

Chapter 3: The Environment

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Throughout this document, five national wildlife refuges (NWRs, refuges) are discussed individually—such as the Gravel Island NWR or the Green Bay NWR. This document also discusses all five NWRs collectively as one entity and when doing so, refers to the group as the “Great Lakes islands refuges” or “Great Lakes islands NWRs.”

Introduction

General Island Geological and Ecological Background

Michigan and Wisconsin are fortunate to have many islands that form a “waterscape” unlike any found elsewhere in the world. Of the three Upper Great Lakes (Huron, Michigan, and Superior), there exists approximately 200 islands within the confines of the states in Lake Huron, 76 in Lake Michigan, and 175 in Lake Superior (not counting 86 in the St. Mary’s River) (Soule, 1993).

The glacial history of island chains differs across the Upper Great Lakes. Glacial till overlying limestone bedrock forms the bulk of the Beaver Island group in northern Lake Michigan, although Pismire Island (part of Michigan Islands NWR) is an example of a sand and gravel bar island. Conversely, most islands in Lake Superior are formed of igneous and metamorphic bedrock, with the Huron Islands (of Huron NWR) being the result of granite upthrusts (Soule, 1993).

Post-glacial history of these islands also varies. National Wildlife Refuge System (NWRS, Refuge System) records indicate that many of the islands of Michigan Islands NWR were either impacted by human habitation (Gull Island) or by other uses (e.g., Hat Island was used as bombing range prior to refuge establishment) (Gates, 1950). Likewise, Huron NWR and Harbor Island NWR have had a history of human disturbance and manipulations (e.g., buildings are or were on both these refuges).

Many ecological disturbances maintain the character of islands in the Upper Great Lakes, including fire, wind, insects and disease, hydrology, and the effects to vegetation by large flocks of nesting colonial waterbirds or the population cycling of herbivorous mammals such as snowshoe hares. Subsequent colonization of islands after major disturbances and successional

change over time (including colonization by flora and fauna) spurred the *Theory of Island Biogeography* by MacArthur and Wilson (1967). Because of geographic isolation and the resulting impact this isolation has had on colonization by species and human use, many of the islands in the Upper Great Lakes have unique plant and animal communities. Not surprisingly, numerous studies have occurred on these islands to describe flora, fauna, and ecological patterns and processes (see Soule, 1993 for a detailed list of references). And to this day, the study and conservation of islands have multiple values for science and society as a whole. Islands of the Upper Great Lakes are, and have always been, dynamic ecosystems unto themselves.

Gravel Island NWR

Gravel (4 acres) and Spider (23 acres) Islands comprise the Gravel Island NWR. These islands are located in Lake Michigan, approximately 1 mile east of the northern tip of the Door County Peninsula, Wisconsin. Both islands provide optimum conditions for nesting birds, including Herring Gulls, Caspian Terns, and Double-crested Cormorants. Gravel Island currently supports the largest colony of Caspian Terns in the Great Lakes Region.

Gravel Island NWR and Hog Island, one component of Green Bay NWR, comprise the Wisconsin Islands Wilderness Area, which, at 29 acres, is one of the smallest wilderness areas in the country. The refuge is managed by staff at Horicon NWR, in Mayville, WI. Public use is not allowed due to ground nesting by migratory birds and limited access.



Spider Island, Gravel Island NWR

Green Bay NWR

Green Bay NWR consists of Hog Island (2 acres), Plum Island (325 acres), and Pilot Island (3.7 acres). The islands are located in Lake Michigan, near Washington Island, off the tip of Wisconsin's Door Peninsula.



Pilot Island Lighthouse, Green Bay NWR

The refuge is managed by staff at Horicon NWR, in Mayville, WI. Hog Island supports a nesting colony of herring gulls and a few nesting Great Blue Herons and Red-breasted Mergansers. No development has occurred on Hog Island due to its small size, remoteness, and landing difficulties.

Portions of Plum and Pilot Islands were developed to serve as lighthouse facilities or lifesaving stations during the late 19th century. The lighthouse on Pilot Island was built in 1858 and is listed in the National Register of Historic Places. Plum Island is

home to the historically significant lifesaving station, keeper's quarters, and associated buildings. All are listed on the National Register of Historic Places.

Plum Island essentially functions as a small ecosystem and retains natural qualities absent on the nearby mainland. Habitats on Plum Island consist of cedar lowlands; maple, basswood, and hemlock uplands; and alkaline beach habitat. Today Pilot Island supports nesting colonies of Double-crested Cormorants, and Herring Gulls. Small numbers of Great Blue and Back-crowned Night-Herons also nest on Pilot Island.

All public use is prohibited on Hog and Pilot Islands due to ground nesting by migratory birds and the limited and treacherous access. Plum Island may offer public use opportunities in the future provided they are compatible with the refuge's purpose and mission.

Harbor Island NWR

The 695-acre Harbor Island NWR is located one mile north of Drummond Island, MI and 3.5 miles south of the United States–Canadian (Ontario) border in Potagannissing Bay on Lake Huron. Habitats on Harbor Island consist of balsam/cedar lowlands and oak, beech, and maple uplands. Soil consists of shallow organics or sands over dolomite rock. Resident wildlife species include red fox, Ruffed Grouse, snowshoe hare, White-throated Sparrows, Gray Jays, and Magnolia Warblers. Timber wolves from St. Joseph Island, Ontario may hunt on the island during winter months. Bald Eagles also use the island's large bay for fishing each spring and fall. For more information see the 1978 Harbor Island Report (also known as the *Harbor Island Ecological Inventory*). Access to the island is by private boat. Harbor Island NWR's sheltered bay is used by boaters for fishing and as an overnight anchorage. A sand beach is also used for swimming.

Huron NWR

Huron NWR is comprised of eight islands: West Huron (or Lighthouse) Island, Gull Island, McIntyre Island, Cattle Island, and four nameless, bare rock islands. Despite their small size, totaling only 147 acres, the remoteness and primitive quality of these islands have earned them the designation of a Wilderness Area.

The lighthouse on West Huron Island was built in 1868 and is listed in the National Register of Historic Places. The Huron Islands Lighthouse Preservation Association was formed to raise funds for its restoration.

Habitat of this unstaffed refuge varies from a sparse covering of red pines and white birch with ground-level vegetation to barren granite with scattered lichen growth. Resident wildlife species include Merlins, Bald Eagles and a large gull colony on Cattle and nearby Rock Islands.



West Huron (or Lighthouse) Island, Huron NWR

Access to the island is by private boat. The refuge is located three miles off the south shore of Lake Superior and 18 miles east of the Keweenaw Peninsula. Of the eight islands, only West Huron Island (Lighthouse Island) is open to the public, during daylight hours, for hiking and nature study.

All remaining islands are closed to the public, except by Special Use Permit to biologists, botanists, or other qualified persons in conjunction with approved studies. Exceptions are emergency landings by boats in distress. Camping is prohibited on all islands, except that biologists, botanists, and other qualified applicants may be permitted prescribed primitive-type camping only on West Huron Island (Lighthouse Island) by Special Use Permit, in conjunction with approved studies.

Michigan Islands NWR

Michigan Islands NWR is comprised of nine islands in Lakes Michigan and Huron. Thunder Bay, Sugar, and Scarecrow Islands in Thunder Bay (near Alpena, MI), and Big and Little Charity Islands in Saginaw Bay are managed by Shiawassee NWR in Saginaw, MI. Seney NWR has management responsibility for Gull, Pismire, Hat, and Shoe Islands, part of the Beaver Island Group in the northern portion of Lake Michigan. In 1970, Scarecrow, Pismire, and Shoe Islands were officially designated as Michigan Islands Wilderness Area. The portion of Michigan Islands NWR managed by Seney NWR totals 262 acres with Gull Island accounting for 230 of those acres.

Habitats vary considerably. Shoe Island has little to no groundcover and Gull Island has a grass- and forb-covered beach area above the high-water line, a shrub-covered sand dunes area, and balsam fir and white cedar in the interior. Soils consist of shallow organics or sands over cherty limestone and dolomite. At some point in their history, all nine islands have supported waterbird colonies, some of significant size and diversity.

Big Charity and Thunder Bay Islands have lighthouses and keeper's quarters.

Climate

Due to its inland location, northern latitude, and relatively high elevation, the Great Lakes islands refuges are characterized by a relative 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).

Climate Change Impacts

The U.S. Department of the Interior issued an order 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 increase of carbon dioxide (CO²) within the earth's atmosphere has been linked to the gradual rise in surface temperature commonly referred to as global warming. In relation to comprehensive conservation planning for national wildlife refuges, carbon sequestration constitutes the primary climate-related impact that refuges can affect in a small way. The U.S. Department of Energy's "Carbon Sequestration

Research and Development” defines carbon sequestration as “. . . the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere.”

Vegetated land is important for carbon sequestration. Terrestrial biomes of all types—grasslands, forests, wetlands, tundra, and desert—are effective both in preventing carbon emission and in acting as a biological “scrubber” of atmospheric CO². The Department of Energy report’s conclusions noted that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere.

Conserving natural habitat for wildlife is the heart of any long-range plan for national wildlife refuges. The actions proposed in this Comprehensive Conservation Plan (CCP) would conserve or restore land and habitat and would thus retain existing carbon sequestration. This in turn contributes positively to efforts to mitigate human-induced global climate change.

