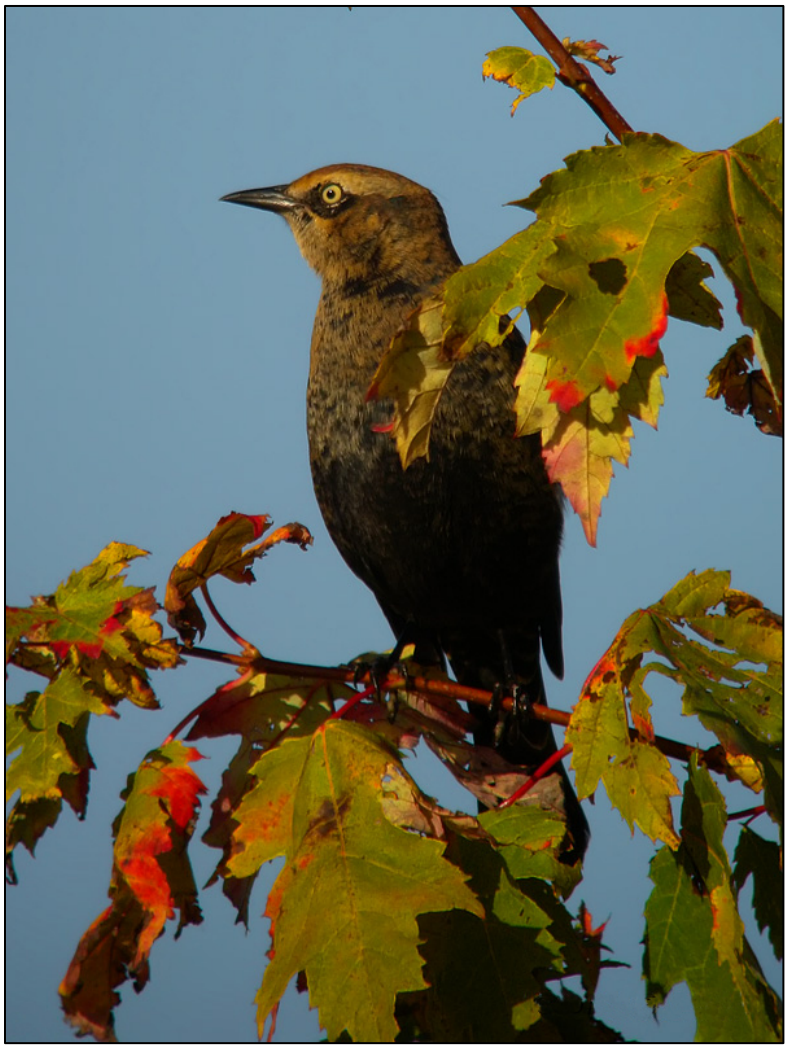
Detroit River International Wildlife Refuge
Habitat Management Plan
June 2016



Rusty blackbird in migration. Photo credit: Jerry Jourdan

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

The National Wildlife Refuge System, managed by the U.S. Fish and Wildlife Service, is the world's premier system of public lands and waters set aside to conserve America's fish, wildlife and plants. Since the designation of the first wildlife refuge in 1903, the System has grown to encompass more than 150 million acres, 550 national wildlife refuges and other units of the Refuge System, plus 37 wetland management districts.

Habitat Management Plan
For
Detroit River International Wildlife Refuge

APPROVALS		
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Table of Contents

Figures

Tables

Appendices

Executive Summary

Located along the Detroit River and western Lake Erie in Wayne and Monroe Counties in southeast Michigan, Detroit River IWR is the first International Wildlife Refuge in the Refuge system. The Detroit River IWR consists of 19 Refuge units, of which 13 are Service-owned land and six are under cooperative management agreements with private land owners. Together, they total approximately 5,700 acres between the Rouge River at the northernmost extreme and North Maumee Bay at the Michigan-Ohio border, a distance of 48 miles. The habitats within these Refuge units protect unique freshwater coastal habitats and contribute to the collective conservation lands in the region. These riverine and shoreline habitats not only have unique species and ecosystem processes, but also host a large migration volume for many species of fish, birds, and insects.

The Comprehensive Conservation Plan (CCP) for the Refuge was completed in 2005. The Habitat Management Plan (HMP) is a step-down plan from the CCP. The HMP adds specific guidance for the implementation of habitat management strategies originally intended under the CCP (Habitat Management Practices 620 FW 1).

The Refuge's Resources of Concern (ROC) were identified by reviewing the species known to occur within Detroit River IWR, as well as those identified in local and regional conservation plans, and analyzing their relation to the biological integrity, diversity, and environmental health (BIDEH) of the habitats present on the Refuge. Based on this analysis, the refuge identified 27 priority ROCs, which include birds, reptiles, fish, plants, and natural communities. Focal ROCs serve as indicators and representatives for other species and groups that may utilize similar habitats. As part of our ROC identification, habitats were also prioritized for future management. Priorities were based on each habitat's ability to be managed effectively to support ROCs. Based on this review, emergent wetland, moist soil/mud, wet prairie, and wet-mesic forest were identified as the Priority 1 habitats for the Refuge.

This HMP builds upon and refines the goals, objectives, and strategies identified in the CCP. As part of the step-down process, most of the habitat-related objectives and strategies identified in the CCP were revised and updated based on current conditions and Refuge management. In addition to updating existing objectives and strategies, new objectives and strategies were identified to guide Refuge management in light of the original guidance provided in the CCP. This HMP provides management guidance, but also a philosophy from its staff that has been cultivated from working in highly stressed ecosystems. Action should be valued as much as time spent in the scientific literature, learning from partners, and encouraging needed research that provides staff with the knowledge to better manage the resource. Reflection and planning how to apply new knowledge must be part of the land restoration process. Actions should be done conservatively, and where uncertainty is high, staff should be structured to learn from their actions.

Chapter 1.
Introduction

Humbug Marsh Unit. (Photo credit: William Welsh, Eastern Michigan University)

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1.1 Scope and Rationale
1.2 Legal Mandates
1.3 Relation to Service Policy
1.4 Relation to Other Plans

1.1 Scope and Rationale

The Detroit River International Wildlife Refuge (IWR or Refuge) is managed by the U.S. Fish and Wildlife Service (USFWS) as part of the National Wildlife Refuge System (NWRS or System). The mission of the NWRS is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. Meeting the wildlife conservation challenges of the 21st century and fulfilling the NWRS mission and vision requires planning and partnerships.

Detroit River International Wildlife Refuge has its origins in an agreement among many partners contained in a 2001 vision document which recognized the significant ecological resources of the region and identified protection priorities in the Detroit River corridor (Metropolitan Affairs Coalition 2001). Through memoranda of understanding and cooperative management agreements, both Canadian and U.S. registries of lands have been established in the spirit and intent of the 2001 Canada-U.S. Conservation Vision for the Lower Detroit River Ecosystem and the Detroit River International Wildlife Refuge. On the Canadian registry of lands are 3,797 acres of Essex Region Conservation Authority land and 981 acres of City of Windsor lands. On the U.S. registry of lands are 7,897 acres of Michigan Department of Natural Resources land and 5,787 acres of lands owned and/or cooperatively managed by U.S. Fish and Wildlife Service. When totaled between Canada and the U.S., 18,462 acres of land in southwest Ontario and southeast Michigan are now being managed collaboratively for conservation and outdoor recreation in the spirit and intent of the 2001 Conservation Vision and the Detroit River International Wildlife Refuge. This HMP focuses on the approximately 2,100 acres under the primary management control of the USFWS. The Comprehensive Conservation Plan (CCP) and the Habitat Management Plan (HMP) are essential to the Refuge's ability to meet these challenges. This HMP provides vision and specific guidance on enhancing and managing habitat for the resources of concern (ROC) at Detroit River IWR. The contributions of the Refuge to ecosystem- and landscape-scale wildlife and biodiversity conservation are incorporated in this HMP.

Typically an HMP sets direction for a 15-year period in concert with the CCP. The additional use of the Annual Habitat Work Plan assists an adaptive process that includes monitoring of ROCs as will be outlined in the Inventory and Monitoring Plan (IMP) as well as scheduled 5-year reviews of the HMP. However, provided that over 10 years have passed since CCP approval, this HMP is intended to provide habitat management direction for the remaining life of the CCP. By this time, the HMP will have been implemented for approximately 4 years and its 5-year review process can help guide CCP revision, establishing renewed 15-year management direction in 2020. The Refuge considers this a "living document" that can be improved and amended as necessary to reflect new knowledge, priorities, and management thinking but holds true to some core principles related to emphases on overall ecosystem function and integrity of remaining natural communities. This plan is a practical one that recognizes the realities of staff and financial limitations.

1.2 Legal Mandates

The U.S. Fish and Wildlife Service is the primary federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. Specific responsibilities include enforcing federal wildlife laws, managing migratory bird populations, restoring nationally significant fisheries, administering the Endangered Species Act, and restoring wildlife habitat such as wetlands. The mission of the Service is to work with others to conserve, protect, and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people.

The Service's role also includes managing the NWRS, the world's largest collection of lands specifically managed for fish and wildlife. The System is a network of more than 550 national wildlife refuges and other units plus 38 wetland management districts encompassing more than 150 million acres of public land and water.

Refuge Purpose Statements are primary to the management of each refuge within the System. The Purpose Statement is derived from the legislative authority used to acquire specific refuge lands and is, along with NWRS goals, the basis on which primary management activities are determined. Additionally, these statements are the foundation from which allowed uses of refuges are determined through a defined compatibility process.

Detroit River IWR was established by an Act of Congress, which became Public Law 107-91 on December 21, 2001. The following refuge purposes were defined in the Act:

1. To protect the remaining high-quality fish and wildlife habitats of the Detroit River before they are lost to further development and to restore and enhance degraded wildlife habitats associated with the Detroit River.

2. To assist in international efforts to conserve, enhance, and restore the native aquatic and terrestrial community characteristics of the Detroit River (including associated fish, wildlife, and plant species) both in the United States and Canada.

3. To facilitate partnerships among the United States Fish and Wildlife Service, Canadian national and provincial authorities, State and local governments, local communities in the United States and in Canada, conservation organizations, and other non-Federal entities to promote public awareness of the resources of the Detroit River.

Other legislation that directs refuge management includes the National Wildlife Refuge System Administration Act (1966) as amended by the National Wildlife Refuge System Improvement Act (1997)16 U.S.C. 668dd668ee (Refuge Administration Act). This defines the National Wildlife Refuge System and authorizes the Secretary to permit any use of a refuge provided such use is compatible with the major purposes for which the refuge was established.

The landmark National Wildlife Refuge System Improvement Act, passed by Congress in 1997, prepared the way for a renewed vision for the future of the refuge system where:

- Wildlife comes first
- Refuges are cornerstones for biodiversity and ecosystem-level conservation
- Lands and waters of the System are biologically healthy
- Refuge lands reflect national and international leadership in habitat management and wildlife conservation

Considered the "Organic Act" of the NWRS, the Refuge Improvement Act clearly defines a unifying mission for the Refuge System; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation and photography, environmental education, and interpretation); establishes a formal process for determining compatibility; established the responsibilities of the Secretary of Interior for managing and protecting the System; and requires a CCP for each refuge by the year 2012. This Act amended portions of the Refuge Recreation Act and National Wildlife Refuge System Administration Act of 1966.

1.3 Relation to Service Policy

Important guidance for habitat management on refuges has already been provided by several key policies outlined by the Service. These policies are included within the Fish and Wildlife Service Manual, which documents re-delegation of the Director's authority, prescribes the policies and procedures for administrative activities and program operations, and steps down our compliance

with other requirements, such as statutes, Executive Orders, Departmental directives, and regulations of other agencies (USFWS 2013). Several policies are pertinent to the development of HMP's:

Habitat Management Planning Policy - 620 FW 1 (USFWS 2002)
This chapter of the Service Manual establishes Service policy for planning habitat management within the NWRS. The guidance in this chapter applies to the development of HMPs and Annual Habitat Work Plans (AHWP) and discusses their relationship to refuge CCPs. The policy and guidance in this chapter describe strategies and implementation schedules for meeting CCP goals and objectives. We utilize this policy to direct the content and considerations addressed in this HMP.

Biological Integrity, Diversity and Environmental Health Policy - 601 FW 3 (USFWS 2003)
This chapter provides policy for maintaining and restoring, where appropriate, the biological integrity, diversity, and environmental health (BIDEH) of the NWRS. The policy is a System directive for refuge managers to follow while achieving refuge purpose(s) and System mission. It provides guidance for conservation and management of the broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems. Further, it provides refuge managers with an evaluation process to analyze their refuge and recommend the best management direction to prevent further degradation of environmental conditions; and where appropriate and in concert with refuge purposes and System mission, restore lost or severely degraded components. We consider the role of BIDEH in our habitat management to the extent that it supports the Refuge purpose, goals, and objectives.

Inventory and Monitoring Policy - 701 FW 2 (USFWS 2014)
This updated chapter (currently in draft form) provides guidance for developing an Inventory and Monitoring Plan (IMP) for a station of the NWRS. It describes priorities for natural resource surveys, the selection and design of survey protocols, data storage and analysis, and reporting results. It accommodates all levels of natural resource surveys from the station level to participation in landscape, regional, national and international inventory and monitoring programs, both internal and external to the Service. Overall, this policy promotes consistency in the planning and implementation of inventory and monitoring throughout the Refuge System. We utilize its guidance to direct the development of inventory and monitoring strategies outlined within the Inventory and Monitoring Plan, which will be developed following the completion of the HMP.

1.4 Relation to Other Plans

Important guidance for wildlife habitat management at the Refuge has already been provided by several important Refuge, regional, national, and international plans.

Interagency Plans

U.S. Department of the Interior Adaptive Management Guide (Williams et. al 2009)
The planning team used adaptive management principles in the development of this HMP and the Refuge will use adaptive management to respond to changing conditions that impair the ability to measure and achieve habitat objectives. It should be noted that although aspects of the U.S. Department of the Interior's (DOI) adaptive management guide were used throughout the entire process of developing this HMP, it is not a required aspect of completing the HMP. As such, the processes outlined below were strictly used as guidance and Service policy (620 FW 1, 601 FW 3, 701 FW 2) for development of HMPs was the overarching direction used to complete the Detroit River IWR HMP. As defined by the DOI (Williams et al. 2009), adaptive management is:

> "…a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and

> other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders."

There are two phases in implementing the DOI's adaptive management procedures; the "Set-up Phase" (Steps 1-5 below) where key components of the program are developed, and the "Iterative Phase" (Steps 6-9) where components of the program are put in practice and linked together in a data driven, results oriented sequential decision making process. The DOI suggests these nine steps in establishing an adaptive management program:

Step 1 – Stakeholder Involvement
This step involves gathering stakeholders to assess the problem(s) and reach agreements about its scope, objectives, and potential management actions. Effort should be made to identify and engage all stakeholders and all steps of the adaptive management process should be open and transparent to them.

Step 2 – Objectives
This step involves identifying clear, measureable, and agreed-upon management objectives to guide decision making and evaluate management effectiveness over time. Objectives should address the resource issue and reflect the social, economic, and/or ecological values of the stakeholders. When drafting objectives, it is important for them to be specific and unambiguous, measureable with the appropriate field data, achievable but challenging, results-oriented, and time fixed.

Step 3 – Management Actions
This step involves identifying potential management actions for decision making. Potential actions should consist of activities that are under management control and alternative actions should be explicit and documented.

Step 4 – Models
This step involves identifying models that characterize different ideas and hypotheses about how the system works. The models should: 1) be understood to change through time; 2) be focused on key components of interest; 3) describe resource changes directly influenced by management; 4) incorporate fluctuating environmental conditions; 5) apply a cost/benefit analysis and; 6) be calibrated with available data and knowledge.

Step 5 – Monitoring Plans
This step involves designing and implementing a monitoring plan to track resource status and other key resource attributes. The monitoring plan should include procedures to: 1) evaluate progress towards achieving objectives, 2) determine resource status in order to identify management actions, 3) increase the understanding of resource dynamics by comparing predictions and results, and 4) enhance and develop models of resource dynamics.

Step 6 – Decision Making
This step involves selecting management actions from a comprehensive list of all possible actions based on management objectives, resource conditions, and enhanced understanding. Actions should be based on objectives and both may need to be adjusted over time to account for the changing of resource conditions or updated understanding of resources and resource dynamics.

