MICHIGAN ISLANDS NATIONAL WILDLIFE REFUGE

Michigan Islands Wilderness

A Report on Wilderness Character Monitoring

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U.S. Fish and Wildlife Service
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On leaving the island with its sounds of the wild, herring gulls trail behind the boat, reminding us of our recent glimpse of undisturbed nature.

~ Michigan Islands Wilderness Study Area Report; USDOI Fish and Wildlife Service Bureau of Sport Fisheries and Wildlife, 1966 ~

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INTRODUCTION

The Wilderness Act was signed into law on September 3, 1964 by President Lyndon Johnson. The Act was Congress's response to the evidence that the wild spaces of the United States, which once seemed endless, were in jeopardy due to industrialization. The purpose of the Wilderness Act was "to establish a National Wilderness Preservation System for the permanent good of the whole people and for other purposes". The Act further states that "….each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established and also to preserve its wilderness character." The Wilderness Act describes wilderness as having the following qualities:

Untrammeled
Wilderness is "…an area where the earth and its community of life are untrammeled by man…" "… generally appears to have been affected primarily by the forces of nature." – Wilderness Act of 1964

Wilderness is essentially unhindered and free from the actions of modern human control or manipulation.

Natural
Wilderness "…is protected and managed so as to preserve its natural conditions."
– Wilderness Act of 1964

Wilderness ecological systems are substantially free from the effects of modern civilization.

Undeveloped
Wilderness is "…an area of undeveloped Federal land. Without permanent improvements or human habitation." and "...where man himself is a visitor who does not remain." – Wilderness Act of 1964

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern occupation.

Solitude or Primitive and Unconfined Recreation
Wilderness "…has outstanding opportunities for solitude or primitive and unconfined recreation."
– Wilderness Act of 1964

Other Features
Wilderness "…may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value." – Wilderness Act of 1964

Wilderness preserves other tangible features that are of scientific, scenic, or historical value.

From this descriptive language in the Wilderness Act of 1964, an interagency team developed a monitoring framework that incorporates monitoring and preservation of these wilderness qualities and is described in the Forest Service publication, *"Keeping It Wild"*: an interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System (Landres et al. 2008).

Wilderness Character Monitoring:

- Provides information to assess trends and make defensible decisions
- Provides regional and national information to evaluate policy effectiveness
- Communicates a positive and tangible vision for what wilderness is within the agency and with the public
- Allows managers to understand consequences of decisions and actions in wilderness
- Evaluates and documents effects of actions taken inside the wilderness and effects from threats outside the wilderness
- Provides solid information for planning
- Synthesized data into single, holistic assessment
- Provides legacy information that will endure over time when personnel change
- Guards against legal vulnerability
- Improves on-the-ground wilderness stewardship

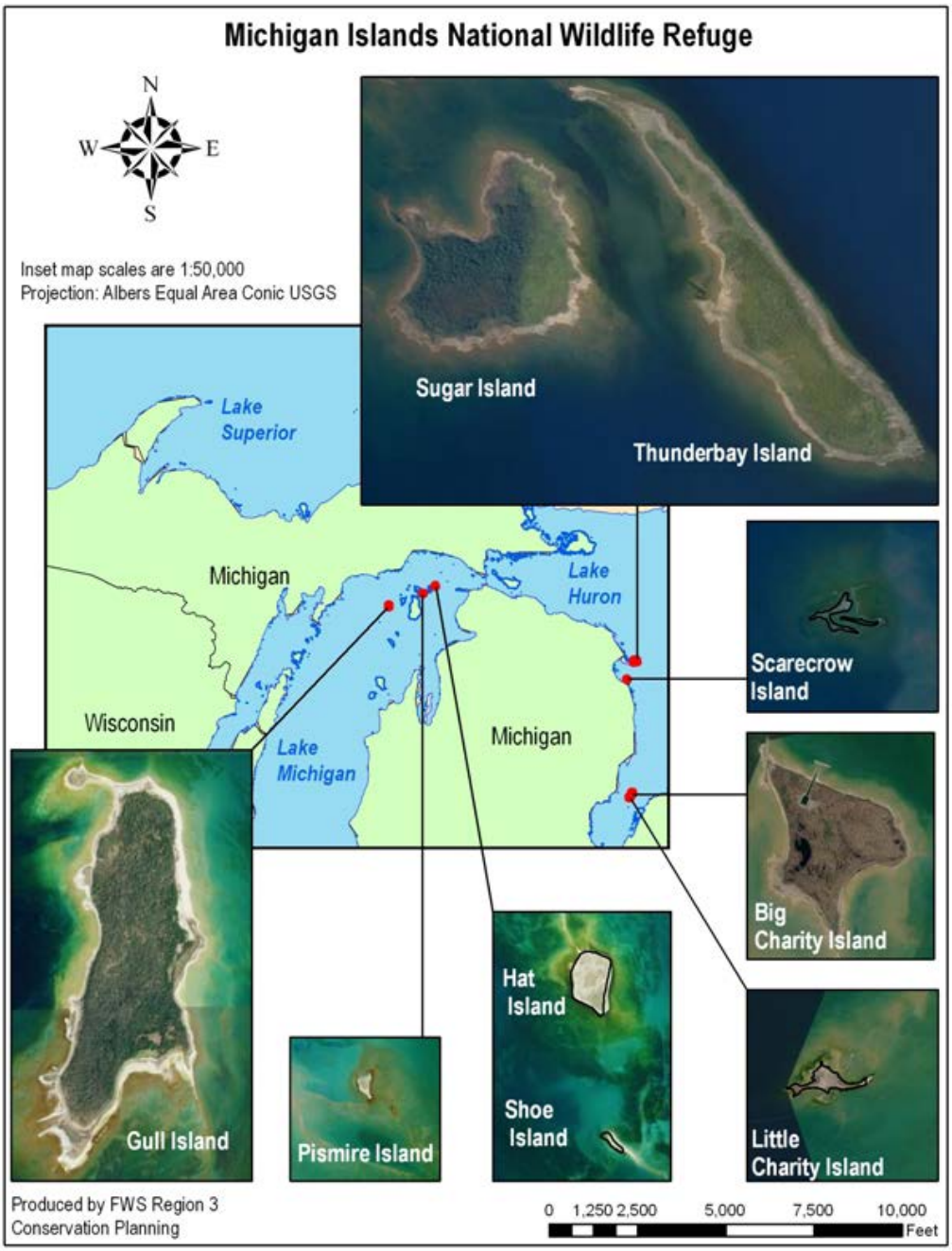
This document describes a wilderness character monitoring program for the Michigan Islands Wilderness Area and provides baseline data for future trend analysis. This report accompanies and explains the results of the Michigan Islands Wilderness character baseline assessment that have been entered into the National Wilderness Character Monitoring Database.

Measures of wilderness character were created that are specifically relevant to the Michigan Islands Wilderness. However, every indicator within the framework must be represented by at least one measure, whether it is pertinent to a particular wilderness or not. The purpose of this is to ensure a comprehensive and consistent representation of wilderness status throughout U.S. Fish and Wildlife Service National Wildlife Refuge System lands.

SETTING OF THE MICHIGAN ISLANDS WILDERNESS

Geographic Setting

Michigan Islands National Wildlife Refuge (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 three islands comprising the wilderness area total only 12 acres in size.



The geographic distribution presents a unique challenge to management and operation of the Michigan Wilderness Islands. The islands are remote and take considerable amount of time and planning to access. For example, the islands located in northern Lake Michigan, managed by staff at Seney NWR are located 50 air miles south of Seney. Twenty-two miles is over open water in Lake Michigan, with a 35 mile drive to reach the launch point at the closest boat launching point. Boat access is required and is dependent on weather and wave height, and requires advanced planning.

General Island Geological and Ecological Background

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. 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. 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.

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 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.

The islands the comprise Michigan Islands Wilderness are geologically similar, varying only in size and elevation.

Shoe Island is approximately 2 acres in size and is composed of glacial till overlying limestone bedrock. The island itself is part of a large shoal of glacial ridges and boulders on Lake Michigan. The island maximum elevation is approximately four feet above the lake level. 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. Herring gulls *(Larus argentatus)* nest on Shoe Island each year; intermittently, ring-billed gulls *(Larus delawarensis)* nest at this location.

Pismire Island is located nine miles to the southwest of Shoe Island. It is approximately three acres and is comprised of the same rocky material as Shoe Island. The island rises ten feet above lake levels and is covered in brush with scattered herbaceous vegetation. Pismire Island supports both herring gulls and ring-billed gulls and double-crested cormorants *(Phalacrocorax auritus)*.

Scarecrow Island is located in Lake Huron at the southern limit of Thunder Bay. It is the largest of the three island wilderness areas and is approximately eleven acres. 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 for nesting. Ring-billed gulls, terns, shorebirds, and waterfowl also nest on Scarecrow Island.

History of Establishing the Michigan Islands Wilderness

The Wilderness Act (Public Law 88-577, Sept. 3 1964) directed the Secretary of the Interior to review roadless areas of 5,000 acres or more, and every roadless island within the National Wildlife Refuges under jurisdiction, and to report on the suitability or nonsuitability of each such area or island for preservation as wilderness.

The provisions of Section 4(a) and 4(b) of the Wilderness Act declares that the Act is to be within and supplemental to the purposes for which National Wildlife Refuges are established and administered so as to meet purposes of wildlife protection for which refuges were established and in such a manner as to preserve and protect their wildlife communities; and shall also be administered within the wilderness area concept to provide recreational, scenic, scientific, educational, conservational, and historical enjoyment insofar as wildlife management objectives permit.

In 1966, The Bureau of Sport Fisheries and Wildlife conducted a detailed study of the three islands. This involved a study of the Bureau's files, an investigation into the history, geography, and geology of the islands as well as an on-the–ground inspection of each. The results of these studies were a recommendation by the Secretary of Interior that the three islands be included in the Wilderness System, but with management restrictions (USDOI, USFWS, 1967). The prime management consideration was the continued protection of the nesting birds by preventing access to the islands during the nesting and brooding seasons.

The Michigan Islands Wilderness proposal was included in the 1970 Omnibus Wilderness Act (Public Law 91-504) which was signed into law prior to the January 2, 1970 adjournment of the 91st Congress.

Refuge Purposes

The purposes of the refuges come from executive orders Congress passed as it established each refuge. There are also specific purposes Congress designated for managing the National Wildlife Refuge System. This wilderness character monitoring plan has been designed with consideration to the establishing legislation and purpose of each refuge.