One U.S. Fish and Wildlife Service (FWS, Service) activity in particular—prescribed burning—releases CO² directly to the atmosphere from the biomass consumed during combustion. However, there is actually no net loss of carbon, since new vegetation quickly germinates and sprouts to replace the burned-up biomass and sequesters or assimilates an approximately equal amount of carbon as was lost to the air (Boutton et al., 2006). Overall, there should be little or no net change in the amount of carbon sequestered on the Great Lakes islands refuges from any of the proposed management alternatives.

Several impacts of climate change have been identified that may need to be considered and addressed in the future:

- Habitat available for coldwater fish such as trout and salmon in lakes could be reduced.
- Forests may change, with some species shifting their range northward or dying out and other trees moving in to take their place.
- Ducks and other waterfowl could lose breeding habitat due to stronger and more frequent droughts.
- Changes in the timing of migration and nesting could put some birds out of sync with the life cycles of their prey species.
- Animal and insect species historically found farther south may colonize new areas to the north as winter climatic conditions moderate.

The managers and resource specialists responsible for the refuges need to be aware of current and future change due to global warming. When feasible, documenting long-term vegetation, species, and hydrologic changes should become a part of research and monitoring programs on the refuges. Adjustments in land management direction may be necessary over the course of time to adapt to a changing climate.

The following paragraphs are excerpts from the 2000 report, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, produced by the National Assessment Synthesis Team, an advisory committee chartered under the Federal Advisory Committee Act to help the U.S. Global Change Research Program fulfill its mandate under the Global Change Research Act of 1990. These excerpts are from the section of the report focused upon the eight-state Midwest Region.

Observed Climate Trends

Over the 20th century, the northern portion of the Midwest, including the Upper Great Lakes, has warmed by almost 4 °F (2 °C), while the southern portion, along the Ohio River valley, has cooled by about 1 °F (0.5 °C). Annual precipitation has increased, with many of the changes quite substantial, including as much as 10- to 20-percent increases over the 20th century. Much of the precipitation has resulted from an increased rise in the number of days with heavy and very heavy precipitation events. There have been moderate to very large increases in the number of days with excessive moisture in the eastern portion of the basin.

Scenarios of Future Climate

During the 21st century, models project that temperatures will increase throughout the Midwest and at a greater rate than has been observed in the 20th century. Even over the northern portion of the region, where warming has been the largest, an accelerated warming trend is projected for the 21st century, with temperatures increasing by 5 to 10 °F (3 to 6 °C). The average minimum temperature is likely to increase as much as 1 to 2 °F (0.5 to 1 °C) more than the maximum temperature. Precipitation is likely to continue its upward trend, at a slightly accelerated rate; 10- to 30-percent increases are projected across much of the region. Despite the increases in precipitation, increases in temperature and other meteorological factors are likely to lead to a substantial increase in evaporation, causing a soil moisture deficit, reduction in lake and river levels, and more drought-like conditions in much of the region. In addition, increases in the proportion of precipitation coming from heavy and extreme precipitation are very likely.

Midwest Key Issues

1. Reduction in Lake and River Levels

Water levels, supply, quality, and water-based transportation and recreation are all climate-sensitive issues affecting the region. Despite the projected increase in precipitation, increased evaporation due to higher summer air temperatures is likely to lead to reduced levels in the Great Lakes. Of 12 models used to assess this question, 11 suggest significant decreases in lake levels while one suggests a small increase. The total range of the 12 models' projections is less than a 1-foot increase to more than a 5-foot decrease. A 5-foot (1.5-meter) reduction would lead to a 20- to 40-percent reduction in outflow to the St. Lawrence Seaway. Lower lake levels cause reduced hydropower generation downstream, with reductions of up to 15 percent by 2050. An increase in demand for water across the region at the same time as net flows decrease is of particular concern. There is a possibility of increased national and international tension related to increased pressure for water diversions from the Lakes as demands for water increase. For smaller lakes and rivers, reduced flows are likely to cause water quality issues to become more acute. In addition, the projected increase in very heavy precipitation events will likely lead to increased flash flooding and worsen agricultural and other non-point source pollution as more frequent heavy rains wash pollutants into rivers and lakes. Lower water levels are likely to make water-based transportation more difficult with increases in the costs of navigation of 5- to 40-percent. Some of this increase will likely be offset as reduced ice cover extends the navigation season. Shoreline damage due to high lake levels is likely to decrease 40- to 80-percent due to reduced water levels.

Adaptations

A reduction in lake and river levels would require adaptations such as re-engineering of ship docks and locks for transportation and recreation. If flows decrease while demand increases, international commissions focusing on Great Lakes water issues are likely to become even more important in the future. Improved forecasts and warnings of extreme precipitation events could help reduce some related impacts.

2. Agricultural Shifts

Agriculture is of vital importance to this region, the nation, and the world. It has exhibited a capacity to adapt to moderate differences in growing season climate, and it is likely that agriculture would be able to continue to adapt. With an increase in the length of the growing season, double cropping—the practice of planting a second crop after the first is harvested—is likely to become more prevalent. The CO₂ fertilization effect is likely to enhance plant growth and contribute to generally higher yields. The largest increases are projected to occur in the northern areas of the region, where crop yields are currently temperature-limited. However, yields are not likely to increase in all parts of the region. For example, in the southern portions of Indiana and Illinois, corn yields are likely to decline, with 10–20 percent decreases projected in some locations. Consumers are likely to pay lower prices due to generally increased yields, while most producers are likely to suffer reduced profits due to declining prices. Increased use of pesticides and herbicides are very likely to be required and to present new challenges.

Adaptations

Plant breeding programs can use skilled climate predictions to aid in breeding new varieties for the new growing conditions. Farmers can then choose varieties that are better attuned to the expected climate. It is likely that plant breeders will need to use all the tools of plant breeding, including genetic engineering, in adapting to climate change. Changing planting and harvest dates and planting densities, and using integrated pest management, conservation tillage, and new farm technologies are additional options. There is also the potential for shifting or expanding the area where certain crops are grown if climate conditions become more favorable. Weather conditions during the growing season are the primary factor in year-to-year differences in corn and soybean yields. Droughts and floods result in large yield reductions; severe droughts, like the drought of 1988, cause yield reductions of more than 30 percent. Reliable seasonal forecasts are likely to help farmers adjust their practices from year-to-year to respond to such events.

3. Changes in Semi-natural and Natural Ecosystems

The Upper Midwest has a unique combination of soil and climate that allows for abundant coniferous tree growth. Higher temperatures and increased evaporation will likely reduce boreal forest acreage and make current forestlands more susceptible to pests and diseases. It is likely that the southern transition zone of the boreal forest will be susceptible to expansion of temperate forests, which in turn will have to compete with other land use pressures. However, warmer weather (coupled with beneficial effects of increased CO₂), are likely to lead to an increase in tree growth rates on marginal forestlands that are currently temperature-limited. Most climate models indicate that higher air temperatures will cause greater evaporation and hence, reduced soil moisture, a situation conducive to forest fires. As the 21st century progresses, there will be an increased likelihood of greater environmental stress on both

deciduous and coniferous trees, making them susceptible to disease and pest infestation, likely resulting in increased tree mortality.

As water temperatures in lakes increase, major changes in freshwater ecosystems will very likely occur, such as a shift from coldwater fish species (e.g., trout) to warmer water species, (e.g., bass and catfish). Warmer water is also likely to create an environment more susceptible to invasions by non-native species. Runoff of excess nutrients (such as nitrogen and phosphorus from fertilizer) into lakes and rivers is likely to increase due to the increase in heavy precipitation events. This, coupled with warmer lake temperatures, is likely to stimulate the growth of algae, depleting the water of oxygen to the detriment of other living things. Declining lake levels are likely to cause large impacts to the current distribution of wetlands. There is some chance that some wetlands could gradually migrate, but in areas where their migration is limited by the topography, they would disappear. Changes in bird populations and other native wildlife have already been linked to increasing temperatures, and more changes are likely in the future. Wildlife populations are particularly susceptible to climate extremes due to the effects of drought on their food sources.

Climate Change and The Great Lakes

At various times throughout its history, the Great Lakes basin has been covered by thick glaciers and tropical forests, but these changes occurred before humans occupied the basin. Present-day concern about the atmosphere is premised on the belief that society at large—through its means of production and modes of daily activity, especially by ever-increasing carbon dioxide emissions—may be modifying the climate at a rate unprecedented in history.

The very prevalent “greenhouse effect” is actually a natural phenomenon. It is a process by which water vapor and carbon dioxide in the atmosphere absorb heat given off by the earth and radiate it back to the surface. Consequently the earth remains warm and habitable: 16 °C average world temperature rather than -18 °C without the greenhouse effect. However, humans have increased the carbon dioxide present in the atmosphere since the industrial revolution from 280 parts per million to the present 350 ppm, and some predict that the concentration will reach twice its pre-industrial levels by the middle of the next century.