Step 7 – Follow-up Monitoring
This step involves using monitoring to track system responses to management actions. Monitoring should occur after management actions have taken place, but in certain situations (e.g. population monitoring) it may be necessary to monitor before the implementation of actions to establish baseline information.

Step 8 – Assessment
This step involves comparing predicted vs. observed change in resource status to improve understanding of resource dynamics. These assessments should include (from monitoring results) parameter estimation, comparative assessments, and prioritization of management alternatives. The results of these comparisons are used to update the understanding of management impacts, inform the selection of management actions, and evaluate the effectiveness of management actions.

Step 9 – Iteration
This step involves returning to step 6 and amending if necessary management actions based upon the results of steps 7 and 8. Occasionally it may be necessary to return to step 1.

Certain aspects of adaptive management as outlined in steps 1-9 have previously been completed with the 2005 CCP (USFWS 2005), while others were revisited or completed with the development of this HMP. Specifically, Step 1 was utilized in developing the HMP with the research of the Refuge history (Chapter 2), the selection of priority resources (Chapter 3), and the development of updated goals, objectives, and strategies (Chapters 4 and 5). In certain cases, outside partners were consulted for their expertise on the wildlife and habitat of the Refuge. In other instances, "stakeholder involvement" involved interactions between the planning team and other experts within the Service as well as by consulting peer-reviewed and/or published literature (e.g. state, regional, national and international plans listed below). Step 2 was first addressed in the 2005 CCP but was revisited in the HMP with the modification of goals and objectives as outlined in Chapter 4, and these modifications took into account aspects of Steps 3 and 4. Step 5 requires the Refuge to establish and maintain a monitoring program to ensure that changing conditions can be detected and responded to adequately and efficiently. The monitoring program will be created in accordance with 701 FW 2 and will be developed as a step down plan that is incorporated into Chapter 6. Step 6 has been achieved with the strategies as outlined in Chapter 5 and these will be revisited every 5 years with the internal review and update of the HMP as mandated in Service policy (620 FW 1). Steps 7-9 will be achieved on an annual basis over the 15 year life of this HMP.

State, Regional, National and International Plans

USFWS Migratory Bird Program Strategic Plan (2004a)
The Migratory Bird Program Strategic Plan provides direction for the Services' migratory bird management over the next decade (2004-2014). The plan contains a vision and recommendations for the Refuge System's place in bird conservation. It defines strategies for the Service to actively support bird conservation through monitoring, conservation, consultation, and recreation. This HMP, to the extent it is practical, will utilize standard monitoring protocols, habitat assessment and management, and promote nature-based recreation and education to forward the vision of the Migratory Bird Program Strategic Plan.

USFWS North American Waterfowl Management Plan (USFWS 2004b)
The North American Waterfowl Management Plan was originally written in 1986 and envisioned a 15-year effort to achieve landscape conditions that could sustain waterfowl populations. The 2004 revision establishes a new 15-year timeframe for waterfowl conservation in North America by assessing and defining the needs, priorities, and strategies required to guide waterfowl

conservation in the 21st century. The species and habitat priority lists were reviewed during our development of Refuge-specific ROC.

Partners In Flight Bird Conservation Plan for the Upper Great Lakes Plain (Knutson et al. 2001)
This plan outlines objectives for the conservation of bird populations across a variety of habitats within the Upper Great Lakes Plain region. It identifies species of concern based on established assessment criteria. It also proposes science-based management strategies, research, modeling, and monitoring of bird populations within the region. Species identified as priority species in this plan were considered during our development and prioritization of Refuge-specific ROC.

Upper Mississippi and Great Lakes Region Joint Venture (UMGL JV) Implementation Plan (2007)
This plan intends to integrate bird conservation priorities at the regional, state, and local levels and provide land managers with guidance regarding management for bird habitat. The plan also promotes research, monitoring, and adaptive management at strategies to improve existing information on bird populations. It also provides management recommendations to improve habitat for bird-groups of conservation concern. Species identified in the plan were considered during our development and prioritization of Refuge-specific ROC.

Upper Mississippi and Great Lakes Region Joint Venture (UMGL JV) Conservation Plans
The UMGL JV developed conservation strategies for landbirds (Potter et al. 2007a), shorebirds (Potter et al. 2007b), waterfowl (Soulliere et al. 2007), and waterbirds (Wires et al. 2010). These plans are intended to provide step-down conservation plans at the regional scale that provide managers guidance for designing landscapes with increased value to birds. Species and habitats identified in the plan were considered during our development and prioritization of Refuge-specific ROC.

Michigan's Wildlife Action Plan (Eagle et al. 2005)
Michigan's Wildlife Action Plan was developed by the Michigan Department of Natural Resources (MDNR) to identify conservation actions, research needs, and long-term monitoring needs associated with the protection of wildlife, including birds, fish, mammals, reptiles, and other species guilds. Species identified as greatest conservation need were considered during our development and prioritization of Refuge-specific ROC.

Fish-Community Goals and Objectives For Lake Erie (Ryan et al. 2003)
The Lake Erie Committee (LEC), representing five fisheries-management agencies comprised of New York, Pennsylvania, Ohio, Michigan, Ontario have developed a set of fish-community goals and objectives for Lake Erie. Species and habitats identified in the plan were considered during our development and prioritization of Refuge-specific ROC.

Draft Fish Community Goal and Objectives for Lake St. Clair, St. Clair River, and Detroit River (St. Clair System) (MacLennan et al. 2003)
This report presents information on the fish community of the St. Clair System, including the Detroit River providing trophic status, historic and recent harvests. It also outlines fish community management principles and recommended objectives for the management. The report is intended to be dynamic as ecosystem changes occur and research data become available. Species and habitats identified in the plan were considered during our development and prioritization of Refuge-specific ROC.

Lake Erie Lakewide Management Plan (LaMP 2008)
The Lake Erie LaMP is coordinated by a committee of water quality and natural resource managers from Canada and the United States, with participation from federal, provincial, state, and local governments that have a role in implementation. Through the development of issue-related strategies, the LaMP identifies actions required to restore and protect the lake and

evaluate the effectiveness of those actions. Habitats identified in the plan were considered during our development and prioritization of Refuge-specific ROC.

Remedial Action Plans (RAPs)
Lake Erie, River Raisin, Rouge and Detroit River RAPs are developed and implemented for all Areas of Concern (AoCs) under the Great Lakes Water Quality Agreement. During this process, impaired uses of the resource are identified, proposes remedial actions, and implements them. The Refuge can play a pivotal role in de-listing an area as an active partner in a de-listing project.

Refuge Plans

Detroit River IWR CCP (USFWS 2005)
The 1997 National Wildlife Refuge Improvement Act required all refuges to complete CCPs by 2012. A CCP is an all-encompassing document that guides biological and public use actions on the Refuge for a 15-year period. The CCP for the Refuge was completed in September 2005. This HMP is a step-down plan of the CCP.

The CCP contains a defined set of Refuge-specific goals, with the one habitat-specific goal being that "fish and wildlife communities are healthy, diverse, and self-sustaining." This goal and its objectives were modified for inclusion in this HMP. Additional goals were set forth in Chapter 4 of the CCP in accordance with 601 FW 1 parts 1.8 D-E. While these goals are not specifically addressed in this HMP, they are relevant to the extent that they indirectly influence habitat management at the Refuge.

Wyandotte NWR CCP (USFWS 2001)
The CCP for Wyandotte National Wildlife Refuge was completed in 2001 prior to the establishment of the Detroit River IWR, which encompasses the former Wyandotte NWR. The Wyandotte CCP was integrated into the development of the Detroit River CCP.

Refuge-Specific "Step-Down" Plans

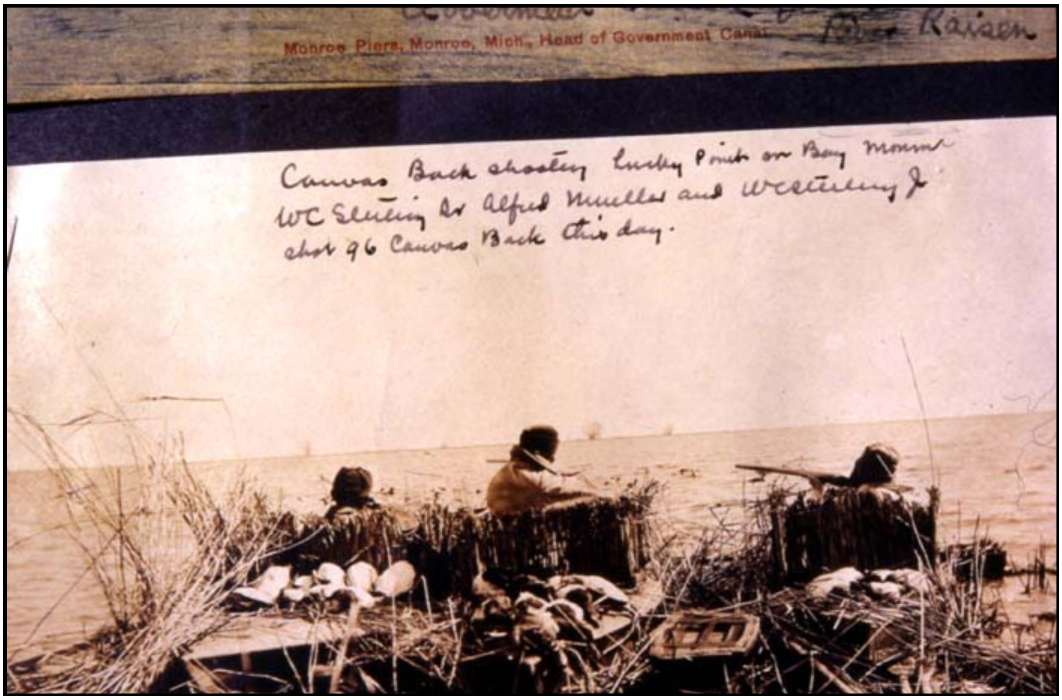
In addition to the aforementioned plans, a number of other Refuge-specific plans have provided guidance either in their draft or final format, including but not limited to:

Fire Management Plan (FMP)
Each refuge containing "vegetation capable of sustaining fire" is required to prepare a Fire Management Plan as mandated by Service policy. Prescribe fire, which is utilized to mimic natural processes and manage certain habitats, has been incorporated as a management strategy into this HMP.

Annual Habitat Work Plan (AHWP)
Each refuge prepares an Annual Habitat Work plan that includes a review of the habitat management activities of the previous year, an evaluation of monitoring programs, and updated recommendations for habitat management strategies for the coming year. It is a tool to accomplish the goals and objectives of this HMP.

Inventory and Monitoring Plan (IMP)
An Inventory and Monitoring Plan is a required Refuge plan and will be developed following the completion of the HMP. Management objectives and strategies developed in the HMP will provide for the framework for how refuge staff can measure progress or status of stated goals.

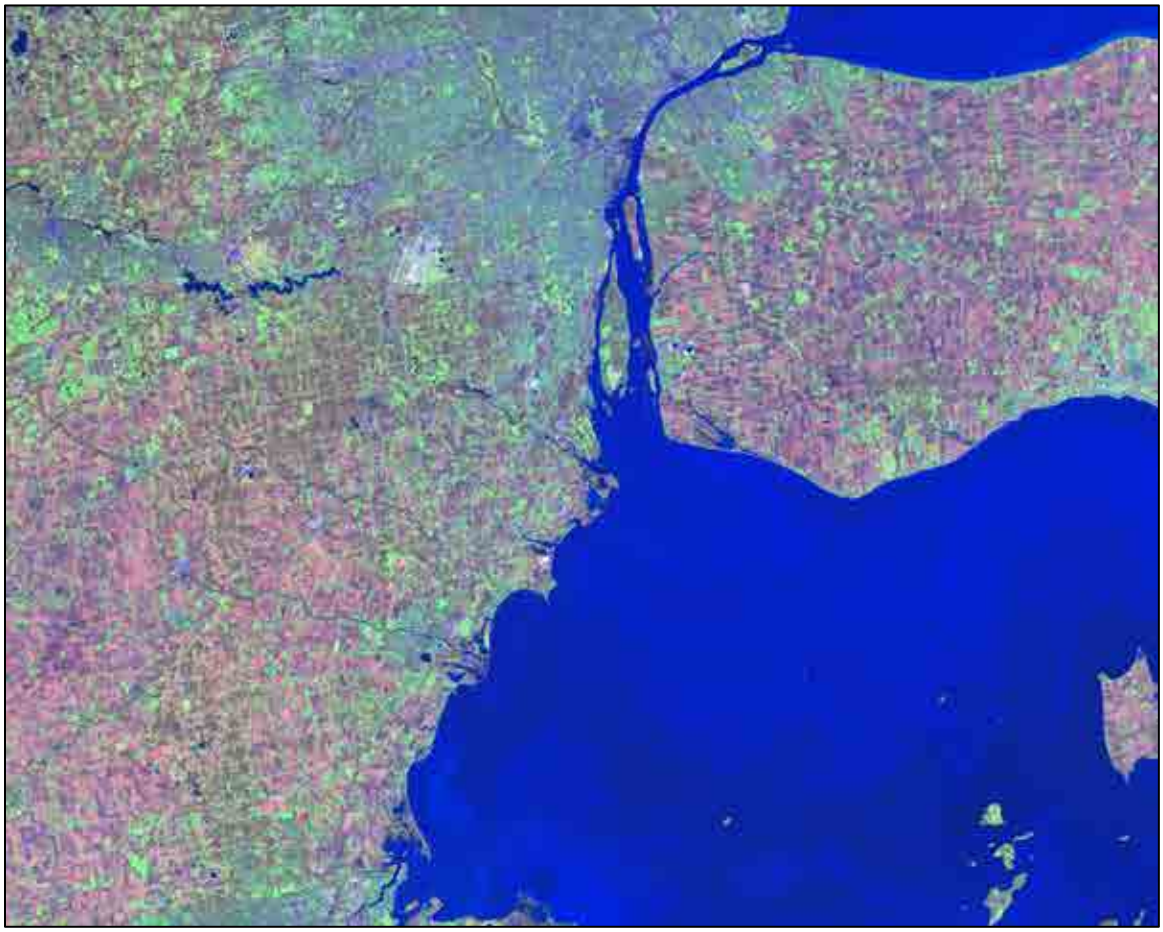
Chapter 2.
Background



Canvasback hunting near modern-day Detroit River IWR, late-1800s. (Photo courtesy of Monroe County Historical Museum Archives)

2.1 Refuge Location and Description

Located along the Detroit River and western Lake Erie in Wayne and Monroe Counties in southeast Michigan, Detroit River IWR is the first International Wildlife Refuge in the Refuge System. Complementary to the Refuge's authorized acquisition boundary on the Michigan side of the Detroit River, the Western Lake Erie Watersheds Priority Natural Area is the mechanism to grow the Refuge in Ontario.



Landsat 7 satellite image of western Lake Erie basin and Detroit River. (Image credit: USGS)

Detroit River IWR consists of 19 Refuge units, of which 13 are Service-owned land and six are under cooperative management agreements with private land owners. They total approximately 5,700 acres between the Rouge River at the northernmost extreme and North Maumee Bay at the Michigan-Ohio border, a distance of 48 miles (Figure 2-1). Refuge units protect unique freshwater coastal habitats and contribute to the collective conservation lands in the region, including those managed by the Michigan DNR Wildlife Division, Michigan State Parks, Huron-Clinton Metroparks, and The Nature Conservancy. These shoreline habitats not only have unique species and ecosystem processes, but host a large migration volume for many species of fish, birds, and insects.

The major reason for the rich abundance and diversity of fish and wildlife is the geographic setting of the Refuge. First, Refuge shoals connect to other extensive beds of aquatic vegetation in the lower Detroit River, which regionally connect similar resources in Lake St. Clair and western Lake Erie. This network cumulatively attracts continentally-significant numbers of certain waterfowl species as they migrate through the lower Great Lakes. These shoals and aquatic

vegetation beds are also used extensively by fish for migration, spawning, and rearing young. In fact, the Refuge provides some of the largest existing shoals and coastal wetlands in western Lake Erie. Secondly, large bodies of water, including Lake Erie, interrupt migration, concentrating birds, bats, and insects along shorelines where they can take advantage of food resources and cover before continuing their migration. Shorelines and islands within the Refuge contain a variety of vegetation types including prairies, shrub-dominated areas, and mature trees, which provide a range of habitat types suitable for a diverse assemblage of migratory animals. The preservation and sharing of the cultural and ecological past of the area through outreach and recreation opportunities is also an important aspect of the Refuge.