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

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

The vision statement of Great lakes Island Refuges, as stated in the Great Lakes Islands Comprehensive conservation Plan (2012), 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. With the help of our conservation partners, we will apply sound, scientific principles based on research, studies, and adaptive management strategies to:

- sustain the long-term health and integrity of Great Lakes habitats;
- expand community outreach and environmental education and interpretation programs; and
- motivate visitors to embrace stewardship of natural resources.

RESOURCES AND PROCESS

Documents Consulted

The following is a list of documents used to prepare this report. Information from these documents, along with interviews of refuge staff were the main sources used to help identify measures and also supplied data for some of the measures.

Documents:

Gravel Island, Green Bay, Harbor Island, Huron Island, and Michigan Island DRAFT Comprehensive Conservation Plan. October 2012. U.S. Fish and Wildlife Service. Electronic PDF.

State of the Great Lakes Islands Report: Proceedings from the 1996 U.S. Great Lakes Island Workshop. 1999. Print.

The Fourth Decadal U.S. Great Lakes Colonial Waterbird Survey (2007-2010): Results and Recommendations to Improve the Scientific Basis for Conservation and Management. Submitted by Cuthbert and Wires. Feb. 2011. Electronic PDF.

Upper Mississippi Valley/Great Lakes Waterbird Conservation Plan. U.S. Fish and Wildlife Service. 2010. Print.

Michigan Islands Wilderness Plan: Green Bay and Gravel Islands National Wildlife Refuges. U.S. Fish and Wildlife Service. 1981. Print.

Michigan Islands Wilderness Study Areas; Michigan Islands National Wildlife Refuges. U.S. Fish and Wildlife Service. 1966. Print.

Refuge Files:

Michigan Islands Wilderness
Wilderness Designation
Special Use Permits

Wilderness Character Monitoring Resources:

Landres et al. 2008. Keeping It Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System. US Department of Agriculture, Forest Service: General Technical Report RMRS-GTR-212.

Landres et al. 2009. Technical Guide for Monitoring Selected Conditions Related to Wilderness Character. US Department of Agriculture, Forest Service: General Technical Report WO-80.

Websites:

National Oceanic and Atmospheric Administration (NOAA): National Climatic Data Center
http://www.ncdc.noaa.gov/cdo-web/datasets/ANNUAL/stations/COOP:478905/detail

Staff Consulted:
Seney NWR Staff
Mark Vaniman, Complex Manager
Greg McClellan, Deputy Complex Manager
Greg Corace, Forester and Acting Biologist

Shiawassee NWR Staff
Eric Dunton, Wildlife Biologist
Steve Kahl, Complex Manager

Process Used for Identifying Measures

Wilderness Character Monitoring requires the identification of quantifiable measures that reflect wilderness character. Changes in the values of these measures over time will be used as an index to evaluate trends in the four primary wilderness qualities: Untrammeled, Natural, Undeveloped, and Opportunities for Solitude and Primitive and Unconfined Recreation. The changes in the values of these measures are supposed to correlate with improvements or degradations to wilderness character.

I am fortunate to have worked on the Wisconsin Islands Wilderness islands for the last five years. Having this background knowledge and field experience helped immensely with identifying potential measures for wilderness islands in the Great Lakes, including the Michigan Islands Wilderness Area. Carlita Payne (2012 Wilderness Fellow) and I collaborated on potential measures for all of the Great Lakes Islands Wilderness Areas, as she and I were preparing Wilderness Character Monitoring reports for all of the Great Lakes Island Wilderness Areas. Since most of the wilderness islands in the Great Lakes were similar, we felt it was important to maintain consistency among the measures that were being identified for most, if not all of the islands.

Carlita traveled to Shiawassee NWR to gather background information and meet with staff to provide them with the essential background information on wilderness character monitoring and discuss potential measures for monitoring wilderness character on Scarecrow Island. Both Carlita and I traveled to Seney NWR. We had individual meetings with Mark Vaniman (Refuge Manager), Greg McClellan (Deputy Complex Manager), and Greg Corace (Refuge Forester) to provide them with the essential background information on wilderness character monitoring and discuss potential measures for monitoring wilderness character on the Shoe and Pismire Islands.

I focused my initial efforts on developing a draft document for refuge staff listing potential measures, as discussed in our earlier meeting, including pertinent details for each measure. Similar measures were identified by staff at Seney and Shiawassee NWR during these initial meetings. I used the measures from *"Keeping It Wild"* as a guideline in order to ensure that I was capturing as many characteristics of wilderness as possible. I expanded upon these measures in order to incorporate issues of specific relevance or concern to the Michigan Islands Wilderness.

I provided copies of this document to the refuge staff at both managing refuges. After they had a chance to review these documents, I spoke with them to go over the list of measures and get feedback on each measure, discuss feasibility/relevance of measures, and also provide information on data sources and data collection processes. We also discussed practicality of future monitoring efforts. Since the three islands fall under the same umbrella of Michigan Islands Wilderness, staff at both refuges agreed that the same measures should be reported for all three islands.

I then edited the first draft of measures and incorporated Refuge staff suggestions. I reworded, dropped, changed or added measures based on staff feedback. We then completed prioritization exercises for every potential measure, ranking them based on their importance, vulnerability, reliability, and reasonableness. This process allowed me to edit the set of measures again; focusing, simplifying, and prioritizing specific attributes. Once the measures were finalized, I entered them into a national Wilderness Character Monitoring database application and began collecting data to populate this database.

MEASURES USED

Untrammeled Quality

The Wilderness Act states that wilderness is “an area where the earth and its community of life are untrammeled by man,” and that “generally appears to have been affected primarily by the forces of nature.” This quality is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness. This quality stresses freedom from modern human control or manipulation and is compromised when the wilderness is “manipulated” to sustain or improve another wilderness quality (such as the intentional act of removing an invasive species). Any human action that alters the wilderness is considered trammeling.

The purpose of monitoring the untrammeled quality is to track management decisions and actions rather than track the consequence. Under this quality, actions are recorded to assess trends. An “action” is defined as an act or series of acts that are purposefully taken to manipulate the biophysical environment. Keep in mind, actions that manipulate the biophysical environment may be taken and degrade the untrammeled quality with the long-term desire to improve another quality. For example, the removal of mute swans from islands in the short-term degrades the untrammeled quality with the long-term goal of improving the natural quality. The effect of the action is accounted for under the natural quality.

Table 1. *Summary of measures for monitoring untrammeled quality on the Michigan Islands Wilderness Area*

Untrammeled Quality *Wilderness is essentially unhindered and free from modern human control or manipulation*				
Monitoring Question	**Indicator**	**Measure**	**Data Source**	**Freq (yr)**
What are the trends in actions that control or manipulate the "earth and its community of life inside" wilderness?	Actions authorized by the FWS that manipulate the biophysical environment	1-1 Index of efforts by staff and/or agents conducting double-crested cormorant management activities on wilderness islands	Special Use Permit Reports, Annual PRDO Management Reports, Biologist, Refuge Manager	1
		1-2 Days (per island) staff and/or permitted person(s) access wilderness islands to collect colonial bird data for research and/or inventory and monitoring	Biologist; Special Use Permits.	1
		1-3 Number of research, survey, and monitoring projects that manipulate plants or wildlfe habitat on wilderness islands	Special Use Permits, Biological Staff, Refuge Management	1
		1-4 Number of actions taken to capture, remove, band, and/or mark birds within the widerness boundary	Special Use Permits and Reports, Biological Staff, Refuge Management	1
		1-5 Days (per island) staff and/or agents access island to reduce or remove nonindigenous species on wilderness islands	Biologists, Special Use Reports	1
	Actions not authorized by the FWS that manipulate the biophysical environment	1-6 Number of unauthorized actions to manipulte colonial bird communities	Law Enforcement Officer, Incident Reports and/or RAPP, Biological Staff	1

***[Measure 1-1]* Index of efforts by staff and/or authorized agents conducting double-crested cormorant management activities on wilderness islands per year**

Context: Increasing populations of double-crested cormorants and growing concerns about their impacts to natural resources has resulted in the implementation of damage management programs across the Great Lakes region. Double-crested cormorants are one of the wildlife species with resource needs and behaviors that conflict with human activities and resource uses. Conflicts include but are not limited to cormorant foraging on populations of sport, commercial and forage fish and damage to vegetation and habitat used by other wildlife species. Cormorant management has occurred or been proposed on all the wilderness islands (Mark Vaniman and Eric Dunton, personal communication, Oct. 2012). Refuge managers have faced significant pressure to allow cormorant management on wilderness islands. In a few cases, refuge management has made decisions to manage cormorant populations to protect sensitive vegetation and habitat for co-nesting species. Management on wilderness islands has been approached conservatively.

Description: This measure tracks the status and trend of all projects authorized or conducted by the U.S. Fish and Wildlife Service that directly interfere with cormorant populations within wilderness. This would include take of birds under the Public Resource Depredation Order (PRDO). In 2003, the U.S. Fish and Wildlife Service published a Final Environmental Impact Statement and made changes to the regulations governing the take of double-crested cormorants. The final rule, published in the Federal Register in November 2003, established a Public Resource Depredation Order (PRDO; 50 CFR 21.48) and made changes to the 1998 Aquaculture Depredation Order (AQDO; 50 CFR 21.47). The final rule for the current depredation orders is available at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/cormorant/2009/DCCO%20FEA%2019%20March%202009.pdf Actions taken under this measure includes egg oiling, nest and/or egg destruction, and shooting of adult birds on wilderness islands. This does not include actions conducted outside of the wilderness. However, it should be noted that shooting offshore at the wilderness islands does occur. Not all management methods have the same level of impact associated with them. Shooting adult birds and removing a member of the breeding population of a long-lived bird species has a greater impact on the population dynamics of this species than removing nests. In addition, shooting activities may require additional time, the construction of a temporary blind, and spent ammunition on the island landscape. To account for these differences, an inherent weighting has been assigned to each management type based on its perceived impact to the biophysical resources, as shown in the table below. Nest destruction with a relatively low level of impact is assigned a value of 1, egg oiling with a moderate level of impact is assigned a value of 2, and shooting birds with a high level of impact is assigned a 3. A total management level value will be calculated for each management type by multiplying the inherent weight of each type of management type by the number of days the management type was implemented. The resulting products for each management type are summed to generate a total annual score for the entire wilderness. This sum is reported in the Wilderness Character Monitoring database.