Climatologists, using the General Circulation Model (GCM), have been able to determine the manner in which the increase of carbon dioxide emissions will affect the climate in the Great Lakes basin. Several of these models exist and show that at twice the carbon dioxide level, the climate of the basin will be warmer by 2–4 °C and slightly damper than at present. For example, Toronto's climate would resemble the present climate of southern Ohio. Warmer climates mean increased evaporation from the lake surfaces and evapotranspiration from the land surface of the basin. This in turn will augment the percentage of precipitation that is returned to the atmosphere. Studies have shown that the resulting net basin supply—the amount of water contributed by each lake basin to the overall hydrologic system—will be decreased by 23- to 50-percent. The resulting decreases in average lake levels will be from ½ to 2 meters, depending on the GCM used.

Large declines in lake levels would create large-scale economic concern for the commercial users of the water system. Shipping companies and hydroelectric power companies would suffer economic repercussions, and harbors and marinas would be adversely affected. While the precision of such projections remains uncertain, the possibility of their accuracy embraces important long-term implications for the Great Lakes.

The decline in lake levels and a warmer climate would also impact the islands in the Great Lakes. Vegetation would change on some islands as growing conditions evolve. Non-native species of plants and wildlife will pioneer onto some islands. Declining water levels will also expose more shoal habitat and beaches. In general, island sizes will increase, and some nearshore islands will become connected to the mainland. These connections to the mainland will speed the establishment of invasive plant species and provide corridors for predators to impact nesting waterbird colonies.

Island Types, Geology, and Soils

Island systems in the Great Lakes vary greatly in both diversity and complexity. While some island areas are characterized by several large islands with similar features, other areas contain hundreds of islands with variable shorelines and features but are highly integrated in ecological functions. Islands can be categorized by the following categories:

- **Resistant Rock** – Precambrian islands of basalt and granite dominate the northern shores of Lake Superior, Lake Huron, and the St. Lawrence River. Islands on the southern shore of Lake Superior are composed of Precambrian and Cambrian sandstones.
- **Non-resistant Rock** – Limestone and dolomite are represented on many islands in northern Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario.
- **Unconsolidated Sediments** – Islands, such as Turkey Island in the Detroit River can include fine sediments and cobbles that can accumulate on reefs in Lake Superior. Deltaic islands are at the mouths of rivers, especially the St. Clair River.
- **Anthropogenic** – Islands that are not natural and are artificially created can also include key biodiversity significance for birds and fish. Types of artificial islands include breakwaters, breakwalls, and caution points.
- **Floating** – Floating islands can be characterized as marsh ‘mats’ that can occur in some wetlands.

Islands of the Great Lakes support globally rare ecosystems called alvars. Alvars are open areas of flat limestone or marble bedrock with little or no soil and a usually sparse covering of herbs and shrubs. Trees are either absent or sparse. The vegetation and animals of alvars are distinctive—only certain species can withstand the extreme environmental conditions. Alvars typically have poor drainage of rain and snow; so they are flooded in the spring and dry later in the summer. Alvars with exposed bedrock absorb heat from the sun and become extremely hot in the summer. A high proportion of the alvars that exist in the world is present only in the Great Lakes islands and coastal areas.

Archeological and Cultural Values

Gravel Island NWR (Horicon)

Established in 1913 and consisting of Gravel and Spider Islands, Gravel Island NWR has not been subjected to a comprehensive cultural resources field survey. There are no known cultural

sites on the islands, and because of their size and topography the likelihood of significant sites seems low.

Green Bay NWR (Horicon)

Green Bay NWR consists of three islands, Hog, Pilot, and Plum. No cultural resources survey has been conducted on Hog Island, and the likelihood of finding significant sites on the island seems low.

Pilot Island was acquired in 2007. It has a standing 1858 lighthouse/keeper's quarters and a circa 1900 fog signal building. Both were placed on the National Register of Historic Places (NRHP) under one nomination on November 21, 1983 (Reference # 83004279). The lighthouse/keeper's quarters is in fair to good shape but shows signs of increasing wear on the light-colored brick façade and in the wooden doors/windows. After some interior water damage, the roof was replaced in 2009. The U.S. Coast Guard (USCG) maintains the light. The fog signal building is in fair to poor shape due to the collapse of the roof, which threatens to severely damage the brick superstructure. Removing, and perhaps replacing, the collapsed roof and shoring up the walls should be a top cultural resources priority.

The remaining portion of Pilot Island has not been subjected to a cultural resources survey and other sites are possible on those areas with intact soil development. However, the island has become a busy nesting ground for cormorants and gulls, which has killed off most of the vegetation. There are three or more shipwrecks in one location in 20 to 50 feet of water just off Pilot Island to the northwest. It is very popular place for local divers. Placed on the NRHP on March 19, 1992 (Reference #92000103), the site is not currently on Service lands. However, it is possible that parts of the site may wash up on Pilot Island sometime in the future.

Plum Island was added to the Green Bay NWR along with Pilot Island in 2007. Plum Island was reserved from the public domain in 1848 for lighthouse purposes and contains a number of historic buildings and related structures as well as archaeological sites. The 1897 rear range light was placed on the NRHP on July 19, 1984 (Reference #84003659). Nine standing buildings/structures and one site, including the front range light (1964), the original keeper's dwelling (1897), a fog signal building (circa 1900), the USCG lifesaving station (1896), and a boathouse (circa 1930), as well as the pier and breakwater, a flagpole, an outbuilding, a radio tower, and the unimproved access road/path connecting the north and south side of the island were added to the NRHP as a district on June 24, 2010 (Reference #10000385). These NRHP sites on Plum Island are in fair to good condition. The NRHP sites on both Plum and Pilot Islands are undergoing stabilization and restoration work under a partnership agreement with the Friends of Plum and Pilot Islands (FOPPI).

Five additional archaeological sites are known on Plum Island. These include the undressed fieldstone foundation of the original 1848 Port des Morts Lighthouse, the Hanson Site (a Middle Archaic Period Old Copper Culture copper knife findspot), the Plum Island Light Site (a residential dump associated with the light keeper's dwelling), the North Shore Site (a lithic and historic artifact scatter), and the Station Dump Site (the location of a dump associated with the lifesaving station). Two historic Native American (possibly Potawatomi) sites are suspected to exist on Plum Island but have never been confirmed by field survey. These include a campsite and corn garden beds. It seems likely that there are additional archaeological sites yet to be found if a comprehensive field survey is conducted.

At least six shipwrecks have been recorded just off the shores of Plum Island. Items from some of these sites appear to have been washing up on the island. There is also evidence of paleontological fossils within the limestone bedrock of the island.

Harbor Island NWR (Seney)

Acquired in 1983 and consisting of only Harbor Island, past human influences to the vegetation of Harbor Island NWR are still found. According to records at Seney NWR, no cultural surveys have been conducted on the island. At acquisition, at least one 1950s or 1960s era house was removed from the island. Based on the size of the island, its location relative to other islands, the vegetation present and other indicators, prehistoric and historic sites are likely to be present.

Huron NWR (Seney)

Established in 1905, Huron NWR is the oldest refuge in the Midwest Region. The refuge encompasses eight islands including Lighthouse (West Huron), McIntyre (East Huron), Gull (Gull Rock), Cattle, and four small unnamed islands.

The most visible cultural resources on Huron NWR are the Huron Islands Lighthouse and Assistant Keeper's Quarters. The lighthouse, consisting of a keeper's residence and integrated light tower, was originally constructed in 1868 on Lighthouse Island as a navigational aid. It was fully automated in 1972 and was essentially abandoned along with the 1934 Assistant Keeper's Quarters and the other facilities.

Other facilities on the island include a brick privy (1898), an oil house (1896), a pre-1914 barn site, a fog signal building (1898), a 1961 barracks, pre-1966 landing, dock and boathouse on the northwest tip of the island; quarry, boat, and breakwater (1877 to 1892) on the southwest side of island, and a boathouse (1913), as well as a small support building and a new dock installed in 2009. Additional facilities on Lighthouse Island that were associated with lighthouse operations prior to automation include: a 1-mile long footpath—750 feet of which are cement walkway and stairs, a 300 foot tramway, and two footbridges.

Only the lighthouse itself was placed on the NRHP on September 2, 1975 (Reference #75000955). But, as of December 7, 2004, the other facilities associated with the lighthouse, except perhaps the barracks (less than 50 years old at the time of review), were considered to be eligible for listing on the NRHP by the Service. The preservation and maintenance of the NRHP site and associated structures are being addressed under a Memorandum of Understanding with the Huron Island Lighthouse Preservation Association, which is currently in place until July 26, 2019.

Lighthouse Island is the only island with visible buildings/structures. However, there is reported to be a small dilapidated cabin and associated brick pile somewhere on the western end of McIntyre Island. There are no known archeological sites on any of the islands, mainly because no formal surveys have been performed on the refuge. However, there is moderate potential for archeological site discovery on the two largest islands, Lighthouse and McIntyre, and low potential on Cattle and Gull Islands. The four unnamed islands are small rocky outcrops with essentially no potential for finding archaeological sites.