Mud Island Unit

As part of a shoal area with 21 acres constructed to hold clean dredge material in the 1960s, this dredge island is now dominated by mature eastern cottonwood (*Populus deltoides*), box elder (*Acer negundo*), ash (*Fraxinus* spp.), American elm (*Ulmus americana*), and non-native shrubs. Beds of aquatic plants that surround the island are critical for fish reproduction. A deep shipping channel exists east of the island and an expansive bed of wild celery (*Vallisneria americana*) occurs mid-stream that connects the habitats around Mud Island to Grassy Island and Mamajuda shoal to the south. These aquatic and terrestrial habitats are important for many fish and migratory birds. No habitat management has occurred in the Mud Island unit since acquisition.

Grassy Island Unit

Grassy Island is a 72-acre island constructed of contaminated dredge material surrounded by dikes and the Mamajuda shoal. There is diverse rock structure and water current around the island that provide critical habitat for fish, as well as extensive beds of aquatic vegetation, including wild celery, on the north and south ends of the island. The 233-acre Mamajuda shoal is highly significant, with wild celery beds extending contiguously for approximately 3.9 km (2.4 miles) to the south of Grassy Island. The uplands of the island are dominated by eastern cottonwood, box elder, staghorn sumac (*Rhus typhina*), willow (*Salix* spp.), and non-native shrubs that colonized after the island was filled with dredge. The uplands are heavily used by migratory birds, while the shoals provide critical shallow water submergent wetland habitat. No habitat management has occurred since acquisition except temporary phragmites (*Phragmites australis*) control to access monitoring wells.

Calf Island Unit

The 11-acre Calf Island Unit is a naturally-formed island in the lower Trenton Channel and surrounding shoals. Calf Island was historically used for grazing and contained permanent structures that have since burned. The island contains a forested area with mature red oak (*Quercus rubra*) and swamp white oak (*Quercus bicolor*), as well as some non-native shrubs. An emergent wetland occurs on the north side of the island, and the island is surrounded by wild celery beds. These aquatic and terrestrial habitats are important for many fish and migratory birds. Phragmites control has occurred on the island.

Gibraltar Bay Unit

Much of the upland of the 41-acre Gibraltar Bay Unit is occupied by the former D-51 Nike Missile site, which was active between 1955 and 1963. An embankment between the main wetland area and upland continues to protect the former launcher area. Water flows through the embayment on the east side of Grosse Ile into a large coastal wetland which contains diverse communities of emergent and submergent wetland vegetation. This wetland is important for many species of fish that require vegetation for spawning and marsh habitat for nursery. Declining water levels since the early 2000s have likely contributed to a change in the composition of the plant community in recent years, including an expansion of American lotus (*Nelumbo lutea*). The unit also contains hardwood swamp. Refuge staff have also managed phragmites populations along the shoreline. Other habitat management includes the planting of native grassland vegetation on the former missile launcher area after site cleanup was completed in 1998. This constructed

prairie has been enhanced in recent years with more native wildflowers. A number of native forbs were planted along the shoreline as part of a shoreline habitat project in the mid-2000s.

Sugar Island Unit

Sugar Island is a 29-acres situated near the southeast end of Grosse Ile. Water flow on the east side of the island is constricted by the island and Cross Dike, which creates a zone of fast current over a shallow, rocky substrate. This type of aquatic habitat is rare in the Detroit River and is important for some fish. The only two significant sand beaches on the Michigan side of the Refuge exist on the east and west sides of the island. These ever-shifting beaches contain threesquare (*Scirpus pungens*) and rufus bulrush (S*cirpus pendulus*), along with willows, silverweed (*Potentilla anserina*), and milkweeds (*Asclepias* spp.) further away from the water. The interior of the island is dominated by wet-mesic forest, which includes some mature red oak and shagbark hickories (*Carya ovata*) which were spared during previous clearing, grazing, and even the construction of an amusement park (with roller coaster) that was built in the late 1800s. Non-native privet (*Ligustrum vulgare*) dominates parts of the forest understory. The island is heavily used by migratory passerines and is directly in line with a continentally-significant raptor migration. No habitat management has occurred since acquisition.

Refuge Gateway Unit

The Refuge Gateway Unit, adjacent to the Humbug Marsh Unit, is a former 44-acre industrial site that was once the site of a Chrysler automotive plant. The majority of the site is owned by Wayne County and is cooperatively managed by USFWS. The unit now contains approximately 14 acres of wetland created from a previously hardened shoreline and from water flowing from an underground drainage pipe. Also, the site contains approximately 26 acres of riparian buffer habitat including native trees and prairie vegetation. A visitor center, parking areas, a boat dock, and a fishing pier are planned for the site.

Humbug Marsh Unit

The 397-acre Humbug Marsh was identified as Michigan's only "Wetland of International Importance" by the Ramsar Convention on Wetlands in 2010. It is largely forested, although a significant portion of the site was cut in 1998 in preparation for a then-planned development. It is is dominated by rough-leaved dogwood (*Cornus* drummondii) and prickly ash (*Zanthoxylum americanum*). The site is poorly drained (clay and silty clay), which causes water to pond in spring and fall, but low moisture availability in summer. These conditions support a wet-mesic flatwoods natural community, which contains the state-special concern Shumard's oak (*Quercus shumardii*), other oak species (*Quercus* spp.), shagbark hickory, American elm, silver maple (*Acer saccharinum*), and black walnut (*Juglans nigra*). High deer browse has eliminated re-generation of many native trees and has altered the trajectory of the plant communities. Two coastal wetlands (one north of the Handler Drain and one south) is dominated by bulrushes (*Scirpus* spp., *Schoenoplectus* spp., and *Bolboschenus* spp.), blue-joint, sedges, reed canary grass, phragmites, and cattail (*Typha* spp.). The composition of emergent wetland vegetation along the shoreline fluctuates with Great Lakes water levels. Marsh birds are found sparingly because of the small size of the appropriate habitat, but the unit receives high use by a wide-ranging of migrant passerines and raptors, and waterfowl around the island. Phragmites management has occurred in some years since 2007 with invasive shrub and tree removal beginning in 2011.

Gibraltar Wetlands Unit

The Gibraltar Wetlands Unit is a contiguous block of 359 acres of wetland habitat. Brownstown Creek flows through the eastern portion of the unit and is fringed by cattail, river bulrush (*Bolboschoenus fluviatilis*) and blue-joint grass (*Calamagrostis canadensis*). Stands of mature black walnut and pin oak (*Quercus palustris*) exist among larger areas of hardwood swamp, and a wetland mitigation area occurs on the south end of the unit. Some portions of the unit contain dense non-native shrubs, and a heavy infestation of phragmites occurs along the creek. No invasive shrub management has occurred, but phragmites control began in 2011.

Gibraltar Wetlands Unit. (Photo credit: William Welsh, Eastern Michigan University)

Lake Erie Metropark

Lake Erie Metropark is a mixed-use park with 780 acres of wetlands managed in cooperation with the Huron-Clinton Metropolitan Authority (HCMA). Natural habitats within the park include emergent wetlands, remnant lakeplain prairie, and early-successional wet forest, much of it hydrologically connected to Lake Erie. Refuge staff manage phragmites populations through a cooperative agreement with HCMA via the Detroit River-Western Lake Erie Cooperative Weed Management Area. Specifically, a recent grant has included initial phragmites reduction, with additional long-term management facilitated by a Marsh Master (amphibious vehicle, Coast Machinery, LLC) which will be shared between Lake Erie Metropark, Michigan DNR, The Nature Conservancy, and Detroit River International Wildlife Refuge.

Strong Unit

The 204-acre Strong Unit contains mudflat, emergent wetland, wet prairie, shrub-carr, and early-successional forest communities. The composition of mudflat and emergent wetland communities are highly influenced by Lake Erie water levels. Phragmites, which established during the low-water period between 2000 and 2003, is prevalent across the unit, but has been successfully reduced by recent herbicide applications, prescribed burning, and mowing. A 17-acre area adjacent to the main wetland portion of the unit was in agriculture and was taken out of production in 2013 and enhanced with native plant seed.

Brancheau Unit

The Brancheau Unit is 207-acres of former agricultural fields that are now in old field habitats, coastal wetlands open to Lake Erie, and diked emergent wetlands, which allows Refuge staff to manipulate water levels. The north diked unit is managed as a hemi-marsh, while the smaller south diked unit is currently managed as moist soil habitat on an experimental basis; the majority of the diked wetland areas are dominated by cattail and native wetland annuals. The coastal

wetland portion of the unit demonstrates typical coastal wetland zonation, but most of this area is dominated by phragmites. Phragmites populations on Refuge-owned land have been managed by Refuge staff since 2011.

Brancheau Unit coastal wetland and impoundments. (Photo credit: William Welsh, Eastern Michigan University)

Fix Unit

The 95-acre Fix Unit was largely in agricultural production until the initiation of a habitat restoration project that will be completed in 2016. However, the eastern section supports natural wet prairie, shrub-carr, and hardwood swamp communities, and the Refuge has begun control of phragmites infestations. This unit is adjacent to the Michigan Nature Association's Swan Creek Plant Preserve.

Lagoona Beach Unit

The Lagoona Beach Unit, owned by DTE Energy, is a 657-acre block of coastal wetland and hardwood swamp. The unit is one of the largest remaining coastal wetlands in western Lake Erie.

Ford Marsh Unit

The 242-acre Ford Marsh Unit is a diked wetland adjacent to the River Raisin and Lake Erie. It is hydrologically connected to Lake Erie through a 36-inch overflow pipe, but the pipe is high enough that water rarely flows into or out of the wetland. The wetland is dominated by white water lily (*Nymphaea odorata*) in the growing season and is used heavily by migratory waterfowl. Refuge staff have treated phragmites beginning in 2011 and have finished the installation of a pump structure with Ducks Unlimited to enable staff to emulate (to the extent practicable) fluctuations in Great Lakes water levels enough to diversify the habitats over time.

Plum Creek Bay Unit

The 126-acre Plum Creek Bay Unit is influenced by wind-driven seiche events that dictate the amount of water in the bay. West winds blow water out of the bay, while east winds flood the bay. These fluctuating water levels create temporary mudflats and shallows that are extensive at times. Plum Creek, which has several springs along its bank, flows into the northwest corner of the bay. The area around these springs supports diverse herbaceous plant communities, and the south end of the unit is dominated by hardwood swamp.

Lady of the Lake Unit

The Lady of the Lake Unit contains 49 acres of emergent wetland and beach ridge that is cooperatively managed with Consumers Energy. It is connected to Lake Erie by a 12-inch pipe fitted with a screw-gate that provides a hydrological connection to Lake Erie. The Lake Erie side of the wetland contains a bermed trail with an unhardened beach ridge.

Holloway Unit

The Holloway Unit is a 48-acre coastal wetland adjacent to Erie Marsh and Erie State Game Area. The wetland areas are dominated by American lotus (*Nelumbo lutea*). Uplands within the unit contain a mix of shrub-carr and wet prairie habitats.

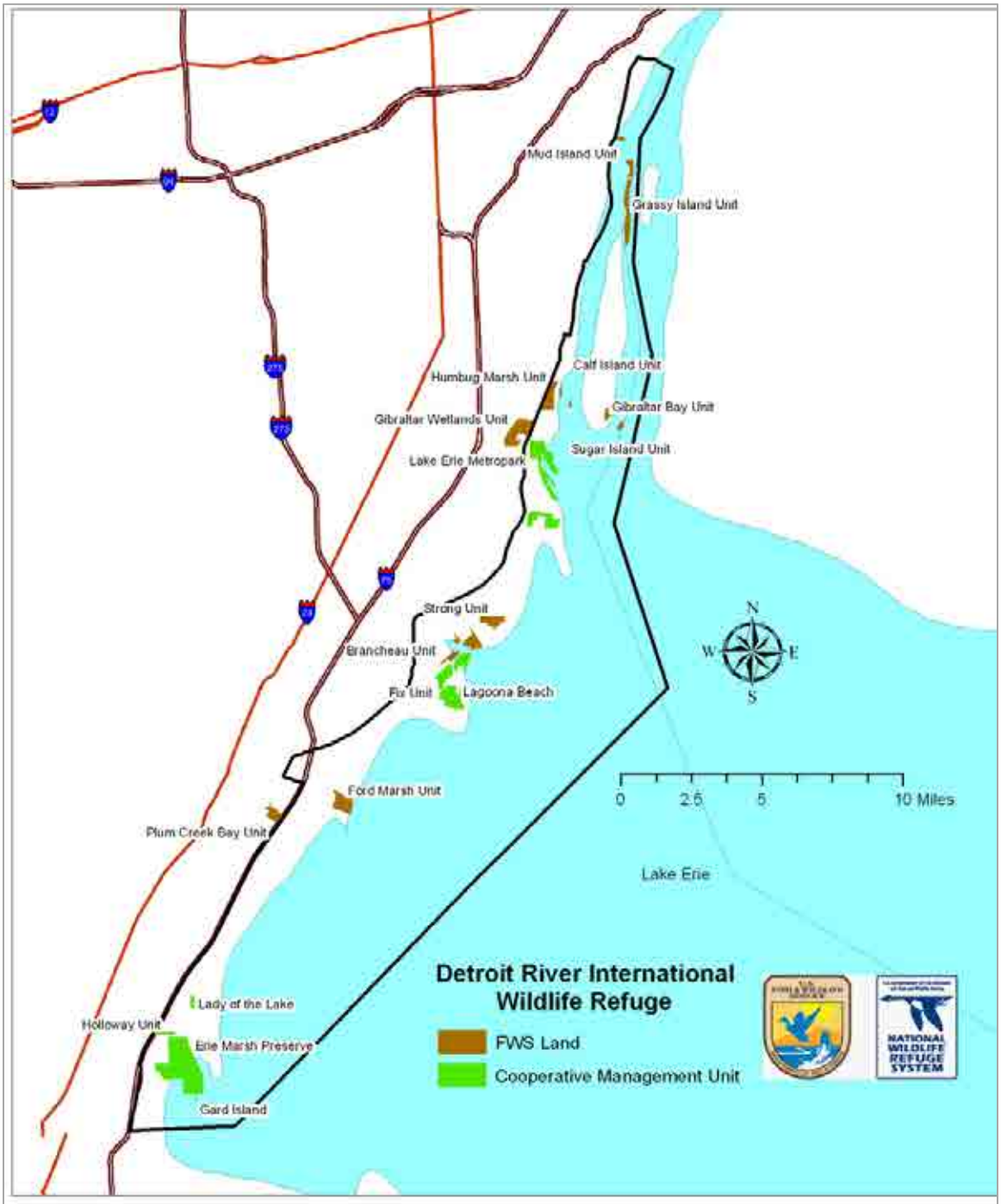
Erie Marsh Preserve Unit

The 2,217-acre Erie Marsh Preserve is managed cooperatively with The Nature Conservancy. Together with the adjacent Erie State Game Area, it forms one of the largest contiguous coastal marshes along the western shore of Lake Erie. Refuge staff are able to cooperate on invasive species management via the Detroit River Cooperative Weed Management Area.

Gard Island Unit

Gard Island is a 19-acre island in North Maumee Bay that is managed cooperatively with the University of Toledo.

Figure 2-1. Authorized Boundary and Management Units of Detroit River IWR.



The Detroit River IWR acquisition boundary contains approximately 126,000 acres of land and water. The Refuge is authorized to acquire a total of 13,300 acres within this larger area. Currently the Refuge contains 5,700 acres.

2.2 Geographical Setting

Great Lakes Basin Ecosystem
The Detroit River IWR is located within the Great Lakes Basin Ecosystem, a system shared with Canada and eight states. The ecosystem is made up of the world's largest freshwater body, which holds 18 percent of the world's supply of freshwater, and has a drainage basin of 228,000 square miles. Major biological concerns within the ecosystem include the impact of exotic species, aquatic and terrestrial habitat loss, contaminants. Human activities including commercial navigation, industrial development and waste disposal, drinking water extraction, recreation, and other uses affect natural resources within the ecosystem.