Table 2. *Inherent weight scores for double-crested cormorant management activities on wilderness islands*

Management Type	Inherent Weight
No Action	0
Nest Destruction	1
Egg Oiling	2
Birds Killed	3

Relevance: Wilderness by definition is land that has been unaltered and remains in a natural state. The management or manipulation of cormorants by humans within wilderness disturbs the unaltered state of the wilderness and therefore mandates monitoring. The objective of wildlife management in wilderness is to provide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of species will exist. The untrammeled quality is degraded when the number of authorized actions that manage cormorant populations within the wilderness increases. This measure will show a degrading trend due to a purposeful decision to minimize the impacts of select species on the wilderness island and surrounding environment.
Data Source: Special Use Permit Reports, Annual PRDO Management Reports, Biologist, Refuge Manager. Data entry sheets were created and will be stored on the Refuge server.
Data Adequacy: All records of cormorant management were gathered. For 2012, data came from refuge staff that had data records displaying annual cormorant management activities. The quality of the data was collected with a high degree of confidence and is representative of the level of impact associated with authorized control projects within wilderness.
Determining Significant Change: Cormorant management activity in 2012 was assigned a score of three. This is the baseline recording for the wilderness monitoring plan. Any change in this data would be a significant enough impact to be interpreted as change in a trend in wilderness character. Interpreting data as a shifting trend should be done on an individual basis.
Notes:

- These data will be measured and entered into the Wilderness Character Monitoring database annually.
- There are multiple factors to consider with regards to the implementation of cormorant management activities on a wilderness island. For example, the disturbance from cormorant control efforts on nearby islands, not under Refuge jurisdiction or without wilderness status, could potentially move birds to wilderness islands. The movement of birds and colonization of a wilderness island could be interpreted as a human induced change rather than a force of natural selection and survival. The decision to implement control and what control methods used should be analyzed very carefully in a minimum requirement analysis. Changes in this value must be interpreted very carefully.

Baseline Data – Michigan Islands Wilderness

Table 3. *Index of efforts by staff and/or authorized agents conducting double-crested cormorant management activities on wilderness islands*

Year	Manegment Type (nest destruction,egg oiling, shooting)	Inherent Weight (nest destruction =1, egg oiling =2, shooting =3)	# of Days Management Type Implimented	Score (inherent X units X days)	Comments
2012	oiling	2	0	0	Visits dependent on activity of birds, Shooting was at Pismire Island
	shooting	3	1	3	
				0	
Total Score (sum of all scores)				**3**	

***[Measure 1-2]* Days (per island) staff and/or permitted person(s) access wilderness islands to collect colonial bird population information for research and/or inventory and monitoring per year**

Context: The islands composing the Michigan Islands Wilderness have exceptional value to colonial nesting waterbird conservation in the Great Lakes Region. The Upper Mississippi Valley/Great Lakes Regional Waterbird Conservation Plan includes Scarecrow Island 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. Colonial waterbirds are a significant natural resource in the North American Great Lakes and information on their distribution and population trends are essential for their conservation and management, as well as for studying ecosystem change (Cuthbert 2011).

Description: This measure is a reporting of the days actions authorized or conducted by the U.S. Fish and Wildlife Service to assess breeding bird populations. This includes all island visits during the breeding season to conduct nest counts, conduct presence or absence surveys and/or ocular estimates, and to conduct avian disease monitoring.

Relevance: This measure is relevant to the indicator because it allows tracking of significant actions that manipulate the biophysical environment. Colonial nesting waterbirds are extremely sensitive to human disturbance. Disturbance during the pre-nesting and nest-building phase can cause the birds to abandon the island for the current and future nesting seasons. During the incubation and chick-rearing phase, disturbance may cause loss of eggs and chicks. When incubating adults are induced to leave the nest, eggs and chicks are vulnerable to predation from gulls and other opportunistic predators (consuming eggs and chicks whole) and heat stress, which can kill eggs and chicks in a matter of minutes on a hot day. This activity within wilderness disturbs the unaltered state of the wilderness and therefore mandates monitoring.

Data Source: Biologist, Special Use Permits. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: All records of access to an island to survey, monitor, and/or inventory colonial nesting waterbirds are known and reported to the refuge. Visits are accurately recorded; therefore the quality of the data is high.

Determining Significant Change: There were nine visits within wilderness in 2012 authorized by the U.S. Fish and Wildlife Service. This is the baseline recording for the wilderness character monitoring plan. It was determined that an increase or decrease of the number of days of access to collect waterbird data by 25% would cause a significant enough impact to the wilderness to be interpreted as a degrading or improving trend.

Notes:

- These data are reported in the Wilderness Character Monitoring database annually.

Baseline Data – Michigan Islands Wilderness

Table 4. *Days (per island) staff and/or permitted person(s) access a wilderness island to collect colonial bird population data for research and/or inventory and monitoring per year*

Wilderness Island	2012
Pismire	3
Shoe	3
Scarecrow	3
Total	**9**

[Measure 1-3] **Number of research, survey, and monitoring projects that manipulate vegetation, soils, and other factors of the abiotic community on wilderness islands per year**

Context: The location and island habitat has attracted researchers interested in waterbird population dynamics. The islands have served as research sites for the Service and colleagues for many years. These islands offer rare opportunities to study the changes that are occurring on the landscape with minimal human intrusion. There are very few such natural sites available to study and document long-term changes in the absence of human disturbance. Research studies conducted at wilderness islands aim to address aspects of waterbird conservation across the Great Lakes region. Examples include waterbird impacts to vegetation and soil.

Description: Projects counted under this measure may overlap with projects in Measure 1-2, but focuses on the number research projects and studies that monitor vegetation, soils, and other factors of the abiotic community within wilderness in addition to the population trends of the waterbird community. The number of projects are accounted for and reported annually.

Relevance: The refuge staff promotes applied research aimed at answering ecosystem-, wildlife-, habitat-, and community-based questions without compromising wildlife and wilderness values. Monitoring and research have many positive implications and often lead to improved management practices. However, some research projects might involve the installation of fencing, flagging, removing or disturbing soil and/or vegetation. The potential impacts can be directly correlated with the number of projects and therefore warrants monitoring.

Data Source: Special Use Permits, Biological Staff, Refuge Management. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: The quality of the data was collected with a high degree of confidence with regard to the number of research projects and studies within wilderness.

Determining Significant Change: There were no projects within wilderness in 2012 authorized by the U.S. Fish and Wildlife Service. This is the baseline recording for the wilderness character monitoring plan. It was determined that an increase or decrease of the number of days of access to collect research data by 25% would cause a significant enough impact to the wilderness to be interpreted as a degrading or improving trend.

Notes:

- Data in this measure should be monitored and recorded in the Wilderness Character Monitoring database annually

Baseline Data – Michigan Islands Wilderness

Table 5. *Number of research, survey, and monitoring projects that manipulate vegetation, soils, and other factors of the abiotic community on wilderness islands*

Wilderness Island	2012
Pismire	0
Shoe	0
Scarecrow	0
Total	**0**

[Measure 1-4] **Number of actions taken to capture, remove, band, mark birds and remove eggs on wilderness islands per year**

Context: Occasionally, capturing, banding/marking birds, and collecting specimens are essential for obtaining crucial scientific information. The concentrated and synchronous nesting typical of colonial waterbirds on the wilderness islands allows for banding on a scale not achievable for other groups of birds. Long life spans for some species and the fidelity of adults to breeding colonies allow for the accumulation of large, long-term sets of recapture and re-sighting data. Other research studies conducted at wilderness islands aim to address other aspects of waterbird conservation across the Great Lakes region. Examples include species food habits, foraging behavior, energetics, movements, impacts on fish populations, and biological impacts of contaminants on waterbird species. The herring gull continues to be recognized as a primary indicator species for environmental toxins in the Great Lakes. These studies often involve the removal of eggs for contaminant analysis. Additionally, some birds may be removed from islands for disease control. For example, birds exhibiting signs of botulism may be removed to prevent an epidemic and protect the waterbird population at large.

Description: This measure tracks management actions, not the individual number of birds. This would include banding, capturing, installing transmitters, collecting blood or eggs, performing tissue removal or removing birds for disease control.

Relevance: Research and monitoring has many positive implications and often leads to improved management. However, some research projects often require capturing, banding and removing birds from the islands. This activity within wilderness disturbs the unaltered state of the wilderness and therefore mandates monitoring.

Data Source: Special Use Permits and Reports, Biological Staff, Refuge Management. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: The quality of the data was collected with a high degree of confidence with regard to the number of research projects and studies within wilderness.

Determining Significant Change: There were four actions within wilderness in 2012 authorized by the U.S. Fish and Wildlife Service. This is the baseline recording for the wilderness character monitoring plan. Any increase or decrease in the number of actions would cause a significant enough impact to the wilderness to be interpreted as a degrading or improving trend.

Notes:

- Data in this measure should be monitored and recorded in the Wilderness Character Monitoring database annually.

Baseline Data – Michigan Islands Wilderness

Table 6. *Number of actions taken to capture, remove, band, and/or mark birds within the wilderness boundary*

Wilderness Island	2012
Pismire	2
Shoe	2
Scarecrow	0
Total	**4**

[Measure 1-5] **Number of actions taken by staff and/or agents to reduce or remove nonindigenous mute swans *(Cygnus olor)* on the wilderness islands per year**

Context: The mute swan is a non-native species and can be found nesting and/or feeding near refuge islands. Mute swan populations continue to grow near refuge islands. Mute Swans compete for resources with native birds utilizing the island habitat. Mute swans have been removed from wilderness islands in the past and efforts to continue managing and/or removing mute swans are planned. Efforts to reduce or remove mute swans include destroying eggs and/or shooting birds.

Description: This measure is a reporting of the number of actions taken to remove and/or reduce invasive mute swans for each wilderness island. Each separate action is counted and tallied annually. The sum of all islands is reported in the Wilderness Character Monitoring Database.

Relevance: Removing non-indigenous mute swans has many positive management implications. Accessing the island to remove and or/destroy eggs disturbs the unaltered state of the wilderness and therefore mandates monitoring.

Data Source: Special Use Reports, Refuge Management, Biological Staff. Partnering agencies (USDA-Wildlife Services) are contracted to perform mute swan removal are required to report annual take to refuge management. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: Data adequacy is expected to be high. All actions to reduce or remove mute swans are recorded by refuge staff.

Determining Significant Change: There were no actions within wilderness in 2012 authorized by the U.S. Fish and Wildlife Service. This is the baseline recording for the wilderness character monitoring plan. Any increase or decrease in the number of actions would cause a significant enough impact to the wilderness to be interpreted as a degrading or improving trend.