Michigan Islands NWR (Seney, Lake Michigan Islands; Shiawassee, Lake Huron Islands)

Established in 1947, the Michigan Islands NWR currently consists of four islands in Lake Michigan including Gull, Hat, Pismire, and Shoe and five islands in Lake Huron including Thunder Bay, Sugar, Scarecrow, Big Charity, and Little Charity. An overview study of archeological and cultural values on the islands in both Lakes Michigan and Huron (except Big Charity and Little Charity) was conducted by Commonwealth Cultural Resources Group, Inc. in 2000 (Robertson et al., 2000). The Commonwealth report was forwarded to the Michigan State Historic Preservation Officer in October 2000.

A summary of the findings for the Lake Michigan islands indicates that there are no previously recorded archeological sites on Hat, Shoe, or Pismire Islands. Gull Island, according to General Land Office survey notes, had a fishing village, four log shanties, and a few Native American wigwams on the east side of the island. There are no existing, previously recorded, historical above-ground resources on any of the four islands. Hat, Shoe, and Pismire Islands are rated as having a low potential for archeological sites due to their small size and limited elevation above the lake. Gull Island is rated as having a high potential for both prehistoric and historic archeological sites on habitable portions of the island.

Except for Scarecrow Island, the islands of Thunder Bay and Sugar within Thunder Bay of Lake Huron are known to contain standing structures and archaeological sites. Thunder Bay Island contains an 1832 standing lighthouse and associated buildings on the southern tip of the island. While on the NRHP (Reference #84001371), these structures are *not* on Service lands and are managed by the Thunder Bay Island Preservation Society. Also not on Service property is an extant USCG lifesaving station/boathouse in the shallows on the west side of the island.

However, there are five other known archaeological sites within Service lands on Thunder Bay Island. These include a portion of an archaeological complex associated with the 1832 lighthouse and its associated buildings, a 19th century lifesaving/fishing house complex, the 19th century Harwood's fish house, the 19th century Hood's fishing cooperage (not field confirmed however), a 20th century dump site. On Sugar Island, archaeologists have identified two archaeological sites including the 19th/20th century McDonald/Paxton's Fish House and an unnamed 19th century fish house complex. While Native American use of both islands is known historically, no sites associated with their use can be confirmed at this time. However, the probability of finding additional archaeological sites on these two islands remains high. Conversely, the probability of finding archaeological sites on Scarecrow Island is low.

Within Saginaw Bay of Lake Huron are the islands of Big Charity and Little Charity. The Service owns all of Little Charity but not all of Big Charity. No known sites are located on Little Charity Island and the probability of finding any sites seems low. Big Charity Island has a light tower with attached keeper's house on the northwest tip of the island. However, currently the house is in private hands, and the tower is owned by The Nature Conservancy (TNC). The Service has a three-acre easement with the conservancy, which excludes the tower (along with a 100-foot buffer). Therefore, to clarify, neither the house nor the tower are on Service property. Also, not on Service property is a long dock complex dredged into the island, which provides boat access for visitors. There are no known archaeological sites on the island. However, if a comprehensive field survey was conducted it seems likely that sites would be found.

Social and Economic Context

Currently the Great Lakes basin is home to more than one-tenth of the population of the United States and one-quarter of the population of Canada. Some of the world's largest concentrations of industrial capacity are located in the Great Lakes Region. Nearly 25 percent of the total Canadian agricultural production and 7 percent of the American production are located in the basin. The United States considers the Great Lakes a fourth seacoast, and the Great Lakes Region is a dominant factor in the Canadian industrial economy.

Agriculture

Early settlers were attracted to the Great Lakes Region because of its agricultural lands. Dairy and meat production for local consumption became the dominant agriculture. As time went by, the growing urban populations created a demand for specialty crops such as fruits, vegetables, and tobacco. Today, corn, soybeans, and hay are the primary crops in the Great Lakes Region. The northwestern region of Michigan's Lower Peninsula is known for its cherry production.

Commercial and Sport Fisheries

Sport and commercial harvest fisheries are important industries in the Great Lakes Region. Commercial fishing began in about 1820 and has increased ever since. About 65 million pounds of fish per year are harvested from the lakes, contributing more than \$1 billion to the Great Lakes economy. Primary commercial catches include whitefish, smelt, walleye, and perch, while sport anglers prefer salmon, steelhead, walleye, lake trout, perch and bass. The commercial fishery in the region has been declining, however, due to over-fishing, pollution, habitat destruction, and the introduction of invasive species.

Sport fishing is a significant tourist attraction, which helps to build the economy of the Great Lakes Region. Sport fishing contributes \$4 billion to the region's economy. Sport fishing has also been responsible for the unintended introduction of some invasive species. Exotic fish such as salmon were purposely introduced to help boost the sport fishing industry.

Shipping

The history of shipping practices in the Great Lakes begins in 1825, when the Erie Canal was used to carry settlers west and to carry freight east. The St. Lawrence Seaway was completed in 1959 and allowed ocean vessels access to the Great Lakes for shipping purposes. More than 200 million tons of cargo is shipped every year through the Great Lakes. The three main cargoes are iron ore, coal, and grain. Other modes of transportation such as trucking and railroads now compete with shipping in the Great Lakes, and thus shipping has not expanded much recently. Historically, shipping has been the vector for most of the invasive species in the Great Lakes.

Recreation and Tourism

The Great Lakes provide a popular tourist attraction. The region is home to many park systems, conservation and wilderness areas, and beaches. Fishing, diving, and boating are a few of the many recreational activities in the region. One-third of all registered boaters in the United States reside in the Great Lakes basin. Recreation and tourism serve as important economic

contributors to many parts of the Great Lakes Region. Boats, marinas, resorts, restaurants, and the production and sale of outdoor sports equipment all contribute to the region's economy.

Industry

Industrialization of the Great Lakes Region began in the early 20th century. There were many harmful environmental impacts of early industrialization, but many are being assessed and fixed today. Historically, the major industries in the Great Lakes Region have produced steel, paper, chemicals, automobiles, and other manufactured goods. Auto manufacturing and steel production continue to be the primary industries in the region.

Environmental Contaminants

More than 400 different man-made chemicals have been detected in Great Lakes biota. Research and monitoring have focused on heavy metals such as mercury, organochlorine pesticides such as dichlorodiphenyltrichloroethane (DDT), dieldrin, and mirex; and other chlorinated organics such as polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), dioxins, and furans. All of these contaminants have been detected in Herring Gull eggs and are routinely measured. Today, the Herring Gull continues to be recognized as one of the major indicator species for environmental contamination in the Great Lakes.

Levels of some contaminants in Herring Gull eggs have remained relatively stable throughout the 1990s, with no significant changes observed in levels of PCBs and DDE at some Great Lake colonies. A few significant decreases in levels of dieldrin and heptachlor epoxide have been noted during this period.

This relative "steady state" in contaminant levels indicates that these chemicals are still being released and/or recycled through the Great Lakes ecosystem by individuals, households, municipalities, industry, and/or agriculture. Atmospheric deposition, agricultural land runoff, the slow movement (leaching) of discarded stocks of pesticides and other chemicals from landfill sites and agricultural soils into the Great Lakes via groundwater, and the resuspension of contaminated lake/river sediments, continue to be major indirect sources of contamination. These indirect sources are difficult to control and contribute slow, but continual, contaminant inputs into the Great Lakes ecosystem. Atmospheric deposition has become an increasingly significant route of entry of contaminants into the Great Lakes ecosystem, especially in the Upper Great Lakes. On Lake Superior, for example, up to 90 percent of toxic contaminants entering this lake comes from the atmosphere in the form of precipitation.

While concentrations of some persistent toxic substances have been significantly reduced in the Great Lakes over the past 30 years, toxins such as polychlorinated biphenyls (PCBs) are still present above levels considered safe for humans and wildlife warranting fish consumption advisories in all five Great Lakes. In addition, chemicals of emerging concern, such as pharmaceuticals, are now being detected in the Great Lakes.

Natural Resources

Fish, Wildlife, and Plant Communities

Gravel Island NWR

Gravel Island

Gravel Island is a small, 4-acre flat-topped island with an elevation of approximately ten feet. Gravel Island has no permanent vegetation due to periodic over washing by waves and ice during high-water years. Jedziewicz (2001) reported no vascular plants present during his visit to the island in July 1999. However, low-water years allow several plants to pioneer on Gravel Island. In August 2004, refuge staff recorded 21 species, including American sea rocket (*Cakile edentula*), a state species of concern. Besides sea rocket, vegetative composition of Gravel Island is very similar to that of Spider Island.

Gravel Island is covered almost entirely by a matrix of Herring Gull and Ring-billed Gull nests except for the northeast portion of the island, where state endangered Caspian Terns nest. With 1,390 nests in 2012, this is the largest Caspian Tern colony in the Great Lakes Region. Common Terns and Great Black-backed Gulls have also been observed nesting in recent years. Like Spider Island, Gravel Island provides important habitat for migrating birds. The eastern shores of Gravel Island provide important shorebird habitat during low-water conditions.