Detroit River
The Detroit River consists of a 32-mile-long channel bordered by a poorly drained clay lakeplain. The river is underlain by limestone bedrock, and the shoreline is dominated by heavy industrial development. Approximately 6,200 acres of wetland occurred as channel-side (fringing) wetlands and submergent vegetation beds on both the U.S. and Canadian sides of the river. These wetlands have been heavily degraded by dredging and filling for industrial development, contamination by heavy metals, oils, and other pollutants, proliferation of exotic invasive species, and isolation from natural processes through diking and other hydrological manipulation. In an effort to support the local community's goals for the Detroit River, it was named as an American Heritage River in 1998.

Lake Erie (Western Basin)
The authorized boundary of the Detroit River IWR extends along the western shore of Lake Erie to the Ohio state line. This shoreline is characterized by several small communities, marinas, agricultural fields, state wildlife areas, and coastal wetlands. Much of the coastline has been altered or armored to prevent erosion from storms and waves during periods of high water. Nutrient-loaded agricultural run-off has created toxic algal blooms in recent years.

Landscape Conservation Cooperative (LCC) Context
Detroit River IWR is located within the Upper Midwest and Great Lakes (UMGL) LCC. The mission of the UMGL LCC is to build a network of knowledge on climate change impacts to fish, wildlife, and other natural resources, while identifying conservation and management strategies that prepare for these and other changes across the region. A list of 36 surrogate species were identified across seven broad habitat types within the Upper Midwest and Great Lakes (UMGL), including many that are found on the Refuge (USFWS 2014) and are Resources of Concern in this HMP. The selection of a representative group of surrogate species can provide a measure of conservation progress at both local and landscape scales.

Bird Conservation Region (BCR)
The regional planning efforts completed by the North American Bird Conservation Initiative (NABCI) in 1999 created a series of regional conservation planning units that span international boundaries. Detroit River IWR is located at the intersection of BCR Regions 13 (Lower Great Lakes/St. Lawrence Plain), 22 (Eastern Tallgrass Prairie), and 23 (Prairie Hardwood Transition), with most of the Refuge falling within the Prairie Hardwood Transition. This region was historically dominated by beech-maple forests, prairies, and oak savannas. Past glaciation in this region led to the formation of many shallow lakes and depressional wetlands, which support high densities of breeding waterfowl (NABCI 2010).

Partners in Flight (PIF) Physiographic Area
Partners in Flight (PIF) has created 99 physiographic areas that link conservation areas by natural environmental characteristics. The Refuge falls within the Upper Great Lakes Plain PIF Physiographic area. Historic vegetation types in this area include broadleaf forests, oak savannas, and various prairie communities.

Upper Mississippi River/Great Lakes Region Joint Venture (UMGL JV)
Detroit River IWR occurs within the UMGL JV, which includes all of Indiana, Michigan, Wisconsin, plus portions of seven other states. Through various partnerships, the UMGL JV seeks to coordinate the development and implementation of bird conservation goals, decision tools, and management strategies across the region.

2.3 Historical Perspective of Ecological Landscape

Geologic Development

The Refuge occurs in the Great Lakes basin, which began to take its modern form during glacial retreat at the end of the last ice age approximately 14,000 years ago. The Refuge is located on the glacial lakeplain of former Lake Maumee, a postglacial lake that was formed by the melting of the Erie lobe of the Wisconsin glacier prior to the formation of modern Lake Erie. The melting glacier deposited a thick layer of clay from glacial lake sediment over Paleozoic-era shale and dolomite bedrock in the area now occupied by the Refuge. Following the retreat of Lake Maumee water levels approximately 9,000 years ago, these glacial lake deposits resulted in a flat landscape consisting of poorly-drained mineral soils that extends 30 to 40 miles inland of modern Lake Erie and Lake St. Clair (Sherzer 1900, Albert 1995). In certain areas, temporary glacial meltwater streams deposited a thin layer of sand on top of the clay. The well-drained sandy soils interspersed with poorly-drained clay soils historically supported a complex mosaic of lakeplain oak openings, wet-mesic flatwood forests, hardwood swamps, and lakeplain prairies (Comer et al. 1995).

Pre-European Settlement

The region of the Detroit River has been inhabited by humans since the Early Archaic Period following the retreat of the glaciers approximately 10,000 years ago. Early Woodland Era (circa 3,000-1,000 years ago) artifacts have been found on the Refuge. Many of the later groups were members of the Algonquin group and likely included Miami, Sauk, Fox, Mascouten, and Kickapoo bands, which were well established from the Detroit River north to Saginaw Bay (Cornell 2003).

A major reason for the settlement of this area was undoubtedly the rich environment of the Detroit River basin, which provided abundant natural resources necessary for establishing a permanent human presence in the area. Archeological evidence suggests that the diet of early Native Americans in the region was varied and consisted of large game, small game, fish, and plants. The landscape during this period of time contained significantly more wetlands than it does today, and supported large numbers of migratory birds, fish, and mammals (Cornell 2003, Lovis 1999, Lovis et al. 1999).

The wetland habitat surrounding the Detroit River supported plentiful beaver, which were an important food source for populations in the area. Beaver modified the landscape through the construction of dams, which provided an extensive network of pathways used by native hunters to traverse lowland areas. The dams also created shallow aquatic pools, which were important for the production of other major food sources including white-tailed deer, muskrats, and wild rice (*Zizania aquatica*) (Cornell 2003). Later, beaver became centrally important to the fur trade in the region, and helped establish a permanent European presence in the area.

The Detroit River itself offered a convenient north-south route for the transportation of goods and people. It also supplied an abundance of fish, including lake sturgeon, which were harpooned from canoes during spawning runs. Native peoples also caught channel catfish, suckers,

northern pike, bass, yellow perch, and walleye, all of which are present at the Refuge today (Cornell 2003).

Archeological evidence suggests that populations had transitioned from a hunter-gatherer lifestyle to the establishment of agricultural communities by at least 1,500 years ago. By this time, the Iroquois, Wyandot (Huron), Ottawa, and Potawatomi had established a presence along with other tribes in the Detroit River basin. Corn, beans, squash, and sunflowers were the primary crops grown in the fertile outwash plains within the Refuge area (Cornell 2003).

European Settlement

Due to its abundant natural resources, the area surrounding Detroit River IWR was hotly contested by the French, British, and Iroquois beginning in the mid-seventeenth century. Shortly after the arrival of European explorers, trade relations were established with Native Americans and the fur trade became central to the economy of the region. After establishing trade connections with Europeans, competition between Native American tribes increased dramatically, culminating in a bloody Iroquois-led campaign which effectively dispersed many of the other native groups in the area by 1700 (Cornell 2003, Givens-McGowan 2003).

The natural abundance of the Detroit River basin was described by European explorers as early as 1679 (Kerr et al. 2003). In 1699, the French explorer Antoine De La Motte Cadillac was brought by the Wyandot to Detroit, in part to verify reports of abundant beaver. Cadillac saw the Detroit River as a strategic transportation corridor that was necessary to secure in order to gain an advantage in the fur trade against the British and Iroquois. In 1701, he established Fort Detroit, the first permanent European settlement in the area, on the site of modern-day Detroit (Burton et al. 1922, Kerr et al. 2003, Givens-McGowan 2003).

For nearly 100 years, Detroit existed as a largely French community built around the fur trade, and transportation along the river was conducted primarily by canoe. In 1796 the first wharf was constructed in Detroit, which began the process of shoreline alteration that continued into the industrial era. The first steamboat arrived in Detroit in 1818, and the construction of the Erie Canal was completed in 1825. With improved transportation on the river, the population of Detroit increased tenfold in the period between 1817 and 1837 (Kerr et al. 2003).

By 1850, the importance of the fur trade had subsided in relation to other commercial activities including wholesale trading and retailing, in part because beaver populations had been vastly overexploited (Hartig 2003). The fishing industry, focused on Detroit River whitefish and sturgeon, became an important export commodity during this time. The processing of fish and other goods including timber, copper, and aggregates laid the foundations of the coming industrial economy (Kerr et al. 2003). The growth in manufacturing of ships, railroad cars, furniture, cigars, shoes, and other products towards the end of the century came as a result of the convenient transportation via the Detroit River and the close proximity to raw materials (Hartig and Stafford 2003). By 1900, the population of Detroit had increased to 285,704 as a result of these commercial and industrial developments (Dunbar and May 1995).

The growth in trade and manufacturing marked the beginning of extensive alterations to natural habitats around the area now occupied by the Refuge. According to Levanen (2000), docks and wharfs stretched continuously for five miles along the Detroit River waterfront by the late 1800s. Channels in the Detroit River and Rouge River were dredged to support the shipping industry (Hartig 2010). The drainage of wetlands for agricultural and commercial development in the city of Detroit and throughout the Detroit River watershed also began accelerating during this period.

20th Century Development

Landscape changes to the area around the Detroit River IWR accelerated with the rise of the automobile industry in the early 1900s. Massive industrial developments, such as the 2,000-acre Rouge Plant built by the Ford Motor Company in 1918, contributed to the eventual loss of nearly all natural habitat surrounding the Detroit River by the middle of the 20th century (Hartig et al. 2007).

Since the 1800s, 97 percent of Detroit River coastal wetlands have been lost to shoreline development and modifications to the channel, including dredging shipping channels, building concrete breakwalls, installing steel sheet piling, and adding fill material and dredge spoils to wetlands and the river itself. In addition to habitat loss, industrial activities contributed to heavy oil pollution in the Detroit and Rouge Rivers. Oil pollution had direct impacts on wildlife, including an incident in 1948 where 11,000 Detroit River waterfowl died after becoming coated in oil (Manny et al. 1988, Hartig and Stafford 2003, Hartig et al. 2007). Other industrial contaminants, including PCBs and heavy metals, persist in certain areas of the Refuge today.

Public outcry following incidents such as the 1948 waterfowl kill and the heightened awareness of pollution following the publication of Rachel Carson's *Silent Spring* led to environmental reforms beginning in the 1960s and 1970s that have contributed to some recovery of natural systems along the Detroit River. The greatest changes have been associated with improvements to oil pollution levels and water quality. Improvements to habitat quality and availability have been less substantial, largely because the Detroit River corridor remains dominated by urban and industrial land uses (Hartig et al. 2007).

Historic Plant Community Characterization

The General Land Office (GLO) surveyed the state of Michigan between 1816 and 1856. Land surveyors recorded the species, locations, and diameters of trees used to mark section corners and boundaries, and also noted the locations of water bodies, wetlands, and soil characteristics. These data were used by Michigan Natural Features Inventory (MNFI) to develop a detailed digital map of historic vegetation across the state (Comer et al. 1995).

Comer et al. (1995) identified 5 broad plant community types that historically occurred within the authorized boundary of the Detroit River IWR. Shrub swamp/emergent marsh and wet prairie communities were the most abundant wetland types along the Detroit River and Lake Erie shorelines. Mixed hardwood swamp was also present, but was not as abundant as herbaceous wetlands (Comer et al. 1995). Beech-sugar maple forests dominated the upland areas west of the Refuge, with ash, oak, basswood, and elm noted frequently in the GLO notes. A detailed crosswalk of plant community types currently found on the Refuge today is provided in Table 2-1.

Historic Changes in Wildlife and Habitat

Like all ecosystems, the Refuge's species and ecosystems have and will continue to change. However, European settlement in the 18th century marked the cataclysmal transition from a complex landscape of forest and prairie to agriculture, which drained and destroyed habitats across the region. Forest loss meant the loss of species requiring large tracts of intact forest, such as gray wolves and black bears. Likewise, the elimination of prairies throughout the area resulted in the removal of the prairie sod containing hundreds of species of plants, subsurface microbes, and associated animals. By the late 1800s, the shoreline was heavily industrialized, and land use intensified throughout the 20th century. In conjunction with shoreline hardening, high water levels in the early 1960s destroyed much of what remained of western Lake Erie's emergent marsh. The hardened shoreline limited any inward shifting of emergent wetland

habitats, leaving open water and hardened shoreline with the absence of transitional wetland zones.

Not surprisingly, land cover change maps created by MNFI show that nearly 100 percent of the original cover of natural vegetation was converted to urban or agricultural uses in this area by 1978 (Michigan Natural Features Inventory 2013). This supports previous findings that 97 percent of Detroit River wetlands and 95 percent of coastal wetlands in western Lake Erie have been lost since the 1800s (Mitsch and Wang 2000, Hartig et al. 2007).

Habitat loss and degradation, coupled with human overexploitation of natural resources, has had direct impacts on wildlife within the Refuge area. The fur trade, centered in Detroit, was driven by demand for fur hats and other fashion items in Europe in the late eighteenth and early nineteenth centuries (Hartig 2003). During this period, hundreds of thousands of beaver skins were exported annually to Europe from the Great Lakes region. As beaver populations plummeted in the Refuge area due to overhunting and the drainage of wetland habitat, fur traders expanded their efforts further north and east. By the mid-1800s, the beaver was hunted to near extinction east of the Mississippi River and the fur trade collapsed (Dunbar and May 1995, Muir 2000, Hartig 2003). Because beaver are ecosystem engineers, their extirpation from the Refuge area dramatically altered wetlands in the region concurrently with drainage for farming.

Another example that illustrates habitat loss and degradation is the decline of lake sturgeon populations within the Detroit River. Lake sturgeon were once an abundant food source for Native Americans, and historically, the Detroit River supported one of the largest lake sturgeon populations in the Great Lakes. Sturgeon once spawned on the rocky bottom in the swift current at seven major spawning areas in the Detroit River, including an area just northeast of Grassy Island. However, overfishing, contamination, and in-channel habitat destruction in the early 1900s devastated populations and brought lake sturgeon to near-extirpation in the area. Recent restoration efforts, including the construction of artificial spawning reefs, have attempted to bring back the lake sturgeon population in the Detroit River. Indeed, follow-up studies have confirmed spawning by lake sturgeon in the Detroit River for the first time in several decades (Manny and Kennedy 2002, Roseman et al. 2011).

Because of its geographic position within the Great Lakes Basin and along the migration route of many species, the Detroit River and western Lake Erie basin has historically been a continentally significant stopover point for migratory birds and waterfowl. Beginning in the mid-1800s, commercial hunters harvested waterfowl from marshes using guns capable of killing dozens of birds in a single shot (Albert 2003). Although overhunting contributed to the decline in waterfowl populations, waterfowl populations reached all-time lows from drought and habitat loss in their breeding areas. As with other wildlife, waterfowl populations have seen some recovery since 1950 levels (USFWS 2005).

Many ecosystem processes that were fundamental to earlier habitats have been altered, just as processes occurring today will continue to change dynamically. Forests have lost wolves as a top predator, hunting no longer controls deer populations in many urban areas, and meso-predators such as raccoons and skunks are abundant. Populations of brown-headed cowbirds have increased with habitat fragmentation, and have presumably resulted in lower breeding success of many forest songbirds. Forests have been highly altered in the last generation by chestnut blight, Dutch elm disease, and the emerald ash borer, which altered the role of American chestnut (*Castanea dentata*), American elm, and ash, respectively. Similar kinds of cascading ecological impacts exist for each of the Refuge's habitats.

2.4 Current Natural and Anthropogenic Disturbances

Invasive Species

Many invasive plant species occur within the Refuge, of which phragmites (Phragmites australis subsp. australis) and reed canary grass (*Phalaris arundinacea*) currently have the largest impact on native vegetation and habitat quality. Several management techniques have been used to reduce encroachment of undesirable plant species, including herbicide, mowing, burning, water level manipulation, plowing, and biological controls (USFWS 2005). Up to the present, Refuge staff have approached management of invasive species selectively where there are multiple benefits. Treatment has been almost exclusively reserved for areas where biodiversity, public use, and overall landscape character simultaneously will be conserved.

Dense phragmites stand prior to management, Strong Unit.

Phragmites is not only abundant in many wetland units throughout the Refuge, but grows to extreme height and density. Reduction of some specific monotypic stands has been an important focus of habitat management since 2010 where it leads to significant multiple benefits. This closed canopy of dense plant material excludes almost all other vegetation and reduces invertebrate productivity and availability to wildlife including wading birds, waterfowl, and shorebirds such as yellowlegs and dowitchers. Also, tall, dense stands of phragmites present a considerable risk of wildfire. Refuge staff have used a combination of herbicide, fire, and mowing to successfully reduce phragmites in previously infested areas.