Notes:

- Data should be monitored and recorded in the Wilderness Character database annually.
- An increase in this measure should offset a concomitant decrease for the measure, average non-native mute swans on wilderness islands (measure 2-3), thus having an overall offsetting stable trend in wilderness character for these two measures. Trends should be tracked appropriately.

Baseline Data – Michigan Islands Wilderness

Table 7. *Number of actions taken by staff and/or agents to reduce or remove nonindigenous mute swans per year*

Wilderness Island	2012
Pismire	0
Shoe	0
Scarecrow	0
Total	**0**

[Measure 1-6] **Number of UNAUTHORIZED actions taken that manipulate colonial waterbird communities on wilderness islands per year**

Context: The only means of accessing the wilderness islands is by boat. Due to the relative remoteness of the refuge and the small surrounding community, there are not many unauthorized actions or activity within the wilderness. This measure tracks unauthorized actions rather than violations because some of the actions may not be citable yet still be unauthorized actions that trammel the wilderness. Examples of actions include intentional or unintentional transport of predators to islands, unauthorized access that intentionally or unintentionally disrupts breeding waterbirds within wilderness. This includes incidents and actions that are observed by staff or volunteers.

Description: This measure is a reporting of the number of actions taken by individuals or groups without authorization from U.S. Fish and Wildlife Service that impacts the nesting colonial waterbird communities. Each separate action is counted and tallied annually. The sum of all islands is reported in the Wilderness Character Monitoring Database.

Relevance: When actions are permitted within wilderness, there is usually a meaningful purpose behind them (e.g., gaining knowledge and insight or accomplishing management goals). Unauthorized actions typically are indicative of harmful or reckless actions and have adverse effects on the biophysical environment, such as the intentional release of exotic pigs to disrupt breeding colonial waterbirds.

Data Source: Law Enforcement Officer, Incident Reports, Biological Staff. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: The quality of the data was collected with a moderate degree of confidence. Due to the limited access to the islands by refuge staff, the refuge is unable to count every instance of unauthorized actions within the wilderness area. However, given the small resident population and remoteness of the islands the actual number of actions is likely to be very similar to the recorded number of actions. This measure is based on the known incidences and the level of effort to collect the data would strongly influence the result.

Determining Significant Change: There were no recorded unauthorized actions in 2012. This is the baseline recording for the wilderness monitoring plan. Any change is a “significant” change because known unauthorized actions rarely occur inside wilderness. These are limited to times when staff happen to observe unauthorized access (i.e. kayaks landing on island, intentional introduction of exotic predator).

Notes:

- Data should be monitored and recorded in the Wilderness Character database annually.
- An increase in this value over time could be caused by actions not under the control of a wilderness manager, but nonetheless impacts the untrammeled character of the wilderness.

Baseline Data – Michigan Islands Wilderness

Table 8. *Number of unauthorized actions taken that manipulates colonial waterbird communities*

Year	Location	Unauthorized Action (s)	Total Actions	Notes
2012	Pismire	None	0	
	Shoe	None		
	Scarecrow	None		

Natural Quality

The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions. This quality calls for the protection of native species communities and the structure and function of ecological systems within wilderness, and should be managed so they are substantially free from the effects of modern civilization.

While the untrammeled quality monitors the actions that manipulate or control wilderness ecological systems, the natural quality tracks the effects of these and other actions on the community of life in wilderness.

Table 9. *Summary of measures for monitoring natural quality on the Michigan Islands Wilderness Area*

Natural Quality *Wilderness ecological systems are substantially free from the effects of modern civilization*				
Monitoring Question	**Indicator**	**Measure**	**Data Source**	**Freq (yr)**
What are the trends in terrestial, aquatic, and atmospheric natural resources inside the wilderness?	Plants and wildlife species and communities	2-1 Presence of breeding native waterbird species	Refuge Biologist; Refuge Manager	2
		2-3 Average number of nonindegenous mute swans	Biological Staff, Special Use Reports	5
	Physical resources	2-4,2-5,2-6,2-7 Air quality	This measure will be monitored at the national level	5
	Biophysical Resources	2-8,2-9,2-10 Climate change	National Climatic Data Center (www.lwf.ncdc.noaa.gov)	5

***[Measure 2-1]* Presence of breeding colonial waterbirds on wilderness islands**

Context: The wilderness islands provide significant nesting and roosting habitat for colonial waterbirds in the Great Lakes region. The intention of wilderness status was to protect the natural and undisturbed quality of islands important for native bird habitat. The location of these islands, near forage fish habitat, combined with their relatively undisturbed condition during spring and early summer, offer these species of migratory birds the necessary protected habitat. The wilderness islands provide important habitat to several species of nesting colonial waterbirds including double-crested cormorant, great-blue heron *(Ardea Herodias)*, great egret *(Ardea alba)*, black- crowned night-heron *(Nycticorax nycticorax)*, ring-billed gull, herring gull, Caspian tern *(Hydroprogne caspia)*, and common tern *(Sterna hirundo)*. The Upper Mississippi Valley/Great Lakes Regional Waterbird Conservation Plan includes Scarecrow Island on its list of the most important sites for breeding colonial waterbirds in the United States Great Lakes. Threats to these species and the island habitat include human disturbances; contaminants; climate induced water level change and storm-driven waves; invasion of exotic species, particularly invasive plants, have potential to change the character and composition of the islands over a short period of time. Such threats could make some islands unavailable for nesting waterbirds.

Description: This measure is a reporting of the presence of breeding bird populations. The number of wilderness islands on which colonial nesting waterbirds are found is summed and reported in the Wilderness Character Monitoring database bi-annually.

Relevance: The presence of breeding waterbirds was chosen for monitoring based on their high relevance to the natural character of the Michigan Islands Wilderness. A presence/absence measure was chosen to measure wilderness character and value. Tracking the distribution and population trends is essential for their conservation and management; however this information is not critical for measuring wilderness character. Islands are extremely dynamic systems and are vulnerable and sensitive to change. Natural variability in species abundance and distribution at the population level must be taken into account. Refuge staff collects important population data and participates in U.S. Great Lakes-wide surveys. Therefore, species abundance and regional population trend information is available via other sources. The most recent data are available from the report: The Fourth Decadal U.S. Great Lakes Colonial Waterbird Survey (2007-2010): Results and Recommendations to Improve the Scientific Basis for Conservation and Management (Cuthbert 2011).

Data Source: Refuge Biologist, Refuge Manager. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: All records of access to an island to survey, monitor, and/or inventory colonial nesting waterbirds are known and reported to the refuge. Visits are accurately recorded; therefore the quality of the data is high.

Determining Significant Change: Nesting waterbirds were present on all three wilderness islands in 2012. This is the baseline recording for the wilderness monitoring plan. Any change or absence of nesting colonial waterbirds would be a significant impact to the wilderness and be interpreted as a degrading trend in wilderness character.

Notes:

- These data are reported in the Wilderness Character Monitoring database every 2 years.

Baseline Data – Michigan Islands Wilderness

Table 10. *Presence of breeding colonial waterbirds on wilderness islands (X = Presence)*

Wilderness Island	2012
Pismire	X
Shoe	X
Scarecrow	X
Total	3

[Measure 2-2] **Average number of nonindigenous mute swans on wilderness islands**

Context: The mute swan is a non-native species and can be found nesting on and feeding near all wilderness islands. Its aggressive breeding behavior and consumption of large amounts of submerged aquatic vegetation have the potential to impact many native waterbird species. Mute swans have also been reported to cause nest abandonment.

Description: This measure is a reporting of the average number of nonindigenous mute swans determined to be nesting and/or utilizing habitat on each wilderness island. This sum is reported in the Wilderness Character Monitoring Database.

Relevance: The presence of mute swans can cause degradation or loss of habitat for native species and directly compete with the native waterbird population for resources such as food and nesting habitat, thus degrading the natural quality of wilderness character.

Data Source: Biological Staff, Refuge Manager, Special Use Reports. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: Data quality of the data was collected with a high degree of confidence. For islands that data is known, the confidence in this data is high based on sightings and nesting activity.

Determining Significant Change: There were zero mute swans reported for 2012. This is the baseline recording for the wilderness monitoring plan. Any change (increase or decrease) in the number of mute swans would be significant enough to indicate change in trend of wilderness character.

Notes:

- Over time, an increase in this value is a decrease in this indicator of wilderness character.
- An increase in the number of mute swans over time could be caused by actions not under the control of a wilderness manager, but is an important impact to the natural quality.
- Periodic review and updates every five years should be sufficient to track changes over time.

Baseline Data – Michigan Islands Wilderness

Table 11. *Average number of nonindigenous mute swans on wilderness islands*

Wilderness Island	2012
Pismire	0
Shoe	0
Scarecrow	0
Total	**0**

[Measure 2-3, 2-4, 2-5, 2-6] Air Quality Data

Context: Ozone and its precursor emissions (nitrogen oxides and volatile organic compounds) can travel long distances, resulting in elevated ozone levels in Wilderness Areas. Deciview is a visibility measurement that provides a cumulative haziness index used to express light extinction (i.e., the visibility a wilderness visitor would experience).

Description: Air quality data is not monitored by the Michigan Islands NWR staff; however, data are available from other agency monitoring programs and will be compiled on all Wilderness Areas by the National Wildlife Refuge System's Naturals Resource Program Center (Fort Collins, CO). This measure is made up of four air quality parameters (1) ozone air pollution, (2) total nitrogen wet deposition, (3) total sulfur wet deposition, and (4) visibility. The values are presented as a 5 year average. In Wilderness areas where we do not have air quality monitors in close proximity, such as the case with the Michigan Islands Wilderness, values have been interpolated between monitors. Conditions of the air quality related value is based on the following cutpoints:

Table 12. *Conditions of air quality values*

Ozone	
< 60 ppb	Good
61-75	Moderate
> 76	Significant Concern

Total -N and S	
<1 kg/ha	Good
1-3	Moderate
> 3	Significant Concern

Visibility	
<2 dV	Good
2-8	Moderate
> 8	Significant Concern

Relevance: The natural quality is degraded when ozone increases, acid deposition increases, and/or visibility declines.

Data Source: National Wildlife Refuge System's Natural Resource Program Center (Fort Collins, CO). Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: All air quality data collected by the Natural Resource Program Center are used to determine the quality of air for the Michigan Islands Wilderness Area. Since most monitors are not in close proximity to the Michigan Island Wilderness, values have been interpolated between monitors. Interpolated data have been assigned a confidence level of medium.