Spider Island

Spider Island is a 23-acre island with an elevation of about 14 feet at the highest point. Spider Island was surveyed in 1905. At that time, the island was dominated by white cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), and white birch (*Betula papyrifera*), with boreal forest and Great Lakes shoreline understory species such as blue flag iris (*Iris virginica*), wood lily (*Lilium philadelphicum*), and Indian paintbrush (*Castilleja coccinea*) (Jedziewicz, 2001). By 1966, nesting Ring-billed and Herring Gulls and Great Blue Herons had reduced the forest to only a few standing trees, abundant Canada yew (*Taxus canadensis*) with the shrubs, red-osier dogwood (*Cornus stolonifera*), red raspberry (*Rubus sp.*), and red elderberry (*Sambucus racemosa*). The activities of the nesting gulls, herons, and later Double-crested Cormorants reduced the white cedar, tamarack, and white birch overstory of the mid-1900s to a single snag in 2009.

Today, Spider Island is mostly a mixture of exotic herbs. A few sandbar willow (*Salix exigua*) and eastern cottonwood (*Populus deltoides*) saplings are pioneering in the low-lying area near the north end of the island. Common mallow (*Malva neglecta*), tumble mustard (*Sisymbrium altissimum*), and wormseed mustard (*Erysimum cheiranthoides*) are the dominant species on the Spider Island.

A large Double-crested Cormorant colony interspersed amongst a matrix of Herring Gull nests covers most of the island. Waterfowl use is limited since there is very sparse vegetation, but this vegetation does provide some cover for scattered nesting of species like Mallards, Black Ducks, and Canada Geese. Killdeer, Ring-billed Gulls, and the non-native Mute Swan have also been observed nesting on the island.

Spider Island provides valuable rest stops for migrating birds traveling across open water. Approximately 6 acres of fissured, depressed dolomite pavement support shallow pools, which warm and provide food for migrating shorebirds. Ruddy Turnstones, Piping Plovers, Dunlins, Semi-palmated Sandpipers, Least Sandpipers, Pectoral Sandpipers, and Sanderlings feed in these areas along the eastern shore of the island. Additionally, Hooded Mergansers, Blue-winged Teal, Common Mergansers, Mallards, and American Wigeon were observed feeding

and loafing on these shorelines during fall migration. Horned Larks, Savannah Sparrows, and American Pipits have also been observed resting on the island.

Green Bay NWR

Hog Island

Two-acre Hog Island rises approximately 20 feet above lake level. Remnant forest still exists on the flat top of the island; however, due to colonial bird activity many overstory trees are dead or stressed and the understory is dominated by invasive or weedy species. A few white birch (*Betula papyrifera*) and chokecherry (*Prunus virginiana*) are in the overstory. Red elderberry (*Sambucus racemosa*) forms a dominant and nearly impassable shrub layer, some Canada yew (*Taxus canadensis*) is still present. Intertwined among the elderberry or interspersed in open areas is a dense herbaceous mixture of weedy or exotic species; fringed bindweed (*Polygonum cilinode*) and American black currant (*Ribes americanum*) dominate.

Limestone ledges, which form broad steps around three-fourths of the island are barren. The remaining quarter of the shoreline has slopes that are covered with vegetation between the heavy woody cover and the bare wave-washed rocks of the lakeshore. A long gravel spit on the northwest corner of the island protrudes northwestward, branching out at the tip.

Hog Island supports a nesting colony of Herring Gulls, which nest around the perimeter of the island on the open areas. Great Blue Herons, Black-crowned Night-Herons, and Great Egrets nest in trees on the island interior, and Red-breasted Merganser nests can be found hidden in the limestone ledges. Sandbar willows (*Salix exigua*) on the gravel spit provide cover for nesting waterfowl like Mallards, Black Ducks, and Canada Geese. Recently, Double-crested Cormorants have attempted to nest on the island, and active control measures are taken to remove the birds and prevent change to woody vegetation.

Pilot Island

In 2007, 3.7-acre Pilot Island was added to the Green Bay NWR. This is the site of a formerly-occupied lighthouse (est.1851) and contains a variety of native and ornamental vegetation. Pilot Island was surveyed in the 1970s; at that time the vegetation was composed of red-osier dogwood (*Cornus stolonifera*), lilacs (*Syringa vulgaris*), Canada yew (*Taxus canadensis*), white cedar (*Thuja occidentalis*), willow (*Salix sp.*), white birch (*Betula papyrifera*), and poison ivy (*Toxicodendron radicans*) (Jedziewicz, 2001). By the 1980s, the activities of nesting gulls, herons, and later Double-crested Cormorants drastically changed the vegetative composition. Vegetation today consists of a shrub layer dominated by chokecherry (*Prunus virginiana*) and Red elderberry (*Sambucus racemosa*). Intertwined among the elderberry or interspersed in open areas is a dense herbaceous mixture of weedy or exotic species. Bittersweet nightshade (*Solanum dulcamara*), catnip (*Nepeta cataria*), and common mallow (*Malva neglecta*) are the most frequently occurring species on Pilot Island.

A large Double-crested Cormorant colony covers much of the island, nesting in the formerly forested area. Hundreds of Herring Gull nests are on the rocks and boulders of the shoreline and on the open area in the center of the island. The vegetation provides some cover for scattered nesting waterfowl species like Red-breasted Mergansers, Mallards, and Canada Geese.

Plum Island

Plum Island was added to the Green Bay NWR along with Pilot Island in 2007. Plum Island was reserved from the public domain in 1848 for lighthouse purposes and contains a number of historic buildings and related structures including the front and rear range lights, the original keeper's quarters, a fog signal building, the USCG station, and a substantial boathouse and dock.

The island is 325 acres, has an elevation of 620 feet, and is surrounded by rocky shoals. Plum Island was visited in 1974; at that time old-growth sugar maple and basswood forest existed in the interior with a dense Canada yew understory. In addition, no deer were reported (Huntoon, 1977). The forest has since been impacted by heavy selective logging in the 1980s and deer herbivory. The logging left the canopy open, and pioneering species such as red raspberry and invasive species have colonized these areas. The east and south coast bluffs are dominated by white cedar. A 15-acre sedge meadow and shallow emergent wetland are on the northeastern part of the island. The wetland is directly connected to the lake and experiences the same changes in water levels. The rising and falling of the water on a seasonal basis and over longer periods creates a dynamic system of change. In low-water years, a calcareous meadow dominated by brook lobelia (*Lobelia kalmia*), rushes (*Juncus spp.*) and St. Johnswort (*Hypericum L*) is exposed. The sedge meadow is dominated by bluejoint (*Calamagrostis canadensis*) and tussock sedge (*Carex stricta*). The federally threatened dwarf lake iris (*Iris lacustris*) is present along a strip of boreal forest along the northeast shoreline.

Migrating and Breeding Birds – Refuge staff has detected more than 70 species during the breeding season on Plum Island. The ubiquitous American Redstart has been observed more than twice as often as the next most common species (in order: House Wren, Indigo Bunting, Red-eyed Vireo, Red-winged Blackbird). Canada Geese, Wood Ducks, Mallards, Bald Eagles, American Woodcock, and Northern Flicker are among the Midwest Region (Region 3) conservation priorities that use Plum Island during the breeding season.

Plum Island also provides valuable rest stops for birds migrating across open water. In early May, densities approaching 60 birds/hectare (up to 17 species/hectare) have been recorded in some forest habitats. Seven species of Wood Warblers and up to 25 Yellow-rumped Warblers per tree, in some locales, have been observed.

Mammals – Refuge staff has conducted trapping efforts to obtain a baseline inventory of mammals. The only species captured was deer mice. White-tailed deer are present and are seen intermittently, and raccoon tracks have been observed on the island. It does not appear that insectivores, lagomorphs, small carnivores, or other rodents have been able to successfully colonize the island, although it should be large enough to support at least some of these species.

Reptiles and Amphibians – Coverboard and call surveys have been conducted on Plum Island to obtain a baseline inventory of reptiles and amphibians. Six species were observed during coverboard sampling: common garter snake, brown snake, western fox snake, northern ringneck snake, blue-spotted salamander, and central newt. A strong chorus of northern spring peepers along with several individual American toads and eastern gray tree frogs were recorded on the call surveys. Incidental to other work on Plum Island, staff observed several northern water snakes. American toads on Plum Island exhibit island gigantism phenomenon; they are much larger in comparison to their mainland relatives.

Fish – According to the *Atlas of the Spawning and Nursery Areas of the Great Lakes Fishes*, the shoals surrounding the refuge islands are historic spawning beds for lake trout and several other Great Lakes fish species. The island reefs and shorelines provide coastal habitat required by these species to complete their lifecycles. Carp spawn by the hundreds in the Plum Island harbor and can be seen in high-water years in the Plum Island wetland.

Harbor Island NWR

During past observations, 149 species of fauna (16 mammal species, 7 herptofaunal species, and 126 bird species) have been observed (see Appendix D). Fourteen Region 3 Birds of Concern Species have been observed on or near Harbor Island NWR:

American Bittern, Black-crowned Night-Herons, Trumpeter Swan, Canada Goose, American Black Duck, Lesser Scaup, Wood Duck, Mallard, Blue-winged Teal, Bald Eagle, Common Tern, Black Tern, Whip-poor-will, and Northern Flicker. Of special note is that in 1965–1978 Louis Benua visited Harbor Island and nearby islands and

noted a number of large predators, including the federally threatened Canada Lynx (*Lynx canadensis*). Although no records of black bear exist in refuge files, this species, too, is thought to use the island.