Based on observations by Refuge staff in recent years, management that is successful in reducing the density and overall vigor of a phragmites stand, as opposed to complete eradication, is often sufficient to achieve increased wildlife use and other management goals. For example,

reducing the cover, height, and/or vigor of a dense phragmites stand can make aquatic food sources available for wildlife at least temporarily, even if some phragmites returns in subsequent seasons. Reducing phragmites also diminishes competitive pressure on native wet prairie and emergent wetland plant species and increases opportunities for the seed bank to re-charge itself, which presumably leads to sustained biodiversity on the Refuge.

Phragmites treatment areas must be prioritized and managed efficiently with specific objectives in mind. Moreover, based on observations by Refuge staff, phragmites stands respond with a high degree of variability following management, with some populations more difficult to control than others. As with all Refuge management activities, phragmites management is done within the context of restoring natural disturbance regimes and successional processes, which allows for some year-to-year fluctuation in the size and vigor of phragmites stands beyond the complete control of Refuge staff. Specific strategies for managing phragmites are provided in Section 5.3.

Reed canary grass is abundant in the Refuge, including in some wet prairie areas, but Refuge staff have not yet managed these areas.

Successful control of purple loosestrife (*Lythrum salicaria*) has been achieved on the Refuge by the release of *Galerucella* beetles, which feed exclusively on purple loosestrife plants. Beetles have been released at Pointe Mouillee State Game Area, Celeron Island, Stony Island, and Grosse Ille, with good results in terms of reducing purple loosestrife populations. In most cases, native species such as cattail, bulrushes, and nut sedges (*Cyperus* spp.) establish after purple loosestrife stands are reduced.

Upland invasive species such as buckthorn (*Rhamnus cathartica* and *R. frangula*), honeysuckle, and multiflora rose (*Rosa multiflora*) have been targeted in certain areas of the Refuge, including the Humbug Marsh and Gibraltar Bay Units. Control of these species has been done in conjunction with more general efforts to set back woody plant succession and/or to increase light gap heterogeneity in forest understories, especially where invasive or high deer browse has lowered forest quality. Other areas of infestation are not being managed. All Refuge forest land is relatively young, secondary forest, and allowing succession to proceed without intervention has been the management direction in all but the above-mentioned units.

The primary imperative for management of exotic species is the prevention of their introduction and spread into quality areas where they do not yet exist. For example, membership in the Detroit River-Western Lake Erie Cooperative Weed Management Area (CWMA) has fostered communication about the status of new species or establishment in new areas.

Water Impoundment System

Most of the Refuge's wetlands are hydrologically connected to Lake Erie, but a portion of the Brancheau, Fix, and Ford Marsh units are maintained by a system of constructed earthen dikes and water control structures that allow manipulation of the water levels based on management objectives and time of year.

Public Use

There are no fees associated with general use of the Refuge. Public access to the Refuge is available for hunting of migratory birds, small game, and big game (i.e., white-tailed deer and wild turkey) in some units of the Refuge. The Refuge Gateway, Humbug Marsh, and Gibraltar Bay Units are opened for scheduled events only. All other use requires a special use permit.

Contaminants

The Detroit River has experienced over a century of contaminant discharges from point and nonpoint sources including stormwater runoff, air deposition, sewer overflows, and municipal and industrial discharges. The primary contaminants are cadmium, copper, lead, mercury, zinc, and PCBs, although other contaminants have been identified (UGLCCS 1988). Many of these contaminants bioaccumulate as they move through the food chain and have been identified at high levels in fish and wildlife inventoried on the Refuge.

Although contamination levels in general have decreased substantially since the 1950s, contaminants are persistent in certain areas throughout the Refuge. There are many contaminated sediment hotspots that represent the legacy of the industrial revolution. These are and will be remediated in the future through the Remedial Action Plans (RAPs) under the Great Lakes Water Quality Agreement. Grassy Island is part of the Refuge and was constructed as a confined disposal facility (CDF) to deposit contaminated dredge spoils from the Rouge River. Because it was constructed without a liner or cap, wildlife may be exposed to contaminated surface soils, and contaminants may be leaching into the Detroit River. The Service is currently proceeding with plans to more fully characterize the risks from the identified contaminants and evaluate the feasibility of several approaches to both remediate contaminant risks and enhance long-term benefits of the area for fish and wildlife (USFWS 2005).

Great Lakes Water Levels

Great Lakes water levels greatly influence the vegetation of all hydrologically connected coastal wetland units on the Refuge because wetland plants respond differentially to variations in water depth. Water level fluctuations occur on short-term, seasonal, and multi-year scales. Wind-driven seiches and storm surges are temporary, but can have marked impacts on wetland vegetation through wave action and ice-scour. These events also help to transport sediments, nutrients, and other materials into and out of coastal wetlands. Seasonal fluctuations are characterized by high water levels in the winter and spring, and lower water levels in summer and fall. Many wetland plants require exposed soils or very shallow water to germinate, but require flooded conditions later in the season to thrive and produce seed. Multi-year fluctuations in water level cause spatial shifts in vegetation communities, which is evidenced at certain units within the Refuge. These natural water level fluctuations are necessary for maintaining species diversity within coastal wetlands (Albert 2003).

2.5 Current Refuge Conditions and Resources

Climate

The climate of Detroit River IWR is humid continental. The average annual precipitation is 33 inches, with most precipitation falling in the spring and summer. Average high temperatures range from 32° F in January to 82° F in July. The frost-free season generally runs from late May through mid-September. Wind speeds are generally light to moderate.

Climate change will have major influences on the Refuge. Like the rest of western North America, the Great Lakes region is already experiencing changes in temperature and precipitation. Under more extreme climate change scenarios, the average annual temperature could increase by as much as 8° F by the end of this century (Maurer et al. 2007). The Intergovernmental Panel on Climate Change (IPCC) also projects that areas throughout North America will experience more severe and longer heat waves and increased impacts from air pollution (Intergovernmental Panel on Climate Change 2007). The total amount of annual precipitation is not projected to change significantly, but the area could see increases in winter and spring precipitation, while summer precipitation could decrease by 50 percent (Kling et al. 2003, Maurer et al. 2007).

Projected climate changes for the Great Lakes Region are expected to have an array of ecosystem impacts related to runoff volume, water quality, evapotranspiration, and erosion. Perhaps the most noticeable effect that climate change will have on Refuge habitats is the drop in Great Lakes water levels. Under some climate change scenarios, lake levels are projected to decline by as much as six feet by the end of this century as a result of higher evaporation due to higher summer temperatures and lower winter ice cover (Kling et al. 2003), but results of model predictions are highly variable (Gronewold et al. 2011). Through research funded by the UMGL LCC, downscaled climate change data for the Great Lakes Region are available and can be used to refine projections for temperature and precipitation change at a fine scale (Vimont 2013).

Topography

Located on the Huron-Erie lakeplain, the land within Detroit River IWR is topographically flat or slopes gently toward the Detroit River and Lake Erie shorelines. Elevation within the authorized boundary of the Refuge ranges from approximately 570 to 580 feet. The long-term average Lake Erie water level is 571 feet.

The lakeplain extends approximately 20 miles to the west of the Refuge, where the Erie lobe of the Wisconsin glacier formed moraines, kames, and other topographically significant deposits of glacial till material during its retreat at the end of the last ice age.

Strong Unit, DRIWR. (Photo credit: William Welsh, Eastern Michigan University)

Soils

The predominant soil types within the Refuge are silt loam and silty clay loam, which result in poorly-drained conditions and support plant communities adapted to seasonal inundation

including wet prairie, hardwood swamp, wet-mesic forest, and shrub-carr wetlands. Following the last glaciation, these soils were deposited over limestone bedrock in a layer ranging in depth from a few inches to 150 feet. Deposits of sandy material occur over the silt and clay in areas of temporary postglacial streambeds. Organic soils of varying thickness occur in parts of many coastal wetlands, particularly those that are protected from direct wave action and seiche events. (Sherzer 1900, Albert 2003).

Hydrology and Water Quality

Great Lakes water levels, which fluctuate on daily, seasonal, and annual timescales, are the most important factor driving hydrological processes within the Refuge. NOAA water level gauges at Wyandotte, Gibraltar, and the Fermi Power Plant provide local information on current and historical water levels throughout the Refuge area (NOAA 2013).

Average Great Lakes water levels have been steadily declining since the mid-1980s, which has altered the composition and distribution of plant communities on the Refuge. Great Lakes water levels may continue to decrease as a result of climate change (Kling et al. 2003; Gronewold et al. 2011).

As a result of urbanization and industrialization of the Refuge area, the Detroit River has undergone severe declines in water quality, although there has been some recovery since the 1950s. Based on the Great Lakes Water Quality Agreement, the U.S. Environmental Protection Agency and the Government of Canada (1995) have listed the following concerns for the Detroit River: degradation of benthic populations, fish tumors and other deformities, restrictions on fish and wildlife consumption, beach closings due to bacteria in the water, restrictions on dredging, taste and odor in drinking water, degradation of aesthetics, and loss of fish and wildlife habitat.

The Detroit River has been designated a bi-national Area of Concern under the Great Lakes Water Quality Agreement. The U.S. Environmental Protection Agency has the lead on the Remedial Action Plan to restore and protect beneficial uses in the Area of Concern. U.S. Fish and Wildlife Service coordination and collaboration in the Remedial Action Plan process is important to address the restoration and protection of fish and wildlife habitat in the Detroit River.

Vegetation and Land Classification

Much of the lower Detroit River shorelines, island shoals, and the western Lake Erie shoreline were originally a marshy, low-lying area of emergent and submersed vegetation that might be classified today as a Great Lakes coastal marsh. On an 1815 map, such marshes were contiguous along both sides of the entire 32-mile length of the Detroit River (USFWS 2005). By 1982, shoreline development had reduced the marshes to less than 3 percent of their original area along the Michigan side of the Detroit River. Today, only remnants of the original marshes remain in Michigan waters, including Humbug Marsh, portions of Stony Island, Gibraltar Bay at the southern end of Grosse Ile, and several coastal lagoons along the Lake Erie shoreline. These remnants contain stands of bottomland hardwoods, glacial lakeplain prairie, coastal plain pond communities, and a variety of wetland types.

The Refuge was generally described in the CCP as having three broad vegetation types: wetlands, wet prairie, uplands and river islands. Wetland habitats within the Refuge are dominated by submerged aquatic macrophytes including wild celery and emergent vegetation such as cattail, bulrushes, and phragmites. Wet prairie, which was historically abundant in the area, is now confined to a few small remnants and restoration areas, and typically contain blue-joint grass (*Calamagrostis canadensis*), a variety of sedges (*Carex* spp. and *Cyperus* spp.), sensitive fern (*Onoclea sensibilis*), marsh fern (*Thelypteris palustris*), swamp milkweed (*Asclepias incarnata*), boneset (*Eupatorium perfoliatum*), joe-pye weed (*Eupatorium maculatum*), goldenrods

(*Solidago* spp.), and swamp rose mallow (*Hibiscus moscheutos*), among others. These areas are characterized by high seasonal water level fluctuation or frequent mowing – disturbances that promote grasses and limit tree growth. The uplands and river islands category describes relatively young forests on wet to mesic portions of the Refuge, which are frequently dominated by dogwood, cottonwood, willow, box elder, silver maple, ash, and/or phragmites. Larger forests contain shagbark hickory, oaks, black cherry (*Prunus serotina*), basswood (*Tilia americana*), black walnut, and hackberry (*Celtis occidentalis*).

The National Wildlife Refuge System adopted the National Vegetation Classification System (NVCS) which was developed by The Nature Conservancy and the Natural Heritage Network as a standard for classifying plant communities (Natureserve 2013). The classification contains hierarchical levels of community specificity. The narrowest level within the classification is the Association. Table 2-1 lists the NVCS Associations found within the various broad scale habitats of the Refuge. Some communities were identified only down to the Alliance level, which is a broader category above Associations.

In addition to utilizing the NVCS, the Refuge's vegetation communities have recently been mapped in a cooperative effort with Eastern Michigan University (Eastern Michigan University 2011; Map 2-5). For the purposes of this HMP, five habitat types have identified in order to classify habitats in terms of practical Refuge management. These habitat types have been crosswalked with habitat types identified in the CCP, and by EMU, the NVCS, and the Michigan Natural Features Inventory (MNFI) classification system (Kost et al. 2007) (Table 2-1).

Table 2-1. Crosswalk of Detroit River IWR Habitat Classifications

CCP Habitat Class	HMP Habitat Class	EMU Map Class	NVCS Alliance	MNFI Type	Conservation Ranking
Wetlands	Open Water/ Submergent Wetland	Submersed Aquatics, with Algae	American Lotus Aquatic Wetland	Submergent Marsh	G3G4 S4
			Water Lily Aquatic Wetland		G4G5 S4
			Northern Water Lily Aquatic Wetland		G5 S4
			Midwest Pondweed Submerged Aquatic Wetland		G5 S4
			Various-Leaved Pondweed Herbaceous Vegetation		G3 S4
			Southern Great Lakes Submergent Marsh		G3G4 S4
		Shallow Embayment, Open Water			N/A
		Canals and Drainage Channels			
		Open Water With Duckweeds			
		Ponds, Lakes, Open Water			
		Trenton Channel			
	Emergent Wetland	Cattail Marsh	Midwest Mixed Emergent Deep Marsh	Emergent Marsh	G4 S4
		Mixed Cattail and Reed Cane			
		Reed Cane (Genotype M) Marsh	Midwest Cattail Deep Marsh		G5 S4
		White Water Lily and Associated Plants			
		Emergent Marsh, Thin Blade, without Reed Cane or Cattail	Great Lakes Coastal Wetlands Complex	Great Lakes Marsh	G3G4 S3

CCP Habitat Class	HMP Habitat Class	EMU Map Class	NVCS Alliance	MNFI Type	Conservation Ranking
Wetlands	Emergent Wetland	Broad-Leaf Emergent Marsh	Great Lakes Coastal Wetlands Complex	Great Lakes Marsh	G3G4 S3
		River Bulrush	Southern Great Lakes Shore Emergent Marsh		G3G4 S3
		Reed Cane Marshes Being Treated, Sprayed, or Mowed			
		Diked Wetland Areas			
		American Lotus			
		Burned areas of Reed Cane			
		Scattered Patches of American Lotus			
	Moist Soil/ Mud	Sand Bars, in Embayment	Lake Mud Flats	N/A	N/A
		Inundated Mudflat, Nearshore Zone			
		Exposed Mudflat	River Mud Flats		N/A
		Beach Deposits			
		Small Islands			
Wet Prairie	Wet Prairie	Mixed Reed Cane and Wet prairie	Blue-joint Wet prairie	Lakeplain Wet Prairie Lakeplain Wet-Mesic Prairie Southern Wet Meadow	G4G5 S1
		Wet prairie, Grassy			
		Wet prairie Communities Disturbed by Agriculture			
		Mixed Wet prairie and Shrub Wetlands	Central Cordgrass Wet Prairie		G3 S1
		Blue-joint Grass Community			
		Upland Meadow	Lakeplain Prairie		G2G3 S1
		Prairie Plant Community			
		Farm Field, Wet, Being Drained			N/A
		Farm Field, Active, With Crop			
		Flooded Farm Field			

CCP Habitat Class	HMP Habitat Class	EMU Map Class	NVCS Alliance	MNFI Type	Conservation Ranking
Uplands and River Islands	Wet-Mesic Forest	Berms, some with Wetland Trees and Shrubs	Maple-Ash-Elm Swamp Forest	Southern Hardwood Swamp	G4 S3
		Shrub Wetlands	Dogwood-Willow Swamp	Southern Shrub-Carr	G5 S5
		Forested Wetlands	Silver Maple-Elm Forest		G4 S3
		Upland Woods	Central Green Ash-Elm-Hackberry Forest		G3G5 S3
		Wet-Mesic Flatwoods (Oak-Hickory Woodland)			
		Wet-Mesic Flatwoods (Dogwood-Hawthorn-Elm-Buckthorn)	Pin Oak-Swamp White Oak Sand Flatwoods	Southern Hardwood Swamp Wet-Mesic Flatwoods	G3G2 S2
		Silver Maple Swamp			
		Black Walnut Opening	Northern (Great Lakes) Flatwoods		G3G2 S2

The five habitat types identified for the purposes of this HMP are described below. The current distribution of these habitat types on the Refuge is provided in Appendix C.