Determining Significant Change: The baseline data are presented as 5-year averages for the years 2005-2009, which are the most recent years for which the Center has complete datasets for all values. For those measures with a medium confidence, a trend for the natural quality is not assessed. However, we can still track whether the numerical value for the indicator is increasing or decreasing over the averaging periods.

Notes:

- Data for this measure will be entered into the Wilderness Character Monitoring database every five years.

Baseline Data – Michigan Islands Wilderness

Table 13. *Ozone Air Pollution*

Year	Unit	Ozone Value	Units	Avg. Value	Condition
2004	Shoe	80.2	ppb	80.6	Significant Concern
	Pismire	80.2	ppb		
	Scarecrow	81.4	ppb		
2009	Shoe	74.8	ppb	74.6	Moderate
	Pismire	74.9	ppb		
	Scarecrow	74.1	ppb		

Table 14. *Total Nitrogen Wet Deposition*

Year	Unit	Total N	Units	Avg. Value	Condition
2004	Shoe	4.9	kg/ha	4.9	Significant Concern
	Pismire	4.9	kg/ha		
	Scarecrow	4.9	kg/ha		
2009	Shoe	4.5	kg/ha	4.6	Significant Concern
	Pismire	4.5	kg/ha		
	Scarecrow	4.7	kg/ha		

Table 15. *Total Sulfur Wet Deposition*

Year	Unit	Total S	Units	Avg. Value	Condition
2004	Shoe	3.4	kg/ha	3.5	Significant Concern
	Pismire	3.4	kg/ha		
	Scarecrow	3.7	kg/ha		
2009	Shoe	2.7	kg/ha	2.9	Moderate
	Pismire	2.7	kg/ha		
	Scarecrow	3.3	kg/ha		

Table 16. *Visibility*

Year	Unit	Visibility	Units	Avg. Value	Condition
2004	Shoe	5.8	Dv	6.5	Moderate
	Pismire	5.8	Dv		
	Scarecrow	7.9	Dv		
2009	Shoe	6.2	Dv	7	Moderate
	Pismire	6.2	Dv		
	Scarecrow	8.6	Dv		

***[Measure 2-7, 2-8, 2-9]* Climate change measures**

Context: 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.

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). 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.

As water temperatures in lakes increase, major changes in Great Lakes ecosystems will very likely occur, such as a shift from cold-water 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. Changes in bird populations have already been linked to increasing temperatures and more changes are likely in the future.

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. 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.

Precipitation patterns are likely to have measureable impacts on Great Lakes Island ecosystems. 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. 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 the Great Lakes. 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.

Description: The Michigan Islands Wilderness does not have Remote Area Weather Stations (RAWS) but, weather conditions for the wilderness islands are very similar to temperatures recorded at weather monitoring stations operated by the National Oceanic and Atmospheric Administration (NOAA) that are in close proximity to the wilderness islands. The weather data recorded at these weather monitoring stations tracks the data pertinent for this measure. Each measure uses data recorded from a NOAA weather stations located on Beaver Island (COOP: 207277) for Shoe and Pismire Islands and Alpena Co Regional Airport (COOP: 200164) for Scarecrow Island. These

measures are: mean summer temperature, mean winter temperature, and total annual precipitation. Summer was defined as the months of June, July, and August. Winter was defined as the months of December, January, and February. Mean summer and winter temperatures were calculated for each year. These seasonal means were then averaged over a five-year time interval. Since the year changes in the middle of the winter season, mean winter temperatures for any given year were calculated using data from December of the previous year and data from January and February of the target year. Total precipitation was calculated for each year and then these totals were also averaged over a five-year time interval.

Relevance: Wilderness is set aside to preserve its natural conditions, but climate change has undeniable repercussions for natural system functioning. Attempting to monitor climate change and its widespread effects on wildlife is a national priority for many organizations, but there is no set protocol for how to do this in a cohesive manner. While the weather data measures described here are admittedly simplified proxies for representing climate change, they are an efficient means for Refuge staff to gather data directly linked to climate change and weather patterns.

Data Source: National Weather Service Station Annual Data Reports. Temperature values can be found using the following URL and searching for the corresponding weather monitoring station.
http://lwf.ncdc.noaa.gov/land-based-station-data/find-station
Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: Data are collected with a high degree of confidence from NOAA however; since the data are interpolated from the nearest weather station the data adequacy assigned is moderate.

Determining Significant Change: The baseline data are presented as a five-year average for the years 2007-2011. The mean annual temperature is likely to fluctuate by several degrees every monitoring period. A significant change value is not as important as tracking temperature values to see if the overall mean annual temperature is increasing or decreasing in the region.

Notes:

- Annual averages will be recorded and summarized every 5 years.

Baseline Data – Michigan Islands Wilderness

Table 17. *Climate Change Data*

Units	Winter	2007	2008	2009	2010	2011	5 Yr. Mean
Shoe and Pismire Island	December (prv.yr)	32.5	26.7	23.0	24.5	25.6	
	January	25.5	24.8	14.2	23.1	16.8	
	February	16.6	19.2	21.9	24.1	22.5	
	Seasonal Mean	24.9	23.6	19.7	23.9	21.6	
Scarecrow Island	December (prv.yr)	32.1	23.6	20.2	23.8	23.5	
	January	23.3	22.5	12.0	21.8	14.3	
	February	14.2	18.1	20.5	22.4	20.8	
	Seasonal Mean	23.2	21.4	17.6	22.7	19.5	
Average Winter Mean Temp. for MI Islands Wilderness		**24.0**	**22.5**	**18.6**	**23.3**	**20.6**	**21.8**
Units	Summer	2007	2008	2009	2010	2011	**5 Yr Mean**
Shoe and Pismire Island	June	na	60.9	60.0	61.5	61.3	
	July	66.8	66.6	62.4	69.8	69.7	
	August	68.5	66.5	64.4	70.6	68.8	
	Seasonal Mean	67.7	64.7	62.3	67.3	66.6	
Scarecrow Island	June	65.5	64.0	60.3	61.8	61.6	
	July	66.6	67.3	63.0	70.1	72.2	
	August	67.5	65.1	64.6	69.8	67.6	
	Seasonal Mean	66.5	65.5	62.6	67.2	67.1	
Average Summer Mean Temp. for MI Islands Wilderness		**67.1**	**65.1**	**62.5**	**67.3**	**66.9**	**65.7**
		2007	2008	2009	2010	2011	**5 Yr Mean**
Shoe and Pismire		98.1	184.9	117.2	60.5	77.1	
Scarecrow Is.		123.5	135.2	119.9	72.8	105.6	
Average Total Precipitation for MI Islands Wilderness		110.8	160.1	118.5	66.6	91.3	**109.5**

Undeveloped Quality

The Wilderness Act states that wilderness is “an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation,” “where man himself is a visitor who does not remain” and “with the imprint of man’s work substantially unnoticeable.” This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment or mechanical transport that increases people’s ability to occupy or modify the environment.

The presence of non-recreational developments such as refuge boundary signs, and area closed signs and the use of mechanical transport and motorized equipment is included under this quality.

Table 18. *Summary of measures for monitoring undeveloped quality on the Michigan Islands Wilderness Area*

Undeveloped Quality *Wilderness retains its primeval character and influence, and essentially without permanent improvement or modern human occupation*				
Monitoring Question	**Indicator**	**Measure**	**Data Source**	**Freq (yr)**
What are the trends in non-recreational development inside wilderness?	Non-recreational structures, installations, and developments	3-1 Number of authorized physical structures	Refuge staff	5
	Inholdings	3-2 Number of inholdings within wilderness	Refuge Manager, USFWS Realty records	5
What are the trends in mechanizaton inside the wilderness ?	Use of motor vehicles, motorized equipment, or mechanical transport	3-3 Index of administrative mechanical transport and motorized equipment	Refuge Biologist, Refuge Manager	1

[Measure 3-1] **Number of authorized physical structures**

Context: Very few developments exist in the Michigan Islands Wilderness and it is likely that no new developments will be added. Signs installed on the wilderness islands may include refuge boundary markers and area closed signs. These signs are necessary to inform the public and protect the wilderness resources.

Description: This measure is a reporting of all physical structures present on the wilderness islands authorized by refuge staff. Each development on wilderness islands is counted. The development type and location is noted, but only a count of developments is reported in the Wilderness Character Monitoring database.

Data Source: Refuge staff. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: All wilderness islands were visited to assess structure presence. A simple count of these structures makes for high confidence in the quality of data.

Determining Significant Change: There were no physical developments recorded in 2012. This is the baseline recording for the wilderness monitoring plan. Any additional development in wilderness would be a significant enough impact to be interpreted as a change in the trend of wilderness character.

Notes:

- Data will be evaluated every 5 years

Baseline Data – Michigan Islands Wilderness

Table 19. *Number of authorized physical structures*

Wilderness Island	2012
Pismire	0
Shoe	0
Scarecrow	0
Total	**0**

[Measure 3-2] **Acres of inholdings within wilderness boundary**

Context: There are currently no inholdings within the wilderness and it is highly unlikely the acres of inholdings will change. This measure serves national reporting guidelines.

Description: Inholdings are private or other federal or state agency lands entirely within the wilderness boundary. This measure is a reporting of the acreage of inholdings found within the wilderness boundary.

Relevance: This measure is relevant to the indicator because it tracks the trends in private properties immediately within the wilderness.

Data Source: Refuge Manager, USFWS Realty records. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: Data adequacy is high since these properties are documents. All relevant refuge records were considered.

Determining Significant Change: There were zero acres of inholdings in 2012. This is the baseline recording for the wilderness monitoring plan. Any change in this data would be significant enough impact to be interpreted as a change in trend of wilderness character.

Notes:

- Data will be reevaluated every five years, but it is unlikely that the data will ever change. Therefore, this measure will likely always report a stable trend.
- The undeveloped quality is degraded if the acreage of inholdings is increased.

Baseline Data – Michigan Islands Wilderness

Table 20. *Acres of inholding within wilderness*

Wilderness Island	2012
Pismire	0
Shoe	0
Scarecrow	0
Total	**0**

[Measure 3-3] Index of administrative mechanical transport and motorized equipment use in wilderness

Context: The Wilderness Act discusses three forms of mechanization that degrades wilderness character: motor vehicles (aircraft and motorboats are included here), motorized equipment, and mechanical transport. Agency policies restrict the use of motorized equipment and mechanical transport, requiring authorization for such uses when deemed necessary. Motorized boats are used to access the Michigan Islands Wilderness, but they do not technically enter the wilderness which starts at the mean high water mark. Mechanical transport and motorized equipment are not often used in the Michigan Islands Wilderness except when such equipment is deemed the minimal tool necessary to accomplish refuge goals and to protect the wilderness resource. For example, using a battery powered drill to install refuge boundary signs in bedrock may be authorized.