Harbor Island NWR

Wildlife harvest regulations for deer and bear on the refuge are the same as State of Michigan regulations, and management of the white-tailed deer populations is of primary concern. A 1978 pre-acquisition survey indicated a year-round deer population and island vegetation was showing the stress imposed by overabundant deer. Other mammals reported include snowshoe hare, beaver, little brown bat, red bat, woodland deer mouse, red-backed vole, and mink. Gray wolves (*Canis lupus*) from St. Joseph Island, Ontario hunt the island during the winter months. Several other species have been reported on Bald Island just east of Harbor Island and are expected to be visitors to the refuge.

During past observations, 127 species of flora have been observed (Appendix E). Four major vegetative associations are on the island. Areas containing northern white cedar and balsam fir predominate. The next most prevalent community is a mixed upland community containing red oak, sugar maple, trembling aspen, white ash, and paper birch. The red oak, in particular, is quite impressive, growing very well on the soils of the island. Marsh is around the interior bay and along the northeast side of the island. Some acreage of open field is just inland from the bay. The species composition is unknown but likely contains timothy, Canada bluegrass, and other species based on similar abandoned agricultural sites in the Upper Peninsula. Figure 3-1 shows the major vegetative associations and is adapted from the unpublished plant community survey by Selzer (2000).

Figure 3-1: Vegetative Associations, Harbor Island NWR (2009)



Huron NWR

In post-glacial times, the islands that now comprise Huron NWR have been modified by changes in water levels and isostatic rebound following glacial retreat. Thus, the islands, and their biota are relatively young, on the order of 8,000- to 15,000-years before present (Soule, 1993). Most wildlife use at Huron NWR involves migratory birds, especially forest-dependent species. However, a small mammal community is present. Past surveys (e.g., Corin, 1976) have documented 93 species of fauna (79 bird species, 8 mammal species, 6 herptofaunal species). Eight Region 3 Birds of Concern Species have been documented on the Huron Islands: Canada Goose, American Black Duck, Mallard, Bald Eagle, Peregrine Falcon, Northern Flicker, Canada Warbler, and Bobolink (which is likely a migrant).

Four islands of Huron NWR are vegetated; the remaining islands are barren outcrops of granite. Vegetation surveys have documented 157 species of flora. The vegetated islands are generally characterized by shallowly rooted trees and exposed granite. Vegetation is a boreal transition type made up of balsam fir, white pine, red pine, white spruce, red maple, bigtooth aspen, and paper birch. Much of the balsam fir is decadent and contributes to a significant fuel loading on Huron Island NWR. The understory contains cherry species, balsam fir regeneration, Canada yew, various woody shrubs, grasses, and forbs. There are a few areas on East Huron that contain small sphagnum bogs with an occasional black spruce. Only Huron, East Huron, Cattle, and Gull Rock Islands have substantial vegetation.

Michigan Islands NWR (Seney)

During past observations, 69 bird species and two mammal species (deer mouse, *Peromyscus maniculatus*; snowshoe hare, *Lepus americanus*) have been observed at Michigan Islands NWR. Of these 69 bird species, nine are Region 3 Birds of Concern Species: Common Loon, Caspian Tern, American Bittern, Black-crowned Night-Heron, Canada Goose, Lesser Scaup, Mallard, Bald Eagle, Northern Harrier, and American Woodcock.

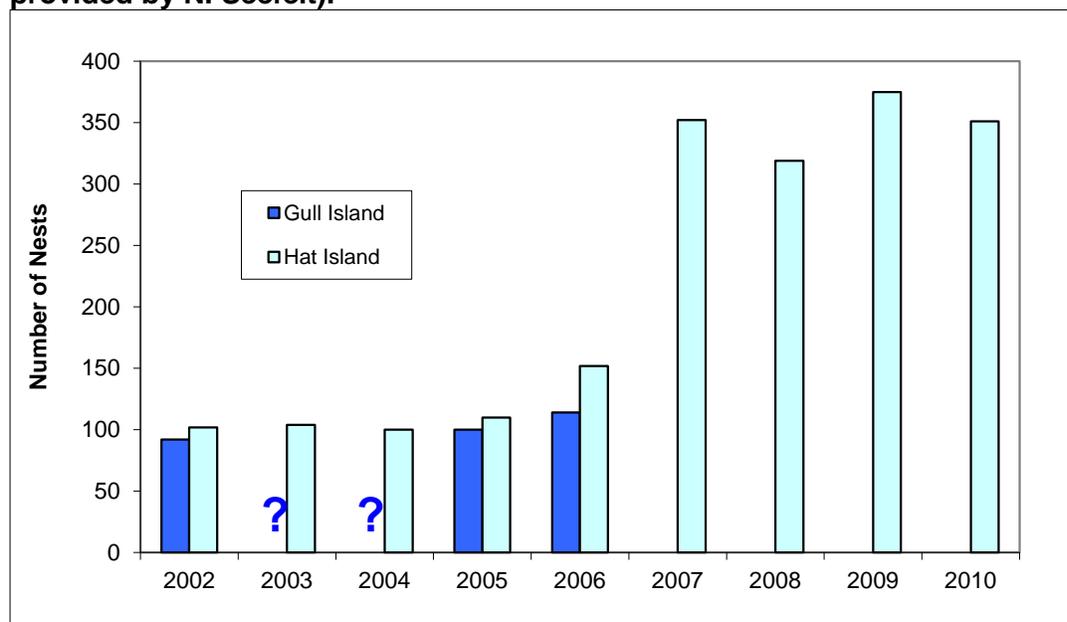
Each of the islands of Michigan Islands NWR support breeding colonial waterbirds. Herring Gulls nest on Shoe Island each year; intermittently, Ring-billed Gulls nest at this location. Pismire Island supports both species of gulls and Double-crested Cormorants. Gull and Hat Islands host the greatest numbers and diversity of species. Over the past ten years, these islands have supported both Ring-billed and Herring Gulls, Great Blue Herons, Black-crowned Night-Herons, Double-crested Cormorants, Common Terns, and Caspian Terns. Other avian species are breeding on these islands, including shorebirds (Spotted Sandpipers and Killdeer), waterfowl and a variety of landbirds. Due to its larger size and more diverse habitats, Gull Island supports a greater diversity of landbirds, including raptors and songbirds.

Michigan Islands NWR has exceptional value to colonial nesting waterbird conservation in the Great Lakes Region and specific islands have been proposed as an Important Bird Area by the National Audubon Society for species such as Black-crowned Night-Heron (Gull Island) and Caspian Tern (Hat Island). And not surprisingly, many past studies have been conducted on population biology and the natural history of species inhabiting these islands, such as Caspian Tern (Shugart et al., 1979; Cuthbert, 1985; Cuthbert, 1988; Wires and Cuthbert, 2000) and Double-crested Cormorant (Cuthbert, 2002; Seefelt and Gillingham, 2004, 2006a,b, 2008; Wires and Cuthbert, 2006).

According to Hatt et al. (1948) an ornithologist, Charles L. Cass, visited Shoe Island in July 1896 and found nesting Caspian Terns at this site. Caspian Terns have nested on Shoe Island

or nearby Hat Island since Cass' first report, often changing islands in response to fluctuating water levels. In the late 1980s, 437 nesting pairs were documented on Hat Island (Scharf and Shugart, 1998), and this site has been consistently used through the present. Hat Island is currently a productive colony and terns have been documented to fledge at this location most years since 2002 (figure 3-2). In addition, Gull Island has supported nesting Caspian Terns between 2002 and 2006; terns were not as successful breeding at this location. As an overview, between 1977 and 1997, Caspian Terns numbers increased in the Great Lakes (Cuthbert et al., 2003). However, more recent censuses indicate that the population in Lake Michigan is declining (Cuthbert and Wires 2008), thus exemplifying the importance of Hat Island. Caspian Terns are currently listed as threatened in Michigan.

Figure 3-2: The number of breeding Caspian Tern pairs on Gull and Hat Island (data provided by N. Seefelt).



Double-crested Cormorants were first recorded nesting on Gull, Hat and Pismire Islands in 1984, and these sites have been used consistently through the present (Ludwig, 1984; table 3-1). Hat Island has become the most important colony for this species in the archipelago, and overall population fluctuations are consistent with this site's breeding activity. The peak population in the archipelago was in 1997 (Cuthbert et al., 2003); however, the Michigan Islands NWR supported its largest number breeding cormorants in 2007, when no other archipelago sites were active. During this same year, population control measures, including both egg-oiling and shooting adults, began on refuge Islands and has continued to the present day. These activities have the potential to impact co-nesting species on these islands, as well.

Table 3-1: The number of Double-crested Cormorant pairs breeding on Gull, Hat and Pismire Islands, 1984–2010 (data provided by N. Seefelt)

	Gull	Hat	Pismire	Total
1984 ^a	139	54	57	250
1989 ^b	260	294	35	589
1997 ^c	1887	4617	383	6887
2000	1532	4917	987	7436
2001	2013	4511	1035	7559
2002	957	3659	615	5231
2003	435*	7341	1164	8940
2004	1274	3515	725	5514
2005	2332	5289	838	8459
2006	2464	5776	512	8752
2007	2821	7942	660	11423
2008	1817	6800	300	8917
2009	1319	5480	272	7071
2010	613	3721	157	4491

^a Nest count data from Ludwig (1984)
^b Nest count data from Scharf and Shugart (1998)
^c Nest count data from Cuthbert *et al.* (1997)
* Partial ground count completed by Seney NWR personnel

Black-crowned Night-Herons are a more elusive species to census. However, this species had been documented to nest in small numbers (6 to 7 pairs) on Hat Island between 2005 and 2008. In addition, these herons have nested among the tree-nesting cormorants on the southeast, south and western shore on Gull Island. At minimum, 20 to 24 pairs have consistently nested on Gull Island between 2005 and the present. Young have fledged from both islands.