Open Water/Submergent Wetland

Submergent wetland habitat occurs in deeper pools within diked wetlands, shoreline areas, and in gradually sloping areas surrounding river islands. The latter areas include wild celery, water stargrass (*Heteranthera dubia*), waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), watermilfoil (*Myriophyllum spicatum* and *M. exalbescens*), curly-leaved pondweed (*Potomogeton crispus*), sago pondweed (*Potomogeton pectinatus*), muskgrass (*Chara* spp.) and redhead grass (*Potamogeton richardsonii*).

Historically, wild celery was abundant and widely distributed near Grassy Island and throughout the Detroit River system. The extent of wild celery was measured in the 1950s, 1980s, and again in 1996-97. There was a 72 percent decline in wild celery from the 1950s to the 1980s. Now, wild celery has rebounded and is at or exceeds the levels of the 1950s. The increase in wild celery is attributed to increased water clarity in Lake St. Clair and the Detroit River. The increased water clarity is attributed primarily to filtration of the water by zebra mussels.

Submergent wetlands are typically inundated for long periods of time, which excludes most emergent wetland vegetation. However, hemi-marsh conditions occur in transition zones between submergent and emergent wetlands where water level is intermediate or fluctuates between deeper and shallower conditions. Similarly, sparsely vegetated transition zones occur between submergent wetlands and open water habitats as a function of water depth.

Open water habitats are deep-water riverine habitats that have little or no vegetation and a rocky or gravelly substrate. They provide critical habitat for many fish species including walleye, lake sturgeon, and northern madtom.

Emergent Wetland

This habitat type is located in shallow areas of diked wetlands and shorelines throughout the Refuge. Emergent wetlands are characterized by emergent narrow and broad-leaved herbs as well as floating-leaved herbs. Common plants include smartweeds (*Polygonum* spp.), sedges, arrowheads (*Sagittaria* spp.), beggarticks (*Bidens* spp.), bulrushes, rushes (*Juncus* spp.), and cattail, and phragmites. Differential germination and growth responses to fluctuations in Great Lakes Water levels results in vegetation zonation within coastal emergent wetlands. Many emergent wetlands within Detroit IWR are dominated by the introduced sub-species of phragmites (*Phragmites australis* subsp. *australis*), which is sometimes a major management concern in these areas.

Sora utilizing emergent wetland habitat (Photo credit: Jerry Jourdan)

Moist Soil/Mud

Mudflats vary in their specific location in western Lake Erie marshes, while sandbars occur along the shorelines of river islands. In coastal wetlands with natural hydrological connectivity to Lake Erie, seiches cause previously inundated areas with little vegetation to temporarily become exposed. It is there where invertebrates and seeds are available to a wide variety of migratory birds. Ice-scour and strong storm surges also produce mudflat by stripping vegetation in the marsh, which is then later exposed when wind blows water out of the coastal wetlands. Sandbars

occur adjacent to Sugar Island and near other Detroit River island units. Because much of the shoreline in the area of the Refuge has been hardened with seawalls and other structures, remaining natural areas of exposed mud and sand provide critical habitat for shorebirds. Exposed mudflats or areas of very shallow water are also important for the germination of many wetland plant species (Albert 2003).

"Managed moist soil" habitat occurs within the 15-acre water-level-controlled area of the Brancheau Unit. This unit is managed on an experimental basis to encourage annual plant species and habitat for overwintering and migratory shorebirds and waterfowl. Mudflat develops in areas of moist soil management where water was too deep for germination of annual plants and was later drawn down to expose the mud (and subsequent invertebrates and seeds).

Wet Prairie

Wet prairie refers to three types of prairie areas on the Refuge. This category refers to areas adjacent to emergent marsh and hydrologically connected to the Great Lakes dominated by tussock sedge (*Carex stricta*) blue-joint grass, other sedges, prairie cordgrass (*Spartina pectinata*), swamp milkweed, and other herbaceous prairie and wetland vegetation. Historically much more abundant and species-rich, the community structure and composition of wet prairie habitats were once maintained by seasonal flooding, cyclical changes in Great Lakes water levels, beaver flooding, and fire (Albert and Kost 1998). Wet prairie habitat has declined because of an extensive network of drainage for agriculture, shoreline development, and disruption of natural disturbance regimes via flooding and fire. On the Refuge, wet prairie also refers to former agricultural areas (i.e., constructed prairies if seed was broadcasted) where fire, mowing, herbicide application, or water level management is intended to keep woody vegetation to no more than 25% canopy coverage. The final category is lakeplain wet prairie, a rare natural community that has not yet been found on the Refuge, but is present at nearby Pointe Mouillee State Game Area.

Wet-Mesic Forest

This habitat type includes all areas of the Refuge where woody vegetation exceeds or will be allowed to achieve at least 25% aerial coverage. This includes early-successional forested wetlands and shrub wetlands dominated by American elm, ashes, oaks, maples (*Acer* spp.), dogwoods, and willows. Wet-mesic forests and associated plant communities occur in areas that have experienced longer intervals between major disturbances such as fire, flooding, and land clearing, and do not exhibit extreme annual and inter-annual water level fluctuation which promotes grasses and sedges. Many of these areas occur on river islands that have slightly higher topography than emergent wetlands and wet prairie communities. Wet-mesic flatwoods, which occurs in a degraded state within the Humbug Marsh Unit, is a rare community type that occurs exclusively on poorly-drained clay on glacial lakeplains in southeast Michigan (Slaughter et al. 2010). The wet-mesic flatwoods at Humbug Marsh may contain the state-threatened pumpkin ash (*Fraxinus profunda*) and Shumard's oak, but has not yet been found on surveys.

Current Wildlife

Wildlife use of the Refuge has been continually inventoried as resources become available. Most lists are unit specific. The Refuge has sought opportunities and put resources into inventorying species, abundance, and habitat use by specific species guilds in particular Refuge units to help guide management priorities. However, comprehensive Refuge lists are incomplete. Additional information about wildlife at the Refuge is detailed in Appendix L of the CCP (USFWS 2005) and the Comprehensive ROC list presented in Appendix A. For background purposes, several highlights related to particular species groups are noted here.

Birds

Partly because of their location along the Detroit River and western Lake Erie where migration is concentrated, the coastal marshes of western Lake Erie and lower Detroit River provide habitat for a very high concentration of waterfowl, neotropical migrants, and other birds. The lower Detroit River is designated as an Important Bird Area that is globally significant as a site for congregating waterfowl. For example, more than 300,000 diving ducks stop each year to rest and feed on beds of wild celery in the lower Detroit River during fall migration. On average, more than 8,260 canvasback and 7,000 common mergansers are recorded each year during the annual Christmas Bird Count centered on Rockwood, Michigan (USFWS 2005). From a regional or national perspective, the habitats provided within the Refuge are more significant for use during migration than for breeding.

Extensive beds of aquatic vegetation, particularly wild celery, attract large concentrations of divers, primarily canvasback, redhead, and scaup. Oil pollution and other factors resulted in the substantial decline of these preferred foods by 1950, but wild celery beds have largely recovered following the invasion of filter-feeding zebra mussels, which increased water clarity (Schloesser and Manny 2007). Today, large rafts of migratory waterfowl can be found in the aquatic vegetative beds surrounding some of the islands in the Detroit River, but mostly occur at the mouth of the Detroit River, and to the north in Lake St. Clair. The shallow, open waters of the Detroit River are an important waterfowl staging and wintering area. Tens of thousands of mallards, black ducks, redhead, canvasback, scaup, and tundra swans, and Canada geese feed in the nearshore waters of the Refuge (USFWS 2005).

A large number of wading and shorebirds can be found within the Refuge area, and the Lake Erie shoreline has been recognized as a Site of International Shorebird Importance. Pointe Mouillee State Game Area has been designated a Western Hemispheric Shorebird Reserve Network site (USFWS 2005).

Likewise, the region contains large concentrations of migrant marsh birds, passerines, and raptors during spring and fall migration including rails, warblers, thrushes, tanagers, vireos, sparrows, kinglets, hawks, falcons, and vultures, among others. Passerines in particular benefit from the abundance of aquatic and terrestrial invertebrate food sources along with fruits from both native and non-native shrubs and vines. Raptors are concentrated in the Refuge in fall and many consume migrant songbirds. An incomplete list of bird species observed in the area can be found in Appendix E of the CCP (USFWS 2005).

Fish

The lower Detroit River and western Lake Erie support at least 60 species of fish (USFWS 2005). In addition to approximately 34 resident species in the Detroit River, 28 species use the river as a migratory pathway between Lake Erie, Lake St. Clair, and Lake Huron, and stop in the river for spawning, feeding, and nursery grounds (Manny et al. 1988). The high diversity of fishes is partially attributable to the variety of habitats: deep channels, shallow-water nearshore, and the land-water edge, including river shorelines, island shorelines, and coastal wetlands.

Although the current fish community is diverse, it has changed dramatically compared to the fish community prior to European settlement. A number of native species have either disappeared or their numbers have been severely reduced. Examples include lake trout, sauger, blue walleye, lake whitefish, lake herring, and lake sturgeon. Contributing factors to these losses include overfishing, habitat loss, and the introduction of exotic species. Recently, in response to improvements in water quality and the construction of artificial spawning reefs, lake sturgeon and lake whitefish have been confirmed to be successfully reproducing in the Detroit River (Manny and Kennedy 2002, Roseman et al. 2007, Roseman et al. 2011). More than 10 million walleye, white bass, steelhead, and salmon migrate through the Detroit River each year and attract many anglers to the Refuge area (USFWS 2005).

Reptiles and Amphibians

Turtles, snakes, frogs, toads, and salamanders occur within the Refuge area, including the state-listed eastern fox snake. Additional snakes include northern water snake, northern brown snake, Butler's garter snake, eastern garter snake, and black rat snake. The Refuge has populations of Blanding's turtle, midland painted turtle, common map turtle, and snapping turtle. American toad, leopard frog, western chorus frog, wood frog, bullfrog and green frog all are regularly detected in the Refuge. Salamaders have not been well inventoried.

Mammals

Several species of mammals are found within the Refuge area. Common species include muskrat, mink, raccoon, opossum, eastern cottontail, groundhog, skunk, white-tailed deer, coyote, gray and fox squirrel, and gray and red fox. White-tailed deer have become overabundant in some areas, including Humbug Marsh, and have reduced understory plant diversity through extensive browsing. Less common species include American beaver, which have recently returned to Wayne County and can be found in more secluded wetland areas. Comprehensive, Refuge-wide surveys of mammal populations have not been conducted. Bats and murids (rats, mice, lemmings, and voles) have not been inventoried

Invertebrates

Wetland and aquatic habitats within the Refuge support a relatively high diversity of freshwater mussels. In a 2006 survey of 36 sites within the Refuge, 18 mussel species were identified, including five state-listed species (Badra 2006a and 2006b). Introduced zebra mussels and quagga mussels have displaced native mussels and altered water clarity and aquatic nutrient cycling in many areas.

Insect inventories at Humbug Marsh in 2007 and 2008 identified 43 Odonata species and 39 Lepidoptera species, among others (Craves 2008). Most notable were reports of three species listed as special concern in the state: elusive clubtail, russett-tipped clubtail, and northern hairstreak. The russet-tipped clubtail population at the Refuge Gateway and Humbug Marsh Unit is believed to be the largest in the Great Lakes Region (Craves 2008), highlighting the Refuge's regional significance as habitat for wildlife of many species groups.

Chapter 3.
Resources of Concern

Blue-winged teal in a western Lake Erie marsh (credit: Jerry Jourdan)

3.1 Introduction

Defining Resources of Concern

Resources of Concern (ROCs) are the focal point of an HMP. The HMP policy (620 FW 1) defines "resources of concern" as

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

The USFWS is entrusted by Congress to conserve and protect migratory birds, federally listed threatened and endangered species, inter-jurisdictional fish, and certain marine mammals (trust species) for the benefit of the American people. Each refuge also has its own specified purpose(s) for which it was created that guides its management goals and objectives. Within these purposes, refuges support other elements of biological diversity such as locally rare plant, invertebrate, and vertebrate species, natural communities, and the ecological processes that contribute to the biological integrity and environmental health at the refuge, ecosystem, and broader scales (601 FW 3).

Importance of Resources of Concern to Refuge Activities

Identifying ROC allows us to identify refuge-scale management objectives aimed at maintaining, increasing, and/or improving the habitats required by trust resources and populations identified in the Refuge purpose. The ROC process facilitates a targeted approach to identifying priority areas and/or gaps in management that may require additional resources such as information (data collection and monitoring) or staff and equipment. Species respond to habitat management differently and therefore identifying ROC allows us to focus management activities at an appropriate level that yields the greatest benefit to trust resources, complimenting biological integrity, diversity, and environmental health (BIDEH) and the Refuge purpose.

The first step of developing a focused habitat management strategy is to define a refuge's comprehensive list of ROC in light of the multiple mandates, purposes, policies, and regional/national plans applicable to that refuge. The following details the development of Detroit River IWR's priority ROC.

3.2 Identification of Refuge Resources of Concern

International, national, and regional conservation plans relevant to Detroit River IWR were identified and used in ROC selection. A comprehensive list of species known to use the Refuge was compiled by season and relative abundance (Appendix A). Each species' conservation significance was then quantified as the number of conservation plans that included that species. The comprehensive list of ROCs was narrowed down by selecting species most likely to represent a suite of habitat needs for other species (i.e., surrogate species) using the process is later defined in section 3.4.1. We refer to this subset of ROC as priority species.

Refuge Purposes and Resources of Concern

As discussed in Chapter 2, the Refuge was established in 2001 in part because of its regional importance for migratory birds and other fish and wildlife. The Refuge currently encompasses

approximately 5,700 acres distributed across numerous habitat types, including open water/submergent wetland, emergent wetland, wet prairie, wet-mesic forest, and moist/soil mud. Because many biological communities on the Refuge are in constant flux due to natural water level changes, the acreages of specific habitat types shift frequently as well. (Appendix C) shows the approximate current distribution of these habitat types on the Refuge.

The purposes for the Refuge are:

1. To protect the remaining high-quality fish and wildlife habitats of the Detroit River before they are lost to further development and to restore and enhance degraded wildlife habitats associated with the Detroit River.

2. To assist in international efforts to conserve, enhance, and restore the native aquatic and terrestrial community characteristics of the Detroit River (including associated fish, wildlife, and plant species) both in the United States and Canada.

3. To facilitate partnerships among the United States Fish and Wildlife Service, Canadian national and provincial authorities, State and local governments, local communities in the United States and in Canada, conservation organizations, and other non-Federal entities to promote public awareness of the resources of the Detroit River.

Refuge System and USFWS Resources of Concern

USFWS Trust Resources
While the designated purpose is the foremost determinant of a particular refuge's management, managing trust resources also is a priority for all Service lands. Trust resources relevant to Detroit River IWR include:

Migratory Birds
A list of all species of migratory birds protected by the Migratory Bird Treaty Act (16 U.S.C. 703–711) and subject to the regulations on migratory birds is contained in subchapter B of title 50 CFR §10.13. The USFWS Division of Migratory Bird Management also maintains lists of priority bird species of concern at national, regional, and ecoregional (Bird Conservation Region) scales (www.fws.gov/migratorybirds). The primary sources of information the Refuge used to identify potential migratory bird species of concern include:

- State and Federal Listed Species
- USFWS Migratory Bird Program Strategic Plan
- USFWS North American Waterfowl Management Plan
- Partners in Flight Bird Conservation Plan for the Upper Great Lakes Plain
- Upper Mississippi and Great Lakes Region Joint Venture Conservation Plans
- Michigan's Wildlife Action Plan
- Lake Erie Lakewide Management Plan
- Natureserve Global and State Conservation Rankings
- Status and trend information for Refuge bird surveys and regional assessments

Interjurisdictional Fish

The primary sources of information the Refuge used to identify potential fish species of concern include:

- State and Federal Listed Species
- Michigan's Wildlife Action Plan
- Fish-Community Goals and Objectives For Lake Erie

- Draft Fish Community Goal and Objectives for Lake St. Clair, St. Clair River, and Detroit River (St. Clair System)
- Lake Erie Lakewide Management Plan

Threatened and Endangered Species

The Endangered Species Act (16 U.S.C. 1531–1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) states in Sec. 8A.(a) that:

> "The Secretary of the Interior… is designated as the Management Authority and the Scientific Authority for purposes of the Convention and the respective functions of each such Authority shall be carried out through the United States Fish and Wildlife Service."