Description: This measure tracks the status and trends of all motorized and mechanized use authorized by the refuge staff in the Wilderness. Not all equipment types have the same level of impact level associated with them. To account for these differences, an inherent weighting system has been assigned to each equipment type based on its perceived impact to social and bio-physical resources, as shown in the table below. A “low” level of impact is a mechanical use that causes a small impact to the social environment and little or no impact to the biophysical environment (i.e., hand held motorized equipment, battery power tool, or wheelbarrow). A moderate level of impact is a mechanized use that causes a large impact to the social environment (i.e. chainsaw, generator). A high level of impact is a mechanized use that causes a large impact to the social environment and biophysical environment (i.e. helicopter). A total use level value will be calculated for each motorized/mechanized use by multiplying the inherent weight of each type of equipment by the amount of actual use, as shown in the table below. The resulting products for each motorized/mechanized use are summed to generate a total score for the entire wilderness. This sum is reported to the Wilderness Character Monitoring database.

Table 21. *Inherent weight scores of mechanized and motorized use on wilderness islands*

Equipment Type	Inherent Weight		Amount of Use	Use Weight	Total
Battery-powered tool	1		One piece, 1 day	1	
Wheelbarrow	1		Multiple pieces, 1 day	2	
Chain saw	2				
Generator	2		One piece, multiple days	2	
Helicopter	3		Multiple pieces, multiple days	3	

Definitions:
Mechanical Transport: Any contrivance for moving people or material in or over land or air, having moving parts that provides a mechanical advantage to the user, and that is powered by a living or nonliving source. This includes, but is not limited to, hang gliders, parachutes, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as a necessary medical appliance. It also does not include rafts, kayaks, canoes, or similar primitive devices without moving parts.
Motorized Equipment: Machines that use a motor, engine, or other nonliving power sources. This includes, but is not limited to, such machines as chain saws, aircraft, generators, and motor vehicles. It does not include small battery or gas powered hand carried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment.
Relevance: This measure tracks the actual use of motor vehicles, motorized equipment, or mechanical transport for emergency use.
Data Source: Refuge Biologist, Refuge Manager. Data entry sheets were created and stored on the Refuge server.
Data Adequacy: The quality of the data was collected with a moderate to high degree of confidence. For 2012, data came from interviews with refuge staff. Data sheets for accurate recording of administrative mechanical and motorized uses have been developed and will be utilized for future record keeping.
Determining Significant Change: There were no motorized or mechanized uses authorized in 2012. This is the baseline recording for the wilderness monitoring plan. Any change is a significant change since the Wilderness Act prohibits the use of motorized equipment, and mechanical transport.
Notes:

- This data will be reported in the Wilderness Monitoring database annually.
- It should be noted that the specific weights are subjectively determined. Best professional judgment was used when assigning weights.

Baseline Data – Michigan Islands Wilderness

Table 22. *Index of administrative mechanical transport and motorized equipment use in wilderness*

2012					
Equipment Type	**Inherent Weight**	**Amount of Use**	**Use Weight**	**Total Weight (Inherent X Use)**	**Comments**
None					

Solitude or Primitive and Unconfined Recreation Quality

The Wilderness Act states that, wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality is about the opportunity for visitors to experience wilderness; it is not directly about visitor experience per se. Factors that reduce these opportunities, and therefore degrade this quality, include visitor encounters, signs of modern civilization, recreation facilities, and management restrictions on visitor behavior.

Recreation-focused developments such as trails, campsites, shelters, or toilets are included under the solitude or primitive and unconfined recreation quality because of the strong connection to recreational experiences. The distinction between non-recreational and recreation physical development is also made to avoid double-counting recreational developments under both qualities.

Table 23. *Summary of measures for monitoring undeveloped quality on the Michigan Islands Wilderness Area*

Solitude or Primitive and Unconfinfined Recreation Quality *Wilderness provides outstanding oppurtunities for solitude or primitive and unconfined recreation*				
Monitoring Question	**Indicator**	**Measure**	**Data Source**	**Freq (yr)**
What are the trends for outstanding opportunities for solitude within the wilderness?	Remoteness from sites and sounds of people inside the wilderness	4-1 Number of visitors (special use permits and staff visits)	Special Use Permits, Biological Staff, Refuge Manager	1
	Remotness from occupies and modified areas outside the wilderness	4-2 Index of the degree of accumulated trash and debris on wilderness islands	Biological Staff, Refuge Manager	5
	Facilities that decrease self-reliant recreation	4-3 Number of agency provided recreational facilities	Refuge Manager	5
	Management restrictions on visitor behavior	4-4 Number of acres closed to the public	Refuge regulations	5

[Measure 4-1] **Number of visitors (Researchers and Refuge Staff) to wilderness islands**

Context: All units of the Michigan Islands Wilderness are closed to public use. Consequently, the wilderness itself does not receive any visitors per se. Visitors to the island consist only of authorized researchers and refuge staff visiting the islands to conduct monitoring and or research activities. However, there are opportunities for other wilderness visitors to view the wilderness islands from boats passing by.

Description: Each visitor to the wilderness islands is counted. The reason for the visit and location is noted, but only a count of visitors is reported in the Wilderness Character Monitoring database.

Relevance: Part of wilderness character is the feeling of remoteness one feels when they are alone and removed from all the noise of urbanization, vehicles and crowds as well as the sights of urbanization. Seeing human activities, conducted by refuge staff and researchers, on an island closed to the public to protect sensitive habitat and bird species would diminish the solitude and primitive quality of the wilderness to a visitor viewing a wilderness island from a boat. Tracking access to island by staff and researchers within wilderness is important to monitor because the number of visitors within wilderness determines the likelihood of a visitor encountering or hearing noise while they are viewing the wilderness islands.

Data Source: Special Use Permits, Biological Staff, Refuge Manager. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: The quality of the data was collected with a high degree of confidence. For 2012, data came from interviews with refuge staff. Data sheets for accurate recording of visitors have been developed and will be utilized for future record keeping.

Determining Significant Change: There were 11 visitors to the wilderness islands in 2012. This is the baseline recording for the wilderness monitoring plan. A 25% change is considered a significant change.

Notes:

- This data will be reported in the Wilderness Monitoring database annually.

Baseline Data – Michigan Islands Wilderness

Table 24. *Number of visitors (Researchers and Refuge Staff) to wilderness islands*

Wilderness Island	2012
Pismire	4
Shoe	4
Scarecrow	3
Total	**11**

[Measure 4-2] **Index of the degree of accumulated trash and debris on wilderness islands**

Context: Islands in large water bodies are the recipients and often the terminus for debris and litter. The wilderness islands are no exception. Waves wash in all sorts of trash and debris that litter the islands. We can accurately assign a degree for accumulated trash and debris on each wilderness island based on 2012 site visits by staff.

Description: Each wilderness island is scored by the degree of debris and litter present. Degree of litter is given an indexed value score, see table below. Only small pieces of litter in very few locations would be recorded as very low degree. Some evidence of small debris at several locations would be recorded as low degree. A moderate degree would be recorded if some larger pieces of debris are accumulating along with several to many small pieces of litter. A high score would be recorded if many pieces of larger debris and many pieces of small litter have accumulated. A very high score would be recorded if the debris and litter has accumulated to a much higher level than stated above. Scores for each island are summed to generate a total score for the entire wilderness. The sum is reported in the Wilderness Character Monitoring database.

Table 25. *Index value scores for degree of litter present on wilderness islands*

Wilderness Island	Degree of Litter Present on Island	Score
	Very Low	1
	Low	2
	Moderate	3
	High	4
	Very High	5

Relevance: Trash, litter, and debris on an island degrade the opportunity for solitude. Opportunities for solitude are most outstanding where the environment appears natural. Accumulating debris and litter take away from the remote feeling of being away from occupied and developed areas.

Data Source: Biological Staff, Refuge Manager. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: Since the degree of litter and debris is estimated and based on best professional judgment, confidence in the quality of data is moderate within the degree categories assigned for this measure.

Determining Significant Change: A score of three was assigned to estimate the degree of accumulated debris and litter on the wilderness islands in 2012. This is the baseline recording for the wilderness monitoring plan. Any increase in the total score of debris and litter recorded after the initial survey, results in a decrease in the trend for this measure and a degradation of wilderness character. If there is effort to remove debris and litter, this would likely cause a shift in the degree of litter present and be an improvement to wilderness character. Interpreting changes in data as a shifting trend of wilderness character should be done on an individual basis.

Notes:

- These data will be reported in the Wilderness Character Monitoring database every five years.

Baseline Data – Michigan Islands Wilderness

Table 26. *Index of trash and debris on wilderness islands*

Year	Wilderness Island	Degree of Litter Present on the Island	Score
2012	Scarecrow	1	1
	Pismire	1	1
	Shoe	1	1
Total			**3**

[Measure 4-3] Number of recreational facilities provided by refuge

Context: All units of the Michigan Islands Wilderness are closed to public use. Consequentially, there are no opportunities for primitive and unconfined recreation. At present, the Michigan Islands Wilderness has no such facilities and it is highly unlikely that such facilities would be installed in the future because the island will remain closed to visitors.

Description: This measure tracks the trends in permanent facilities that are used primarily for recreational purposes, regardless of whether they are for resource protection or visitor convenience. It also serves national reporting guidelines. Data collected for this measure are from simple numerical counts of the number of physical installations including any unit or object created, set in place, erected, built, or positioned by U.S. Fish and Wildlife within wilderness.

Data Source: Refuge Manager. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: The quality of the data was collected with a high degree of confidence and is representative of the number of administrative installations and structures within the wilderness area.

Determining Significant Change: There were no recreational facilities recorded on the wilderness islands in 2012. This is the baseline recording for the wilderness monitoring plan. Any change in this data would be a significant enough impact to be interpreted as a change in trend of wilderness character.

Notes:

- Data will be reevaluated every five years, but it is unlikely that the data will ever change. Therefore, this measure will likely always report a stable trend.

Baseline Data – Michigan Islands Wilderness

Table 27. *Number of recreational facilities provided by refuge*

Wilderness Island	2012
Pismire	0
Shoe	0
Scarecrow	0
Total	**0**

[Measure 4-4] **Number of acres closed to the public**

Context: All units of the Michigan Islands Wilderness are closed to public use. This restriction is in place to protect the other qualities of wilderness character. In the case of Michigan Islands Wilderness, the islands are closed to protect sensitive habitat and nesting waterbird populations.