Vegetation

During past observations, 47 species of flora have been documented, with most work done at Gull Island (B. Leuck, Centenary College of LA, ongoing studies) and Hat Island (Gates, 1950). Historically, Gull and Hat Islands (and to a lesser extent Pismire Island) were the only islands that supported significant vegetation. However, now (due to disturbance by Double-crested Cormorant) only Gull Island has any significant live woody vegetation. Species on this island

include: paper birch, red maple, sugar maple, northern white cedar, balsam fir, white spruce, and trembling aspen. The groundcover is dominated by Canada yew. Mountain ash, red osier dogwood, elderberry, willow, and juniper are also present. On Hat Island there is mostly brush with some grass. Forest vegetative cover is limited to mostly standing dead trees due to effects of some nesting waterbirds. Pismire Island is covered in brush, with scattered herbaceous vegetation. Shoe Island, at high-lake levels, is virtually submerged, and at low-lake levels appears as a gravel bar with a few clumps of grass and herbs.

Michigan Islands NWR (Shiawassee)

Big Charity

The Charity Islands are located near the mouth of Saginaw Bay, approximately 7 miles from the mainland. Big Charity is 250 acres in size and is heavily wooded, with an 11-acre lake in the center. Bald Eagles and neotropical songbirds nest on the island, and Pitcher's thistle (federal and state threatened) is on the island.

Little Charity

Little Charity Island is an undeveloped 5.4-acre island located approximately 2 miles from Big Charity. The island is wooded, and colonial waterbirds such as Double-crested Cormorants, egrets, herons, and gulls nest throughout the island.

Scarecrow Island

Scarecrow Island is a 9-acre island located in Lake Huron at the southern limit of Thunder Bay. This limestone bedrock island is covered with boulders and gravel, with a minimal soil layer supporting shrubs, scattered forbs, and a few snags, which are used by Double-crested Cormorants, Black-crowned Night-Herons, Common Terns, Caspian Terns, and Herring Gulls for nesting. Ring-billed Gulls, terns, shorebirds, and waterfowl also nest on Scarecrow Island.

Sugar Island

Sugar Island is 140 acres and is located east of Thunder Bay Island. 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, a limestone pavement alvar, scattered boulders, and freshwater, coastal wetlands. Alvars are naturally open landscapes formed of a thin layer of soil over limestone, and are found only in the Great Lakes Region, the Baltic, and in Northern Ireland. Sugar Island has a dense interior conifer forest. Tree species include black cherry, white cedar, balsam fir, tamarack, white pine, white spruce, balsam poplar, quaking aspen, and white birch. Songbirds, shorebirds, waterbirds, waterfowl, and raptors have been observed on the island.

Thunder Bay Island

The island supports a rare endemic Great Lakes alvar ecological community of national and global significance. Alvar ecosystems are grassland, savanna, and sparsely vegetated rock barrens that develop on flat limestone or dolomite bedrock where soils are very shallow. Plant communities include little bluestem alvar grassland, alvar pavement, and a limestone bedrock lakeshore. The thin layer of soil associated with alvar communities supports a dense interior

forest of American yew, white cedar, spruce, fir, and birch. The shoreline includes cobble beach and freshwater coastal wetlands. American Redstarts, Ring-billed Gulls, Herring Gulls, terns, and America Black Ducks nest on the island.

Associated Plans and Initiatives

Michigan's Wildlife Action Plan

In 2005, Michigan's Wildlife Action Plan (WAP) was completed to better manage wildlife species and their habitats of "greatest conservation need" in Michigan. 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. Members of the partnership include the Michigan Department of Natural Resources (DNR), the U.S. Fish and Wildlife Service, The U.S. Forest Service, TNC, Michigan Natural Features Inventory, academics from several Michigan universities, as well as many other agencies and conservation organizations.

The action plan:

- provides an ecological, habitat-based framework to aid in the conservation and management of wildlife;
- identifies and recommends actions to improve habitat conditions and population status of species with the greatest conservation need, which are those species with small or declining populations or other characteristics that make them vulnerable;
- recommends actions that will help to keep common species common;
- identifies and prioritizes conservation actions, research and survey needs, and long-term monitoring needed to assess the success of conservation efforts;
- complements other conservation strategies, funding sources, planning initiatives, and legally mandated activities;
- incorporates public participation to provide an opportunity for all conservation partners and Michigan residents to influence the future of resource management;
- provides guidance for use of State Wildlife Grant funds; and
- provides a clear process for review and revision as necessary to address changing conditions and to integrate new information as it becomes available.

Migratory Bird Conservation Initiatives

Several migratory bird conservation plans have been published over the last decade that can be used to help guide management decisions for the refuges. Bird conservation planning efforts have evolved from a largely local, site-based orientation to a more regional, even inter-continental, landscape-oriented perspective. Several trans-national migratory bird conservation initiatives have emerged to help guide the planning and implementation process. The regional plans relevant to the Great Lakes islands refuges are:

- The Upper Mississippi River/Great Lakes Region Joint Venture Implementation Plan of the North American Waterfowl Management Plan;
- The Partners in Flight Boreal Hardwood Transition [land] Bird Conservation Plan;
- The Upper Mississippi River/Great Lakes Region Shorebird Conservation Strategy; and
- The Upper Mississippi River/Great Lakes Region Waterbird Conservation Strategy.

All four conservation plans will be integrated under the umbrella of the North American Bird Conservation Initiative. Each of the bird conservation initiatives has a process for designating priority species, modeled to a large extent on the Partners in Flight method of computing scores based on independent assessments of global relative abundance, breeding and wintering distribution, vulnerability to threats, area importance, and population trend. These scores are often used by agencies to develop lists of priority bird species. The Service based its 2008 list of Birds of Conservation Concern primarily on the Partners in Flight, Landbird Conservation Plan, U.S. Shorebird Conservation Plan, and North American Waterbird Conservation Plan status assessment scores.

Habitat Management

Managing Invasive Plants

No inventories of invasive plants were conducted on the Great Lakes islands refuges. However, island ecosystems are extremely vulnerable to harm caused by natural or intentional introduction of non-native plants. It is likely, but not documented, that some of the wetland areas are infested with purple loosestrife (*Lythrum salicaria*) and that spotted knapweed (*Centaurea maculosa*) may be found locally in the open lands of the larger islands.

Conflict Species Management

Double-Crested Cormorants (DCCO)

DCCO status: The most recent Great Lakes Colonial Waterbird Census estimate (Cuthbert and Wires, 2011) for Cormorants during 2007–2009 was approximately 103,000 pairs in the Great Lakes. Of these, about 54,000 pairs were recorded in U.S. waters. Populations have increased significantly in the last 25 years, and growing concern about their impacts on natural resources, especially fish and vegetation, caused the Service to establish a Public Resource Depredation Order (PRDO) in 2003.

The PRDO authorizes 3 entities—the U.S. Department of Agriculture Wildlife Services (WS), state wildlife agencies, and tribes (acting on tribal lands)—to kill DCCOs, oil their eggs, and destroy their nests in 24 states when they significantly impact fish, vegetation, or other birds. Landowner permission is needed, and there are reporting requirements.

Under the PRDO, the Service has responsibilities to ensure that: 1) the other agencies comply with the provisions of the PRDO (especially relative to documenting impacts on natural resources), 2) the long-term sustainability of regional DCCO populations is not affected by management activities, and 3) DCCO management does not negatively impact other birds or federally listed species that co-occur with DCCOs. Depredation permits may be issued by the Service's Migratory Bird Program for DCCO management to alleviate conflicts related to

economic impacts to private property and to address human health and safety concerns. However, the PRDO is the primary regulatory tool that is relevant to DCCO management on refuge lands.

When DCCO management is proposed for national wildlife refuges, the Service also has to assess whether it's an appropriate use and then grant permission if other action agencies handle the management.

Environmental Assessments (EAs) were conducted where significant DCCO take has been proposed. In the Midwest Region, which includes Minnesota, Wisconsin, Michigan, and Ohio; WS is the lead agency on the EAs, and the Service and sometimes the DNRs and tribes are cooperating agencies. The EAs:

- Review DCCO population status.
- Establish the need for action by reviewing conflicts and evidence of DCCO impacts.
- Develop alternatives within the PRDO framework. All of the EAs have selected as their preferred alternative Integrated Wildlife Damage Management, which allows for a combination of non-lethal and lethal activities, including harassment, nest destruction, egg oiling, and shooting of adults, as appropriate.
- Establish state-level Interagency Cormorant Coordination Groups.