The act also requires all Federal departments and agencies to conserve threatened and endangered species and to utilize their authorities in furtherance of the purposes of this Act.

Federal threatened or endangered species were identified for inclusion in this HMP by reviewing the Federal threatened and endangered species list and relevant recovery plans for listed species (see http://ecos.fws.gov/ecos/indexPublic.do).

3.3 Biological Integrity, Diversity, and Environmental Health

Defining Biological Integrity, Diversity, and Environmental Health

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

- **Biological Diversity** - The variety of life and its processes, including the variety of living organisms, the genetic differences between them, and the communities and ecosystems in which they occur.

- **Biological Integrity** - Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.

- **Environmental Health** - Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.

Identifying BIDEH within the Refuge

The Service will manage for priority species with habitat needs that exist along a continuum of vegetation structure and hydrologic regimes within habitat types present on the Refuge. The Service has reviewed historic information regarding habitats, management changes, and species use within the Refuge's authorized boundary. The planning team also reviewed relevant literature describing requirements of selected priority species and ecosystem processes that regulate natural communities to assess historic, current, and future potential conservation status

for the Refuge. The following resources were used to describe baseline environmental, abiotic, and biotic conditions within the Refuge:

- Reports and associated data on site history and capabilities
- Maps of existing landscape conditions displaying watershed boundaries, habitat connectivity (or isolation), as well as land use conditions and ownership surrounding the Refuge
- Maps of existing and pre-Refuge vegetation types
- Soil Surveys of Wayne and Monroe Counties
- Global/regional trends in climate change and water quality
- Michigan Natural Features Inventory (MNFI) information on threatened, endangered, and special concern species
- MNFI and National Vegetation Classification System (NVCS) natural community descriptions
- Michigan's Wildlife Action Plan
- Status and trend information for potential species of concern as documented in regional/state assessments and reports
- Previous habitat classifications and designations developed for Detroit River by EMU (2011) and the CCP (USFWS 2005)

Based on a review of the existing and historical data listed above, a list of habitat types that contain elements of BIDEH was developed to evaluate processes that influence the ecological and biological integrity of habitat types within the Refuge (see Table 3-1). It should be noted that three nomenclatures reflecting the NVCS Alliance classifications (denoted with an asterisk) were created by the planning team. Existing classifications did not adequately describe vegetative communities and therefore the planning team deemed it appropriate to create Refuge-specific classifications in these instances.

Table 3-1. Summary of Habitats that Represent Existing BIDEH for Detroit River IWR

Habitat Type (Communities representing existing BIDEH)	NVCS Alliance Classification	Populations and Habitat Attributes	Natural Processes	Limiting Factors/Stressors
Open Water/ Submergent Wetland	American Lotus Aquatic Wetland Water Lily Aquatic Wetland Northern Water Lily Aquatic Wetland Midwest Pondweed Submerged Aquatic Wetland Various-Leaved Pondweed Herbaceous Vegetation Southern Great Lakes Submergent Marsh	Deep to shallow water marsh. Loose, poorly consolidated organic soils up to several meters thick overlie mineral soil or bedrock. Rooted and non-rooted submergent plants, rooted floating-leaved plants and non-rooted floating plants dominate. E.g., Common waterweed, water star-grass, milfoils, naiads, pondweeds, stoneworts, coontail, bladderworts and wild celery	Natural water-level fluctuations, fauna, storm waves, and currents all create conditions important for plant regeneration. Openings and depressions created by fish nests and waterfowl feeding, and channels and ponds generated by beaver are important in plant establishment and maintenance.	Boat traffic, invasive species, sediment inputs and dredging activity. Boat traffic disturbs loose substrates and spreads invasive species. Invasive aquatic plants change habitat for fish, invertebrates, and wildlife. Changes to lake levels and storm frequency associated with climate change.

Habitat Type (Communities representing existing BIDEH)	NVCS Alliance Classification	Populations and Habitat Attributes	Natural Processes	Limiting Factors/Stressors
Emergent Wetland	Midwest Mixed Emergent Deep Marsh	Shallow-water wetland. Near neutral to alkaline, fine organic sediments overlie mineral soil including rock, gravel, sand, silt, or clay. Emergent narrow- and broad-leaved herbs and grass-like plants as well as floating-leaved herbs. E.g., water plantain, sedges, spike rushes, arrowhead, duckweed, pickerel weed, water-lily, smartweeds, bulrushes, cattail, wild rice	Frequent or seasonal flooding; low water facilitates seed bank expression, flooding creates oxygen-deprived sediments and accumulation of peat. Muskrat feeding creates openings for vegetation. Wildfires reduce litter, for seedling establishment.	Off-road vehicle traffic, nutrient and sediment inputs, dredging, ditching, and draining activity, invasive species populations, and fragmentation.
	Midwest Cattail Deep Marsh			
	Great Lakes Coastal Wetlands Complex	Along coast of Great Lakes or connecting waterway. Includes a deep marsh with submerged plants; an emergent marsh of mostly narrow-leaved species; and a sedge-dominated wet meadow that is inundated by storms. Wet meadow species such as blue-joint grass, swamp milkweed, sedges, water hemlock, jewelweed, bedstraw, joe-pye weed, and smartweed.	Water level fluctuation due to seiches, and seasonal and interannual conditions. Longshore current, storm wave and ice influence shoreline erosion and redeposition of sediments.	Hardened shorelines, agricultural drainage, nutrient loading, and reduced oxygen. Dredging, dumping chemical contamination, invasive species, and fragmentation. Changes to lake levels and storm frequency associated with climate change.
	Southern Great Lakes Shore Emergent Marsh			

Habitat Type (Communities representing existing BIDEH)	NVCS Alliance Classification	Populations and Habitat Attributes	Natural Processes	Limiting Factors/Stressors
Moist Soil/ Mud	Lake Mud Flats	Flood in spring, but dry out later in the season, exposing wet, muddy sediments on which plant species subsequently grow. Substrate includes silt and clay. Vegetation is composed of dry land forms of aquatic plants and seedlings from seeds dormant in sediment or washed in from other communities	Seasonal fluctuations in water levels or flooding regime.	Potential changes to lake levels and storm frequency associated with climate change, invasive species, sedimentation
	River Mud Flats			
Wet Prairie	Blue-joint Wet Meadow	Seasonally wet ground of glacial lakeplains. One- to two-meter vegetation moderately dense with little exposed bare ground, diverse and dominated by graminoids. E.g., blue-joint grass, sedges, cordgrass, rushes, swamp milkweed, cinquefoil	Cyclic changes in Great Lakes water levels, extreme variation water table levels and moisture limits woody vegetation. Prolific beaver activity and flooding, periodic fire.	Conversion to agriculture, residential and industrial development, and alterations of groundwater and surface hydrology. Fire suppression, shrub and tree encroachment, and fragmentation. Destruction of upland buffers, invasive species, and climate change.
	Central Cordgrass Wet Prairie	Seasonally flooded and includes small pockets that remain wet year around. Species rich lowland prairie; one to two meter vegetation moderately dense with little exposed bare ground, diverse and dominated by graminoids.	Cyclic changes in Great Lakes water levels, extreme variation water table levels and moisture limits woody vegetation. Prolific beaver activity and flooding, periodic fire.	
	Lakeplain Prairie			

Habitat Type (Communities representing existing BIDEH)	NVCS Alliance Classification	Populations and Habitat Attributes	Natural Processes	Limiting Factors/Stressors
Wet-Mesic Forest	Maple-Ash-Elm Swamp Forest	Poorly drained depressions of lakeplains of silt, sandy or clay loam. Lowland hardwoods dominated by silver or red maple, green or black ash, hackberry and elm; with shrubs and herbaceous groundcover.	Impermeable substrates allow prolonged pooling of water. Flooding, windthrow, and senescence in large unperturbed tracts.	Hydrologic alteration associated with agriculture, roads, and draining and ditching. Establishment of invasive species and pathogens. Habitat fragmentation, climate change, absence of top predators and hunting, and succession to closed canopy swamp forest in the absence of flooding and fire.
	Central Green Ash-Elm-Hackberry Forest			
	Silver Maple-Elm Forest			
	Dogwood-Willow Swamp	Persistent successional shrub community on level seasonally inundated, saturated organic soils along rivers, and lakes, on glacial lakeplains. Five to 18-foot vegetation dominated by willows, dogwoods, winterberry and bog birch.	Shrub invasion of wet prairies following fire suppression or lowering of water tables. Beaver herbivory and windthrow allow persistence of shrub-carr species.	
	Pin Oak-Swamp White Oak Sand Flatwoods	Exclusively on poorly drained glacial lakeplain in southeastern Lower Michigan. Diverse canopy species of oaks, hickories, maples, ashes, and basswood with a patchy sparse ground layer.	Seasonal inundation and underlying impermeable substrate allows prolonged pooling of water.	
	Northern (Great Lakes) Flatwoods			

Maintaining and Restoring BIDEH

Human settlement has influenced species and habitats in the vicinity of the Refuge for approximately 10,000 years. However, extensive anthropogenic changes beginning in the mid-19th century significantly reduced coastal wetland acreage and quickly altered many existing processes, reducing BIDEH in the Detroit River and western Lake Erie. Improvement came with the 1972 U.S.-Canada Great Lakes Water Quality Agreement, U.S. Clean Water Act, Canada Water Act, Endangered Species Act and complementary state, provincial, and local programs. More recently, habitat management efforts within the Detroit River and western Lake Erie and adjacent wetland and terrestrial habitats have begun to reverse the decline in BIDEH and have resulted in improvements to water quality, habitat, and fish and wildlife populations. Details of historic habitat alteration within the Refuge area are provided in Chapter 2.

The extent of habitat degradation on the Refuge requires aggressive conservation and management of natural resources to maintain or restore BIDEH within the Refuge and in order to meet Refuge purposes. The Detroit River IWR CCP (USFWS 2005) included a goal that "fish and wildlife communities are healthy, diverse, and self-sustaining," as well as several supporting objectives (USFWS 2005). However, in order to be in compliance with BIDEH policy (610 FW 3) and to encourage the effective protection and restoration of BIDEH on the Refuge, this HMP has amended the original habitat-oriented goal and objectives within the CCP. By maintaining existing BIDEH and sustainably managing it over the life of this HMP, we will support the Refuge purpose and habitat needs of priority resources and other benefitting species. These changes and the rationale behind them are outlined in Chapter 4.

3.4 Priority Refuge Resources of Concern

Priority Resources of Concern Selection

The potential ROC table (Appendix A) contains a comprehensive list of species with a broad array of habitat needs that occur within the Refuge. This list was refined and reduced to identify priority species representing the spectrum of habitat needs for species included in Appendix A. The Service selected priority species using the Service's Identifying Refuge Resources of Concern Handbook (referred to as "the Handbook") (Paveglio and Taylor 2010), as well as aspects of Strategic Habitat Conservation (SHC), which is an iterative process developed by the Service to support strategic decisions on habitat conservation for species on landscape-level scales (USFWS 2008). The selection process outlined within the Handbook and SHC guidance uses a focal resource concept (i.e., surrogate species approaches).

To assist the HMP planning team in identifying refuge-specific ROC, Cardno JFNew developed the Resources of Concern Selection Tool for America's Refuges (ROCSTAR). The ROCSTAR tool was developed to assist national wildlife refuges, waterfowl production areas, wetland management districts, and other conservation lands in identifying priority resources for management and monitoring. This tool is intended to assist managers and planners in completing the selection process outlined within the Handbook. The ROCSTAR tool allows the planning team to review the applicable filters required when considering priority ROC selection. It also provides a decision support framework that allows users to compare various resources and their ability to address the selection considerations outlined in the Handbook (Paveglio and Taylor 2010), and also incorporates aspects of the surrogate species concept as described in Caro (2010) and USFWS (2012). The tool results in a series of resource scorings sorted by habitat type. Based on the scoring results, the planning team can then make an informed decision on the number and type of priority ROC to select for each habitat type managed on the Refuge. The results of the ROCSTAR scoring evaluation is compiled in Appendix B.

The goal of this is to select priority refuge-specific ROC that can be used as indicators of our overall habitat management and benefits to other species utilizing the same habitat types. The

Handbook guides the selection of priority refuge ROC by considering which resources best address the following considerations, including the resources:

1. Relevance to Legal Mandates
2. Management Significance
3. Ecological Significance

Relevant Legal Mandates

Candidate priority resources were evaluated for their ability to be managed in order to fulfill the Refuge purpose and associated Service policies and mandates. Specifically,

- Contribution to Refuge purpose – Achieving Refuge purposes and managing for trust resources as well as BIDEH can be addressed through habitat requirements of focal species, i.e., species that may represent guilds that are associated with important attributes or conditions within habitat types. The use of focal species is particularly valuable in addressing Service trust resources such as migratory birds. By selecting focal species, we can document our Refuge-specific contribution to migratory bird conservation.

- Contribution to listed species – Several species listed at the state or federal level, including lake sturgeon, channel darter, and eastern prairie-fringed orchid have historically occupied Detroit River. Based on our review of previous restoration efforts and habitat conditions necessary for these and other rare or imperiled species, the Service believes that continued repatriation of listed species is worthwhile. Addressing listed species in this plan is a way that we can address this important Service mandate.

- Contribution to Refuge System – The conservation of priority species within the Refuge has an important role in supporting the mission of the NWRS. By selecting priority species that can be used as a measure of our management success, we can use these species in developing our inventory and monitoring program in order to evaluate management and communicate the success and challenges of management with others. In doing so, we will aid in providing long-term support for the NWRS.

Management Significance

Candidate priority resources were evaluated for their management significance to the Refuge. A species was considered significant to management on the Refuge if it had the following characteristics: 1) species have a direct application to key management decisions or effectiveness of past management activities, 2) species are reliant on habitat management to provide suitable or improved conditions, 3) management and protection of the species or its habitat is recognized as important (i.e. presence in regional conservation plans and lists noted previously) by managers, researchers, policy makers and the public. Evaluating the management significance is important to the Refuge because data on the species and its habitats can help inform management decisions and progress toward Refuge goals. Specifically,

- Habitat requirements of priority species – Habitat suitability and availability may limit the Refuge's capability to support or manage for a priority species of concern. The following species-specific factors were evaluated:
    - Historic habitat use and abundance on the Refuge
    - Connectedness and species utilization of habitat types
    - Environmental conditions including soils, hydrology, disturbance patterns, contaminants, predation, and invasive species
    - Specific life history needs – particularly needs for breeding, migrating, and overwintering stages.

- Habitat management for selected priority species – Observations and institutional knowledge of the Refuge and other Service staff were used to determine the feasibility for the Refuge to support a particular species throughout specific seasons (e.g., breeding, migration, overwintering).

- The need for management and protection of the priority species is recognized – Chapter 1 highlighted numerous national, regional, and state conservation plans used to identify conservation priorities for the Refuge. Species on the comprehensive ROC list were initially ranked based on the sum of conservation plans in which they were found. Ranked species were then filtered by relative seasonal (breeding, migrating, wintering) abundance on the Refuge. In doing so, some species that ranked high on conservation plans, but were only incidental on the Refuge, were not included in the priority species selection since they presumably could not be effectively managed for.

- Contribution to inventory and monitoring – Candidate priority species were evaluated for their potential contribution to the development of the Refuge's inventory and monitoring program. Priority species must be able to provide indicators of habitat management by responding to our management actions through increased use, improved breeding, presence/absence, or by another measure. We reviewed each candidate for its ability to be monitored, amount of existing data specific to the station, and the likelihood of it being affected through management.

Pied-billed grebes utilizing submergent wetland habitat. (Photo credit: Jerry Jourdan)

Ecological Significance

Candidate priority resources were evaluated through a series of planning team meetings, literature reviews, and an interagency partner review for their ecological significance to the Refuge. Ecological significance was defined as a species 1) having a strong, defensible link to overall ecological function of the landscape or be strongly associated with a critical resource of the Refuge, 2) sensitive to larger landscape or habitat changes so that it can act as an indicator of potential change, and 3) status of the species or its habitat is representative of other priority species, ecological processes or biological organizations. Evaluating the ecological significance of candidate priority species helps ensure that management and monitoring activities associated with priority species and their habitats contribute to the BIDEH of the Refuge. Priority resources can be used as an indicator of BIDEH based on their presence, absence, abundance, or relative well-being in a given habitat niche. In doing so, it serves as a marker of overall health of its required habitat type.

