,” that is, applied prior to germination to prevent germination or kill the seedling, or “post-emergent” and may have various modes of action (auxin mimic, amino acid inhibitor, mitosis inhibitor, photosynthesis inhibitor, lipid biosynthesis inhibitor). Products may come in granular, pelleted, dust or liquid forms. Liquid herbicides are commonly diluted to an appropriate formula and mixed with other chemicals that facilitate mixing, application, or efficacy. Common application methods include foliar spray, basal bark, hack and squirt, injection, and cut stump. The timing of applications is critical to achieve good control, as the growth stage at which an organism will be most effectively controlled varies with different species.

The advantages are that the right chemicals, applied correctly, can produce desired results over a large area for a reasonable cost. The disadvantages are that the chemicals may affect non-target species at the site (including the applicator) and/or contaminate surface or groundwater. Proper planning includes using the most target-specific, least hazardous (humans and the environment), and most effective chemical for the job. Additionally, one should research minimum effective dosage, as the chemical labels often give higher than necessary concentrations. Herbicides often are most effective when used in combination with mechanical methods described above.

Attention to protective gear, licensing requirements and other regulations is essential. In the U.S. Fish and Wildlife Service, all pesticide and other chemical applications (including adjuvants designed to enhance effectiveness) are covered by Service and departmental regulations, and a Pesticide Use Proposal (PUP) is required for all pesticide applications.

Literature Cited

- [DOI] The U.S. Department of the Interior. 2007. Integrated Pest Management Policy (517 DM 1). Office of Environmental Policy and Compliance. Retrieved from:
<https://www.fws.gov/ecological-services/habitat-conservation/pdf/DOIIPMpolicyFINAL.pdf>
- [DOI] The U.S. Department of the Interior. 2016. Safeguarding America's lands and waters from invasive species: A national framework for early detection and rapid response, Washington D.C., 55p.
- Hulme, P.E. 2006. Beyond control: wider implications for the management of biological invasions. *Journal of Applied Ecology*. 43:835-847.
- Leung, B., Lodge, D.M. Finnoff, D., Shogren, J.F., Lewis, M. & Lamberti, G. 2002. An ounce of prevention or a pound of cure: bioeconomic risk analysis of invasive species. *Proceedings of the Royal Society, Series B* 269: 2407–2413.
- Rawlins, K.A., J.E. Griffin, D.J. Moorhead, C.T. Barger, and C.W. Evans. 2011. EDDMapS: Invasive Plant Mapping Handbook. The University of Georgia. Center for Invasive Species and Ecosystem Health, Tifton GA. BW-2011-02. 32 p.
- Rejmanek, M. and M. J. Pitcairn. 2002. When is eradication of exotic pest plants a realistic goal? Page 249-253 in C. R. Veitch and M. N. Clout, eds. *Turning the Tide: The Eradication of Invasive Species*. Auckland, New Zealand: Invasive Species Specialist Group of the World Conservation Union (IUCN).
- Zimmerman, C., M. Jordan, G. Sargis, H. Smith, K. Schwager. 2011. An Invasive Plant Management Decision Tool. Version 1.1. The Nature Conservancy, Arlington, Virginia.

Appendix H: Measure attributes for Michigan Islands Wilderness Character Monitoring

The following table includes measures selected for Pismire, Shoe and Scarecrow Islands which are part of the Michigan Islands NWR. Islands associated with each measure are in parenthesis. This table is a modified version of the summary table that was included in the wilderness character monitoring addendum document (Gantz and Edwards 2017), which modifies the 2015 addendum (Gantz 2015) and complements the 2012 report on wilderness character monitoring (O'Dell 2012).

Table G.1. Wilderness Character Monitoring Measure attributes for Michigan Islands Wilderness

Quality	Indicator	Measure	Frequency	Data Adequacy	Significant Change	Baseline ¹ Value
Untrammelled	Actions authorized by the federal land manager that intentionally manipulate the biophysical environment	Number of authorized actions to control populations of double-crested cormorants (Pismire, Shoe and Scarecrow combined)	1 year	High	Any	2 actions
		Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat (Pismire and Shoe combined)	1 year	High	25%	0
		Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat (Scarecrow)	1 year	High	25%	0
		Number of actions taken to capture, remove, band, and/or mark birds within the wilderness boundary (Pismire and Shoe combined)	1 year	High	Any	4 actions
		Number of actions taken to capture, remove, band, and/or mark birds within the wilderness boundary (Scarecrow)	1 year	High	Any	0 actions

Quality	Indicator	Measure	Frequency	Data Adequacy	Significant Change	Baseline ¹ Value
	Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment	Number of unauthorized actions to manipulate colonial bird communities (Pismire, Shoe, and Scarecrow combined)	1 year	Low	Any	0 actions
Natural	Plants	Presence of invasive plant species	5 years	Low	Any	
	Animals	Index of disturbance to bird populations on wilderness islands (Pismire, Shoe and Scarecrow combined)	1 year	High	Any	12
	Air and water	Ozone air pollution	5 years	Medium	Categorical	74.6 ppb
		Total nitrogen wet deposition	5 years	Medium	Categorical	4.6 kg/ha
		Total sulfur wet deposition	5 years	Medium	Categorical	2.9 kg/ha
		Visibility	5 years	Medium	Categorical	7 dV
	Ecological processes	Index of breeding native colonial waterbirds presence (Pismire, Shoe, and Scarecrow combined)	2 years	High	Any	3
		Mercury contamination	Annually	Medium	Any	
Undeveloped	Presence of non-recreational structures, installations, and developments	Number of authorized physical structures (Pismire, Shoe, and Scarecrow combined)	5 years	High	Any	0
	Presence of inholdings	Number of inholdings within wilderness (Pismire, Shoe, and Scarecrow combined)	5 years	High	Any	0

Quality	Indicator	Measure	Frequency	Data Adequacy	Significant Change	Baseline ¹ Value
	Use of motor vehicles, motorized equipment, or mechanical transport	Index of administrative mechanical transport and motorized equipment (Pismire, Shoe, and Scarecrow combined)	5 years	High	Any	0
Solitude or primitive and unconfined recreation	Remoteness from sights and sounds of human activity <i>inside</i> wilderness	Number of visitors (special use permits and staff visits) (Pismire and Shoe combined)	1 year	High	25%	8 visitors
		Number of visitors (special use permits and staff visits) (Scarecrow)	1 year	High	25%	3 visitors
	Remoteness from sights and sounds of human activity <i>outside</i> the wilderness	Index of the degree of accumulated trash and debris on wilderness islands (Pismire, Shoe and Scarecrow combined)	5 years	Medium	Any	3
	Facilities that decrease self-reliant recreation	Number of agency provided recreational facilities (Pismire, Shoe, and Scarecrow combined)	5 years	High	Any	0
	Management restrictions on visitor behavior	Number of acres closed to the public (Pismire, Shoe, and Scarecrow combined)	5 years	High	Any	12 acres

¹ The baseline value is defined as the data value entered into the Wilderness Character Monitoring Database from the first year of available data for a particular measure. An individual measure's baseline year may be different from the baseline year of Wilderness Character Monitoring as a whole.