Cormorant Management in Michigan

Michigan DCCO numbers rose from about 4,100 pairs in 1980–1991 to 30,500 pairs in 1997–1999. The numbers declined slightly to 29,300 pairs in 2007–2009 (Cuthbert and Wires, 2011). As of the last decadal census, 39 DCCO colonies were active in the Michigan portions of Lakes Huron, Michigan, and Superior; and the St. Marys River.



Cormorant Nest, Hat Island, Michigan Islands NWR

A 2006 EA established an allowable take of up to 10,500 DCCOs annually in Michigan, which would be ~14 percent of the state's breeding population. In 2008, WS and four tribes in Michigan killed ~8,300 DCCOs and oiled eggs in ~16,000 nests, mostly to reduce documented or perceived impacts on fish populations. About two-thirds of the DCCO colonies in Michigan are subject to some sort of control activities. Michigan accounts for about 40 percent of the birds killed and 50 percent of the eggs oiled in the U.S. under the PRDO, so it's an important state for DCCO management.

Refuge islands where DCCO management has occurred or has been proposed include:

- Seney NWR, part of the Michigan Islands NWR (Beaver Archipelago, Lake Michigan):

- Gull Island: 2,821 nests in 2007; 449 nests in 2011; management is permitted on the entire island, a formally off-limits Caspian Tern colony site was abandoned after a storm.
- Pismire Island: 660 nests in 2007; 142 nests in 2011.
- Hat Island: 7,942 nests in 2007; 2,608 nests in 2011; access to the island for egg oiling or shooting birds is not allowed due to the presence of one of the largest Caspian Tern colonies in the northern Great Lakes. However, Wildlife Services does shoot birds on nearby open water. Hat Island has a large DCCO population.
- Shiawassee NWR, part of the Michigan Islands NWR (Lake Huron):
 - Scarecrow Island (Thunder Bay): Egg oiling and shooting are not allowed on this island, because the evidence does not warrant control, and there is concern about co-nester impacts. DCCOs abandoned Scarecrow Island in recent years. WS shoots DCCOs offshore in Thunder Bay (1,300 birds in 2008).

Cormorant Management in Wisconsin

DCCOs were state-listed as endangered in Wisconsin in 1972, primarily due to the use of DDT. Numbers increased to ~10,000 pairs by 1997 and are currently at ~15,000 pairs. Approximately 80 percent of the breeding birds in the state are in the Lower Green Bay and Door County areas.

The EA on DCCO management in Wisconsin was completed in 2009 and established an allowable take of up to 6,600 DCCOs annually in Wisconsin, which would be ~18 percent of the state's breeding population. In Green Bay, the goal is to ultimately reduce the breeding population from 13,000 to 6,000 pairs, mostly through egg oiling. The Service is not convinced that fish impacts can be strongly linked to DCCOs there, plus it has other objectives for the refuge islands.

In 2011, WS in Wisconsin killed 3,197 cormorants and oiled eggs in 8,588 nests, mostly to reduce documented or perceived impacts on fish populations.

Refuge islands where DCCO management has occurred or has been proposed include:

- Gravel Island NWR:
 - Spider Island: 4,055 nests in 2011. No management occurs on Spider Island. At the time the EA was written, refuge staff felt there was not sufficient justification for DCCO reduction at a refuge established specifically to protect breeding birds. Additionally, DCCO reduction would disrupt an on-going DCCO banding and observation study started in 1988. The study is aimed at improving DCCO demographic data. The wilderness designation also requires additional consideration with regards to cormorant reduction activities and the requirement to protect wilderness character.
- Green Bay NWR:
 - Pilot Island: 4,124 nest in 2011. This island is also off limits to management because, DCCO banding observation program has expanded there and the site serves as a "control" to better allow us to assess the effects of DCCO management.

- Hog Island: 464 nest in 2011. DCCOs have nested at Hog Island in small numbers in the past, until recent years when increasing numbers have attempted to nest on the island. To protect the remaining vegetation and habitat for co-nesting species refuge staff began destroying nests and eggs in 2007 (working as agents of the DNR). Nests are initiated late in the season, suggesting these birds are possibly pushed there by egg oiling activities at nearby sites. Refuge staff will continue to monitor and manage to reduce and prevent adverse impacts of DCCO on vegetation and co-nesting species by carefully managing colonization.
- Plum Island: Currently vegetated, and the refuge staff wants to prevent DCCOs from nesting on the island. None have initiated nesting there to date.

Visitor Services

The National Wildlife Refuge System Improvement Act of 1997 emphasizes wildlife management and that all prospective public uses on any given unit of the Refuge System must be compatible with the wildlife-related purposes before they can be allowed. The Improvement Act also identifies six priority uses of national wildlife refuges that in most cases a considered compatible uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Opportunities to participate in all of these wildlife-dependent activities exist on those islands open to the public.

Gravel Island and Green Bay NWRs

Gravel, Hog, Spider and Pilot Islands are all closed to public use to protect the nesting bird colonies and fragile habitats. Environmental education and interpretation activities may occur at a distance from the Islands (e.g., by boat around the perimeter of the Islands) or be offered offsite.

Plum Island is currently closed to general public access except for specific, seasonal uses under refuge permit. Since 1982, the USCG allowed deer hunting on the island. When the Service retained ownership, hunting was allowed to continue, but by permit only. About 76 people have hunted since 2007, harvesting 39 deer. It is critical to control the deer herd on the island in order to protect the forest diversity.

The Service is considering new wildlife-dependent activities for Plum Island. These proposed activities are discussed in detail in Chapter 4 of the CCP and in the Compatibility Determinations located in the Appendix B.

Harbor Island NWR

The main harbor on the island is well protected and provides abundant opportunities for boats to anchor or beach on shore. There is a sandy beach on the north end of the island that is used by swimmers during the summer months. During winter this area of the lake is normally frozen, and access to the island is only via snow machine. Currently the refuge is not staffed. Based upon current documentation, the Service estimates that the refuge will receive about 200 visitors per year. At this time there are no self-guided interpretive services on the island, just informational and regulatory signs.

Hunting is currently allowed for big game. The entire island is open to the hunting of white-tailed deer and black bear. These hunts are conducted in accordance with State of Michigan regulations.

Wild blueberries and morel mushrooms, when present, may be harvested throughout the spring, summer, and fall. Activity is normally concentrated during the few weeks that fruit is ripe. This activity most likely occurs on the refuge incidental to other activities.

Huron NWR

The Huron NWR, with the exception of the lighthouse and associated structures/features, is designated a Federal Wilderness Area. This designation was part of Public Law 91-504 passed October 23, 1970. Current regulations include the following:

- Only West Huron Island (Lighthouse Island) is open to the public—and only during daylight hours, for hiking and nature study.
- All remaining islands are closed to the public, except by Special Use Permit to biologists, botanists, or other qualified persons in conjunction with approved studies. Exceptions are emergency landings by boats in distress.
- Camping is prohibited on all islands, except that biologists, botanists, and other qualified applicants may be permitted prescribed primitive-type camping only on West Huron Island (Lighthouse Island) by Special Use Permit, in conjunction with approved studies.

Michigan Islands NWR (Seney)

Shoe, Pismire, Gull and Hat Islands are closed to the public to protect colonial nesting birds. Exceptions are emergency landings by boats in distress. Special Use Permits may be issued for approved purposes. Wildlife observation and photography are welcome offshore.

Michigan Islands NWR (Shiawassee)

Scarecrow, Thunder Bay, Sugar, Big Charity, and Little Charity Islands are currently closed to the public; no public uses have been permitted. There is little public demand to access Little Charity, Scarecrow, Thunder Bay, and Sugar Islands. Most of the demand is from local residents and vacationers that are curious to explore the island and its shores during the summer. Occasionally anglers beach on the shoreline and waterfowlers hunt from the islands.

All of these islands are surrounded by treacherous waters. These waters are shallow and littered with large boulders and shallow reefs. Consequently, the islands are only accessible to boaters that are very experienced with the underwater terrain and have small vessels. Navigating these waters is not safe for the inexperienced boater.

Archaeological and Cultural Resources Management

Cooperative maintenance and restoration of lighthouses and other maritime buildings is the only cultural resources management that occurs on the Great Lakes islands refuges. In general, cultural resources management in the Service is the responsibility of the Regional Director and is not delegated to field managers for the Section 106 process when historic properties could be

affected by Service actions, for issuing archeological permits, and for Indian tribal involvement. The Regional Historic Preservation Officer advises the Regional Director about procedures, compliance, and implementation of cultural resources laws. The field manager assists by informing the Regional Historic Preservation Officer about Service actions, by protecting archeological sites and historic properties, by monitoring archeological investigations by contractors and permittees, and by reporting violations.

Law Enforcement

Staff of the Great Lakes islands refuges is dedicated to safeguarding the resources under their jurisdiction including natural resources, cultural resources, and facilities. Resource management includes both protective and preventive functions. Protection is safeguarding the visiting public, staff, facilities, and natural and cultural resources from criminal action, accidents, negligence, and acts of nature such as wildfires. Preventing incidents from occurring is the best form of protection and requires a known and visible law enforcement presence as well as other proactive steps to address potential threats and natural hazards.

Over the years, the most common violations on the Great Lakes islands refuges have been vandalism and trespass. Vandalism incidents have included damage to buildings, signs, and other structures.