Description: This measure tracks the trends in restrictions that the agency places on visitor behavior inside the wilderness. Since all of the islands are closed to the public, a reporting of the total acres closed is reported.

Data Source: Comprehensive Conservation Plan, Refuge Manager. Data entry sheets were created and will be stored on the Refuge server.

Data Adequacy: The quality of the data was collected with a high degree of confidence and is representative of the number of the restrictions on visitor behavior.

Determining Significant Change: All acres comprising the Michigan Islands Wilderness are closed and reported. This is the baseline recording for the wilderness monitoring plan. Any change in this data would be a significant enough impact to be interpreted as a change in trend of wilderness character.

Notes:

- Data will be reevaluated every five years, but it is unlikely that the data will ever change. Therefore, this measure will likely always report a stable trend.

Baseline Data – Michigan Islands Wilderness

Table 28. *Number of acres closed to the public*

Wilderness Island	2012
Pismire	2
Shoe	1
Scarecrow	11
Total	**14**

DROPPED MEASURES

Table 29. *Summary of measures considered but ultimately chose not to use*

Dropped Measure	Reason why measure was dropped				
	Low relevance to assessing wilderness character	Low relevance to this wilderness	Data not available/quality of data poor	Not feasible for Refuge to monitor	Notes
Number of actions to control nonidigenous invasive plant species		X			This does not occur on wildernes islands.
Abundance and distribution of nonindigenous plant species of concern		X			Breeding waterbirds dicate plant communities
Index of select waterbird species	X				Waterbirds are dynamic species, populations naturally fluctuate
Index of the percent of wilderness island acreage that is occupied by nonindigenous invasive zebra mussel shells			X		Zebra mussels are present in waterbody, however no data was available to properly assess impacts
Area and magnitude for pathways for movement of non-indigenous species into wilderness				X	There are potential pathways for movenement of invasive species(ie.travel paths taken by staff and researchers) but not feasible to monitor
Index of emergency use of motor vehicles, motorized equipment and mechanical transport		X		X	Islands are closed to the pulblic decreases need for emergency use
Index of unauthorized (user created) physical development		X			Islands are closed to the public, reducing potential for user-created physical development
Night sky visibility		X		X	Islands are closed to the public
Average number of watercraft in transit adjacent to wilderness islands		X		X	Islands are remote and boat traffic is minimal

CONCLUSIONS

The Michigan Islands Wilderness is a unique unit in the Wilderness Preservation System and is one the smallest areas of land protected by the Wilderness Act. The small size, remoteness and landing difficulties have helped to protect these islands from development. These same traits have made the islands attractive to gulls and other nesting waterbirds. The islands remain much as they were when first placed under protective status, except for natural ecological changes over time.

I believe that the wilderness character monitoring described in this report has taken into account issues that apply specifically to the Michigan Islands Wilderness. These issues are very similar to issues on the other National Wildlife Refuge Wilderness Areas in the Great Lakes. Selected measures for all the island wilderness areas are almost entirely identical. The plan responds to all nationally required wilderness character indicators and the selected measures have been identified as priorities and feasible for Refuge staff to monitor over time.

The Michigan Islands Wilderness requires relatively few, if any, management actions. The islands will remain closed to public visitation to protect the sensitive nature of the islands and bird species using the islands as nesting sites. In most cases, the refuge is collecting data for research and observation rather than direct management. I suspect that the quality of the Michigan Islands Wilderness will not degrade significantly in the immediate or near distant future. It is more likely that the implementation of the wilderness character monitoring plan will result in improved wilderness stewardship and improvement of wilderness character.

APPENDICES

Appendix A – Priority ranking sheet of all measures considered

WORKSHEET: PRIORITIZING POTENTIAL MEASURES OF WILDERNESS CHARACTER

MICHIGAN ISLANDS WILDERNESS DATE: 9/13/12 BIOLOGIST: SADIE O'DELL

In each row, write the potential measure in the left column under the appropriate indicator. Add or delete rows as needed. Use the criteria and ranking guide below to create an overall score for each measure. If the combined score for criteria A and B is ≤ 2, STOP and do not score criteria C and D. Those measures with the highest overall scores should be the highest priority for assessing trends in wilderness character.

A. Level of significance (the measure is highly relevant to the quality and indicator of wilderness character, and is highly useful for managing the wilderness):
High = 3 points, Medium = 2 points, Low = 1 point

B. Level of vulnerability (measures an attribute of wilderness character that currently is at risk, or might likely be at risk over 10-15 years): High = 3 points, Medium = 2 points, Low = 1 point

C. Degree of reliability (the measure can be monitored accurately with a high degree of confidence, and would yield the same result if measured by different people at different times):
High = 3 points, Medium = 2 points, Low = 1 point

D. Degree of feasibility (the measure is related to an existing effort or could be monitored without significant additional effort):
High = 1 point, Low = 0 point (if 0 is given, do not use)

POTENTIAL MEASURE	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	A. Significance	B. Vulnerability	C. Reliability	D. Feasibility	
UNTRAMMELED QUALITY					
Indicator: Authorized actions that manipulate the biophysical environment **Measure:** Index of efforts by staff and/or authorized agents conduct double-crested cormorant management activities on wilderness islands per year(	3	2	3	1	9
Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Days (per island) staff and/or permitted person(s) access wilderness island to collect colonial bird data for research and/or inventory and monitoring per year	2	2	3	1	9
Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat on wilderness island per year	2	2	2	1	8
Indicator: Authorized actions that manipulate the biophysical environment **Measure:** Number of actions taken to capture, remove, band, and/or mark birds within the wilderness boundary per year	3	2	3	1	9
Indicator: Authorized actions that manipulate the biophysical environment **Measure:** Days (per island) staff and/or agents access island to reduce or remove nonindigenous mute swans on wilderness island per year	2	2	3	1	8
Indicator: Authorized actions that manipulate the biophysical environment **Measure:** Number of actions to control nonindigenous invasive plant species	1	2	1	1	5

WORKSHEET: PRIORITIZING POTENTIAL MEASURES OF WILDERNESS CHARACTER

MICHIGAN ISLANDS WILDERNESS DATE: 9/13/12 BIOLOGIST: SADIE O'DELL

Indicator: Unauthorized actions that manipulate the biophysical environment **Measure:** Number of unauthorized actions to manipulate colonial bird communities	1	2	1	0	4
NATURAL QUALITY					
Indicator: Plant and animal species and communities **Measure:** Presence of native breeding waterbird species	3	2	3	1	9
Indicator: Plant and animal species and communities **Measure:** Index of the population status of select nesting waterbirds	2	1	1	1	5
Indicator: Plant and animal species and communities **Measure:** Index of the percent of wilderness acreage occupied by nonindigenous zebra mussels shells	1	1			
Indicator: Plant and animal species and communities **Measure:** Average number of nonindigenous mute swans on wilderness islands	2	2	2	1	7
Indicator: Plant and animal species and communities **Measure:** Abundance and distribution of nonindigenous plant species of concern	1	2	1	0	4
Indicator: Physical resources **Measure:** Air quality data	1	1			
Indicator: Biophysical processes **Measure:** Change in mean seasonal temperature	1	1			
Indicator: Biophysical processes **Measure:** Change in mean annual precipitation	1	1			
Indicator: Biophysical processes **Measure:** Area and magnitude for pathways for movement of non-indigenous species	1	2	1	0	4
UNDEVELOPED QUALITY					
Indicator: Non-recreational structures, installations, or developments **Measure:** Number of authorized physical structures	1	1			
Indicator: Non-recreational structures, installations, or developments **Measure:** Index of unauthorized (user-created) physical development	1	1			
Indicator: Inholdings **Measure:** Acres of inholdings within wilderness	1	1			
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport **Measure:** Index of administrative mechanical transport and motorized equipment use in wilderness	2	1	3	1	7
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport **Measure:** Index of emergency use of motor vehicles, motorized equipment and mechanical transport	1	1			

WORKSHEET: PRIORITIZING POTENTIAL MEASURES OF WILDERNESS CHARACTER

MICHIGAN ISLANDS WILDERNESS DATE: 9/13/12 BIOLOGIST: SADIE O'DELL

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION QUALITY					
Indicator: Remoteness from sights and sounds of people inside the wilderness **Measure:** Number of visitors to wilderness islands (special use permits for visitation)	2	1	3	1	7
Indicator: Remoteness from occupies and modified areas outside the wilderness **Measure:** Index of the degree of accumulated trash and debris on wilderness islands	2	1	1	0	4
Indicator: Remoteness from occupies and modified areas outside the wilderness **Measure:** Night sky visibility	1	1			
Indicator: Remoteness from occupies and modified areas outside the wilderness **Measure:** Average number of watercraft in transit adjacent to wilderness islands	1	2	1	0	4
Indicator: Facilities that decrease self-reliant recreation **Measure:** Number of recreation facilities provided by refuge	1	1			
Indicator: Management restrictions on visitor behavior **Measure:** Number of acres closed to public	3	1	3	1	8

Appendix B – Effort Required for Wilderness Character Monitoring

Effort per Measure:

Quality	Indicator	Measure	Were data gathered from office paper files, computer files, or field work (professional judgment is an option)?	Time you spent gathering data for each measure (in whole hours)	Comments
Untrammeled	Authorized actions	Index of efforts by staff and/or authorized agents conducing double-crested cormorant management activities	Computer files	2	Compiling data and creating a easy reporting spreadsheet took time, but now that the initial work is complete future data entry should require minimal time and effort
Untrammeled	Authorized actions	Days (per island) staff and/or permitted person(s) access island to collect colonial bird population information	Computer files	1	These data came from refuge staff and was based on Special Use Permit information. Easy reporting data sheets were created so that this measure can be accurately tracked in the future.
Untrammeled	Authorized actions	Number of research, survey, and monitoring projects that manipulate vegetation, soils, and other factors of abotic community	Computer files	1	These data came from refuge staff and was based on Special Use Permit information. Easy reporting data sheets were created so that this measure can be accurately tracked in the future.
Untrammeled	Authorized actions	Number of actions taken to capture, remove, band, and/or mark birds	Computer files	1	These data came from refuge staff basic knowlede of projects. Easy reporting data sheets were created so that this measure can be accurately tracked in the future.
Untrammeled	Authorized	Days (per island) staff and/or agents access islands to remove nonindigenous mute swans	Computer files	1	Acquiring the data from the authorized agency conducting mute swan control work took minimal time and future efforts to obtain data will remain minimal.
Untrammeled	Unauthorized	Number of unauthorized actions that manipulate colonial bird communities	Refuge staff	1	Compiling data and creating a easy reporting spreadsheet took time, but now that the initial work is complete future data entry should require minimal time and effort
Natural	Plant and animal species and communities	Presence of native breeding waterbirds	Refuge staff	1	Defining the measure took some time however, this information was common knowledge and gathering data took minimal effort. More time will be required to gather future data because staff will need to visit islands.
Natural	Plant and animal species and communities	Number of nonindigenous mute swans on wilderness islands	Computer files, professional judgment	1	These data came from refuge staff and their memory of recent visits to islands.
Natural	Physical Resources	Air quality data	I & M	1	It took some time to create a data reporting spreadsheet
Natural	Biophysical processes	Climate change data	NOAA Website	2	Defining the measure and creating a data reporting spreadsheet took some time. The data was easy to obtain form the NOAA website and It took minimal effort to enter the data

Quality	Indicator	Measure	Were data gathered from office paper files, computer files, or field work (professional judgment is an option)?	Time you spent gathering data for each measure (in whole hours)	Comments
Undeveloped	Non-recreational structures, installations, or developments	Number of authorized physical structures	Refuge staff	1	Basic refuge knowledge
Undeveloped	Inholdings	Acres of inholding	Refuge staff, USFWS realty	1	Basic refuge knowledge
Undeveloped	Use of motorized vehicles, motorized equipment, or mechanical transport	Index of administrative mechanical transport and motorized equipment use	Refuge staff	2	These data came from refuge staff and was based on memory. Easy reporting data sheets were created so that this measure can be accurately tracked in the future.
Solitude +	Remoteness from inside	Number of visitors	Refuge staff	1	These data came from refuge staff and was based on basic knowledge of staff and permitted visits to the islands. Easy reporting data sheets were created so that this measure can be accurately tracked in the future.
Solitude +	Remoteness from outside	Index of the degree of accumulated trash and debris	Refuge staff, Professional judgement	2	Defining the measure took some time however, this information was based on recent field observations and gathering data took minimal effort. More time will be required to gather future data because staff will need to visit the island. This measure will likely be monitored in conjunction with other refuge monitoring efforts
Solitude +	Facilities that decrease self-reliant recreation	Number of recreation facilities provided by refuge	Refuge staff	1	Basic refuge knowledge
Solitude +	Mgmt. restrictions on visitor behavior	Number of acres closed to public	Refuge staff	1	Basic refuge knowledge

Effort by Refuge Staff:

Title of staff involved in identifying, prioritizing, and selecting measures	Staff time to identify, prioritize, and select measures (in whole hrs)	Comments
Wildlife Biologist	5	helped to identify potential measures
Deputy Complex Refuge Manager	3	helped to identify, review, and rank measures
Complex Refuge Manager	10	helped to identify, review, and rank measures

Effort by Wilderness Fellow:

Time you spent to identify, prioritize, and select all the measures (in whole hours)	Time you spent to learn how to enter data into the WCM database application (in whole hours)	Time you spent to enter all data into the WCM database application (in whole hours)	Time you spent on other tasks directly related to WCM (e.g., reading CCP, giving presentations, talking with staff) (in whole hours)	Time you spent doing other Refuge tasks not directly related to WCM (in whole hours)
105	3	25	Not applicable	Not applicable

Appendix C – Detailed Description of Data Sources and Data Collection Process

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and Protocols for How the Data Were Gathered
Untrammeled Quality		
Index of efforts by staff and/or authorized agents conducting double-crested cormorant management activities on wilderness islands per year	H	*Source:* Special Use Permits Reports, Biologist, Refuge Manager *Process:* Consulted refuge staff. Each action was reported into a data collection spreadsheet. An index was calculated based on management type (egg oiling, nest destruction, shooting) and the number of day's management occurred per island. Management activity is recorded and reported annually. Data entry sheets will be stored on the Refuge server.
Days (per island) staff and/or permitted person(s) access wilderness islands to collect colonial bird population information for research and/or inventory and monitoring efforts per year	H	*Source:* Biologist, Special Use Permits *Process:* Consulted refuge staff to obtain a count of the number of annual visitors. The number of visits were reported and entered into a data collection spreadsheet. This includes all island visits during the breeding season to conduct nest counts, conduct presence or absence surveys and/or ocular estimates, and to conduct avian disease monitoring of breeding birds. The number of days is counted and tallied annually. Data entry sheets will be stored on the Refuge server.
Number of research, survey, and monitoring projects that manipulate vegetation, soils, and other factors of the abiotic community on wilderness islands per year	H	*Source:* Special Use Permits, Biological Staff, Refuge Management *Process:* Consulted refuge staff to determine the number of research projects conducted. This number included projects that only involved manipulation of vegetation, soils, and abiotic community. It did not include research projects that only involved bird census efforts. The number of projects were reported and entered into a data collection spreadsheet. Every project is counted and tallied annually. Data entry sheets will be stored on the Refuge server.
Number of actions taken to capture, remove, band, mark birds and remove eggs on wilderness islands per year	H	*Source:* Special Use Permits and Reports, Biological Staff, Refuge Management *Process:* Consulted refuge staff to determine the number of actions taken to band, capture, and remove birds from all of the islands. The number of projects were reported and entered into a data collection spreadsheet. Each separate action is counted and tallied annually. Data entry sheets will be stored on the Refuge server.
Number of actions taken by staff and/or agents to reduce or remove nonindigenous mute swans on the wilderness islands per year	H	*Source:* Special Use Reports, Refuge Management, Biological Staff *Process:* Consulted refuge staff to determine if any actions were taken to remove invasive mute swans on any of the islands. The number of actions were reported and entered into a data collection spreadsheet. Each separate action is counted and tallied annually. Data entry sheets will be stored on the Refuge server.
Number of UNAUTHORIZED actions taken that manipulate colonial waterbird communities on wilderness islands per year	M	*Source:* Law Enforcement Officer, Incident Reports, Biological Staff *Process:* Consulted refuge staff to determine if any unauthorized action was documented. This information was reported in a data collection spreadsheet. Each separate action is counted annually. Data entry sheets will be stored on the Refuge server.

Natural Quality		
Presence of breeding colonial waterbirds on wilderness islands	H	*Source:* Refuge Biologist, Refuge Manager *Process:* Consulted refuge staff to determine if waterbirds were nesting and present on all islands. This information was entered into a data collection spreadsheet. This information is reported every two years. Data entry sheets will be stored on the Refuge server.
Average number of nonindigenous mute swans on wilderness islands	M	*Source:* Biological Staff, Refuge Manager, Special Use Reports *Process:* Consulted refuge staff to obtain an estimate of the average number of mutes swans (per island) based on their recent visits to the islands. This data was recorded in a data collection spreadsheet. This measure reported every five years. Data entry sheets will be stored on the Refuge server.
Air Quality Data	L	*Source:* National Wildlife Refuge System's Natural Resource Program Center *Process*: Air quality data is not monitored by the Michigan Islands NWR staff; data was provided by the National Wildlife Refuge System's Naturals Resource Program Center (Fort Collins, CO). This measure is made up of four air quality parameters (1) ozone air pollution, (2) total nitrogen wet deposition, (3) total sulfur wet deposition, and (4) visibility. The values are presented as a 5 year average. Data entry sheets will be stored on the Refuge server.
Climate change measures	M	*Source:* National Weather Service Station Annual Data Reports. *Process:* Each measure utilizes data recorded from NOAA weather stations located on Beaver Island for Shoe and Pismire (COOP: 207277) and Alpena Co. Regional Airport for Scarecrow Island (COOP: 200164). These measures are: mean summer temperature, mean winter temperature, and total annual precipitation. Summer was defined as the months of June, July, and August. Winter was defined as the months of December, January, and February. Mean summer and winter temperatures were calculated for each year. These seasonal means were then averaged over a five-year time interval. Mean annual precipitation was obtained by adding the amount of rainfall and snowfall for each year and averaging these amounts over the five year period. Data entry sheets will be stored on the Refuge server.
Undeveloped Quality		
Number of authorized physical structures	L	*Source:* Refuge staff *Process:* Consulted refuge staff to obtain a count of all authorized physical structures on the islands. Each development on wilderness islands was recorded in a data collection spreadsheet. This information will be reported every five years. Data entry sheets will be stored on the Refuge server.
Acres of inholdings within wilderness boundary	L	*Source:* Refuge Manager, USFWS Realty records *Process:* Consulted refuge staff to verify acres of inholdings. This measure is reported every five years. Data entry sheets will be stored on the Refuge server.

Index of administrative mechanical transport and motorized equipment use in wilderness	M	*Source:* Refuge Biologist, Refuge Manager *Process:* Consulted refuge staff to obtain information about motorized, mechanized use on the islands and the types of equipment used. This information was entered into a data collection spreadsheet. An index was developed using an inherent weighting system and assigning a score to each equipment type based on its perceived impact to social and biophysiscal resources. This information is reported annually. Data entry sheets will be stored on the Refuge server.
Solitude or Primitive and Unconfined Quality		
Number of visitors (Researchers and Refuge Staff) to wilderness islands	M	*Source:* Special Use Permits, Biological Staff, Refuge Manager *Process:* Consulted refuge staff to determine the number of visitors to each island regardless of purpose for visit. This included all visits by staff, researches, etc. Each visitor to the island was recorded in a data collection spreadsheet. This information will be reported annually. Data entry sheets will be stored on the Refuge server.
Index of the degree of accumulated trash and debris on wilderness islands	M	*Source:* Biological Staff, Researchers *Process:* Consulted refuge staff to determine the degree of trash on each wilderness islands based on their most recent visit to the islands. This information was entered into a data collection spreadsheet. Each wilderness island is scored by the degree debris and litter present. This information will be collected every five years. Data entry sheets will be stored on the Refuge server.
Number of recreational facilities provided by refuge	L	*Source:* Refuge Manager *Process:* Consulted refuge staff to verify the number of recreational facilities present There are no recreational facilities and it is highly unlikely any will be installed in the future. Data entry sheets will be stored on the Refuge server.
Number of acres closed to the public	H	*Source:* Comprehensive Conservation Plan, Refuge Manager *Process:* All islands are closed to the public; a reporting of the total acres closed is reported. Data entry sheets will be stored on the Refuge server.