Using these criteria, the planning team refined the list of potential ROC during the development of the HMP based on continued review of the criteria previously described. Twenty-eight priority species for Detroit River IWR were selected by the planning team. During this iterative process, we did not include some candidate priority species that effectively duplicate the habitat requirements and/or potential management response of other species. In most cases, these "redundant" species were removed because the selected priority species were preferred for management and/or monitoring purposes, according to available datasets, literature review, and/or professional judgment by the planning team. A list of these species, general habitat requirements, and other benefitting species can be found in Table 3-2. Discussion of the selection considerations for each priority ROC can be found following the table.

Table 3-2. Priority ROCs and Key Habitat Relationships for Detroit River IWR

Priority Resource	Habitat Type(s)	Key Habitat Relationships			
		Vegetative Composition	Vegetative Structure	Patch Size	Special Considerations
American Black Duck	Emergent Wetland	Migrant in wide variety of emergent vegetation, especially floating-leaved plants, and pondweeds	• Shallow, relatively permanent wetlands with emergent vegetation	Variable, 0.16-3.8 ha (Longcore et al. 2000)	
Wood Duck		Flooded shrubland, water-tolerant trees, small areas of open water, emergent and submergent plants. Oak mast is a preferred food (Bellrose 1976).	• Living or dead deciduous trees with cavities • Scrub/shrub wetland with overhead cover of downed timber • Dense stands of emergent plants • Mixture of shallow freshwater wetland types in close proximity	Not available	Restoration of aquatic habitat may be more effective than supplementing nest site abundance (Denton et al. 2012)
Black-crowned Night Heron		Wide variety, including red oak, willow, hackberry, poison ivy *(Toxicodendron radicans),* box elder, phragmites, cattail	• Wide variety of nesting habitat and vegetation with proximity to foraging habitat (swamps, streams, rivers, marshes, pool margins) • Good vegetative cover essential	Not available	Most colony sites are on islands, in swamps, or over water, suggesting that site selection is related to predator avoidance. (Hothem et al. 2010)
Pied-billed Grebe		Wide variety of emergent vegetation	• Dense stands of emergent or aquatic vegetation close to surface and nearby open water • Riparian areas limited to still bays, sloughs, or other bodies of nonmoving water • Water depth >25 cm	Not available	
Sora		Cattail, sedges, burreeds (*Sparganium* spp.) and bulrushes	• Wetland edges, adjacent upland fields • Interspersion of fine and robust emergent vegetation and water	Occurs more commonly in wetlands of > 5 ha (Melvin et al. 2012)	

Priority Resource	Habitat Type(s)	Key Habitat Relationships			
		Vegetative Composition	Vegetative Structure	Patch Size	Special Considerations
Blanding's Turtle	Emergent Wetland	Abundant aquatic vegetation	• Wetland complexes and adjacent uplands of moist but well-drained sandy or loamy soil • Shallow waters with abundant aquatic vegetation and soft muddy bottoms over firm substrates	Not available	
Great Lakes Marsh	Emergent Wetland, Wet Prairie Moist Soil/Mud	Blue-joint grass, sedges, river bulrush, softstem bulrush (*Schoenoplectus tabernaemontanii*), dark-green bulrush (*Scirpus atrovir*ens), threesquare, spotted touch me not (*Impatiens capensis*), joe-pye weed, swamp milkweed, beggarticks, marsh fern, and sensitive fern Michigan indicator species include hardstem bulrush (*Schoenoplectus acutus),* threesquare, and common spikerush (*Eleocharis palustris*) Rare plants include arrowhead (Sagittaria *montevidensis*, state threatened), American lotus (state threatened), and wild rice (state threatened)	Most Great Lakes marshes have three distinct zones: • Wet meadow, which includes saturated organic soils, grasses and sedges dominate • Emergent marsh, which includes permanently flooded areas with shallow water; bulrushes, spike-rushes (*Eleocharis* spp.), rushes (*Juncus* spp.), and cattails, in addition to submergent and floating plants • Submergent marsh, which includes deep water and few or no emergent species, but numerous floating or submergent species	Not applicable	Great Lakes marsh is an herbaceous wetland community restricted to the shoreline of the Great Lakes and their major connecting rivers.

Priority Resource	Habitat Type(s)	Key Habitat Relationships			
		Vegetative Composition	Vegetative Structure	Patch Size	Special Considerations
Eastern Fox Snake	Wet Prairie	Sparse to moderate meadow vegetation	• Marshes and adjacent wet meadows • Shoreline marshes, vegetated dunes and beaches	Not available	Rare in many areas where formerly abundant, due to loss and degradation of habitat by human activities, killing and collecting by humans
Eastern Prairie Fringed Orchid		Common associates include little bluestem *(Schizachyrium scoparium),* big bluestem *(Andropogon gerardii)* prairie cordgrass, shrubby cinquefoil (*Potentilla fruticosa*), and blazing star (*Liatris spicata*)	• Wet prairies and bogs • Lakeplain wet or wet-mesic prairies bordering Saginaw Bay and Lake Erie.	Not applicable	Persists in degraded prairie remnants, colonize ditches, railroad rights-of-way, fallow agricultural fields, disturbed areas (Penskar and Higman 2000)
Lakeplain Wet Prairie		Blue-joint grass, prairie cordgrass, Baltic rush (*Juncus balticus*), sedges (*Carex stricta, Carex pellita,* and *C. aquatilis*), twig-rush (*Cladium mariscoides*), swamp milkweed, and shrubby cinquefoil	• Level, sandy glacial lakeplains and deposits of dune sand in silt/clay glacial lakeplains • Transition zone between emergent marsh and lakeplain wet-mesic prairie • Seasonal flooding and small pockets that remain wet	Not applicable	Lakeplain wet prairie is a species-rich prairie community that occurs on the seasonally wet ground of glacial lakeplains in the southern Great Lakes region (Albert and Kost 1998).
Northern Flicker	Wet-mesic Forest	Most tree species of woodlands	• Forest edge and open woodlands • Riparian woodlands • 93 snags/100 ha optimum (Thomas et al. 1979)	Not available	Create cavities used by many other species.
Rusty Blackbird		Migrant associated with wet woodlands	• Swamps, wet open woodlands, and pond edges • Soft mud and loose soil	Not applicable	Opportunistic during winter and migration. Feeds on dogwood berries.

Priority Resource	Habitat Type(s)	Key Habitat Relationships			
		Vegetative Composition	**Vegetative Structure**	**Patch Size**	**Special Considerations**
American Woodcock	Wet-mesic Forest	Young forest. Dogwood, cottonwood, willow, ash, elm, especially clearings.	• Young forest and abandoned farmland mixed with forest and shrubs • Overstory canopy cover 53–64%; Shrub canopy cover 75–87% • Proximity to grassy openings	Numerous records of closely spaced nests ≤ 8 m (Keppie and Whiting 1994)	
Southern Hardwood Swamp		Dominated by silver maple, green ash (*Fraxinus pennsylvanica*), and American elm with swamp white oak subdominant; also hackberry, sycamore (*Platanus occidentalis*), and cottonwood; shrubs include nannyberry (*Viburnum lentago*), prickly ash, elderberry (*Sambucus canadensis*), highbush cranberry, (*Viburnum trilobum*); ground layer is characteristically sparse.	• Water levels fluctuate seasonally, with standing water typically occurring throughout winter and spring • Windthrow creates a pit and mound microtopography, canopy gaps; regeneration of a diverse overstory • Mucky pools and exposed tip-up mounds foster high plant diversity	Not applicable	Southern hardwood swamp is a minerotrophic forested wetland occurring in southern Lower Michigan on mineral or occasionally organic soils dominated by a mixture of lowland hardwoods (Kost et al. 2007; Slaughter 2009.)

Priority Resource	Habitat Type(s)	Key Habitat Relationships			
		Vegetative Composition	Vegetative Structure	Patch Size	Special Considerations
Wet-mesic Flatwoods	Wet-mesic Forest	Trees include red oak, Shumard's oak, white oak (*Quercus alba*), swamp white oak, chinquapin oak (*Q. muhlenbergii*), pin oak, bur oak (*Q. macrocarpa*), shagbark hickory, bitternut hickory (*Carya cordiformis*), shellbark hickory (*C. laciniosa*), silver maple, American elm, green ash, white ash (*Fraxinus americana*), pumpkin ash (*F. profunda*), and basswood, and black walnut.	• Surface soils sandy loam to loam and sandy clay loam, clay loam, or clay with impervious clay layer • Seasonal inundation and patchy, sparse ground layer • Highly diverse tree canopy	Not applicable	Wet-mesic flatwoods is a wet to mesic forest on mineral soils dominated by a highly diverse mixture of upland and lowland hardwoods (Slaughter et al. 2010).
Blue-winged Teal	Moist Soil/Mud	Seasonal and semi-permanent wetlands with much emergent vegetation; Preferred vegetative foods: algae, muskgrass, duckweeds (*Lemna* spp.), coontail, pondweeds, nut sedges, smartweeds, and rice cut grass (*Leersia oryzoides*)	• High density stands of short to moderate grasses w/in 150m of water for nest sites • Shallow water for foraging	Not available	Large permanent wetlands became more important during drought years when small, preferred wetlands were dry (Denton et al. 2012)
Wilson's Snipe		Migrant in sparsely vegetated mud flats	• Soft organic soil rich in food organisms just below surface • Clumps of vegetation	Not available	Avoids marshes with tall, dense vegetation
Lesser Yellowlegs		Migrant in sparse vegetation; mudflats, pools, shores, fields and seasonal wetlands	• Shallow flooded habitats	Not applicable	

Priority Resource	Habitat Type(s)	Key Habitat Relationships			
		Vegetative Composition	Vegetative Structure	Patch Size	Special Considerations
Canvasback	Open Water/ Submergent Wetland	Migrant in open water with wild celery and pondweeds	• Large slow-moving rivers, lakes • Open marshes, ponds, sewage lagoons, occasionally flooded fields	Not available	Prefers larger water bodies that provide ample food
Lesser Scaup		Migrant in open water with wild celery and pondweeds	• During migration, larger semi-permanent and permanent wetlands and lakes, and impounded portions of rivers • Emergent and submergent forage species veg	River impoundments >3000 ha during migration (Austin et al. 1998)	
Tundra Swan		Migrant in open water with wild celery and pondweeds, agricultural grain crops	• Shallow ponds, lakes, and riverine marshes, dry and flooded harvested grain fields • Large contiguous areas of open water	Non-foraging swans prefer wetlands with > 95% open water and > 1.30 km2 in size (Earnst in press)	
Bald Eagle		Large mature trees	• Mature and old-growth forest with relatively open canopy • Close (usually <2 km) to water with suitable foraging opportunities • Some form of habitat discontinuity or edge	1–2 km^2 is a typical territory size	Nest tree >500m from human development (Buehler 2000).

Priority Resource	Habitat Type(s)	Key Habitat Relationships			
		Vegetative Composition	Vegetative Structure	Patch Size	Special Considerations
Lake Sturgeon	Open Water/ Submergent Wetland	Not available	• Lakes and big rivers, low to moderate gradient, deep mid-river areas and pools, where water depths vary between 4 – 9 m and food is abundant • Substrates include firm sand, gravel, or rock at depths of 5-10 meters	Adults require large areas of water less than 30 feet (914 cm) in depth Migrations to spawning habitat can be 125 km	Spawning waters generally 0.3-4.7 m deep, in areas of swift currents, rapids, or waterfalls (Scott and Crossman 1973, Priegel and Wirth 1971).
Walleye		Not available	• Lakes; pools, backwaters, and runs of medium to large rivers; generally in moderately deep waters	Summer range 3-5 miles, 160 km to spawning habitat	Spawns in turbulent rocky areas in rivers, boulder to coarse gravel shoals of lakes, flooded marshes (Becker 1983, Sublette et al. 1990).
Northern Madtom		Not available	• Large creeks and small rivers with clear to turbid water and moderate current	Not available	Eggs are laid under flat stones (or sometimes in cans with large openings) in current (Taylor 1969, Cooper 1983)
Northern Pike		Flooded short grasses, sedges, and other emergent vegetation for spawning	• Clear small lakes, shallow vegetated areas of larger lakes, marshes, creeks, and small to large rivers	Not available	Spawning habitat is flooded area with emergent vegetation, optimally over short grasses or sedges
Lake Whitefish		Not available	• Cool water lakes and large rivers	Not available	Spawns in shallow water, hard or stony bottom, occasionally sand and deeper water (Scott and Crossman 1973).

Priority Refuge Resources and Relation to Refuge BIDEH

Birds

The **canvasback** is a diving duck that flocks on deeper areas of open water with some submergent vegetation. Although canvasbacks typically gather in greatest numbers offshore of Refuge units, the Detroit River and Western Lake Erie basin provide regionally-significant migratory stopover and overwintering habitat. Canvasbacks are heavily reliant on beds of wild celery, which occur near several Refuge islands, for feeding. Thus, the abundance of canvasback may indicate the relative abundance of wild celery beds, which are in recovery in some places within the Detroit River. Together with lesser scaup, canvasbacks represent a focal resource for other diving duck species on the Refuge.

The **lesser scaup** is a diving duck that gathers in large numbers in open water areas of the Detroit River and Western Lake Erie during migration and winter periods where there are mussels and other animal food sources. Together with canvasback, lesser scaup represent other diving duck guilds.

Tundra swans are relatively abundant in nearshore open water areas of the Refuge during winter and migration periods. They are identified as a priority on other regional bird plans, and are an indicator of high-quality open water/submergent wetland habitat.

Bald eagles, which are listed as special concern in Michigan, are included as a priority species in many regional plans. On the Refuge, bald eagles nest in canopies of cottonwoods or other tall trees adjacent to open water. Because they require both mature trees for nesting and perching and open water for feeding, they indicate a diversity of high quality forested and open water habitats on the landscape.

American black duck populations have declined since the 1950s, and are listed as a priority species in several regional bird conservation plans. They utilize open areas within emergent wetlands on the Refuge for feeding, and their presence indicates the availability of appropriate food resources, water depth, and vegetative cover during migratory periods. They are indicators of later-successional emergent wetlands.

The **wood duck** is a dabbling duck that utilizes shallow, muddy emergent wetland habitats on the Refuge that are in close proximity to mature standing trees in forested areas or overgrown dikes. Wood ducks use cavities in these trees for nesting. As such, they are indicators of both mature forested wetlands and emergent wetlands on the Refuge.

The **black-crowned night heron** is listed as special concern in Michigan and is included as a priority species in many regional bird conservation plans. Black-crowned night herons nest and roost in trees near the edge of emergent wetlands on the Refuge, and have large colonies of greater than 400 nesting pairs at Pointe Mouillee State Game Area. It was selected as a priority species in part because of the regional significance of this and other potential rookeries near the Refuge. Black-crowned night herons also represent other herons and wading bird species that use similar habitats.

Sora, another emergent wetland species, requires dense stands of vegetation without open water. Dense stands of vegetation, which are often dominated by cattails, sedges, and other grasses, can be managed for by manipulating water levels in impoundments, but more widely occur naturally in units with hydrological connectivity to Lake Erie where dense vegetation natural develops. Habitat suitable for sora is also important for American bittern, Virginia rail, marsh wren, least bittern, and migratory yellow rails and sedge wrens, which require dense vegetation.

The **pied-billed grebe** utilizes emergent wetlands that are in proximity to deeper submergent marshes, or wetlands that have a mix of both emergent and submergent vegetation. Thus, they

are important indicators of diverse hemi-marsh conditions on the Refuge, and providing habitat variability within emergent marshes benefits a wide range of species that depend on open water, standing vegetation, or a mix of both.

The **northern flicker** utilizes open, mature, wet-mesic forests on the Refuge or open areas in close proximity to closed-canopy wet-mesic forest. Although they feed on ants and other insects on the forest floor, they create cavities in dead standing trees, where they nest. Because the cavities created by northern flickers are used by a host of other species including wood ducks and gray squirrels, northern flickers act as a keystone species for wet-mesic forests. They also represent other guilds of species that rely on the patches of mature wet-mesic forest that occur on the Refuge.

The **rusty blackbird** is one of the most rapidly declining bird species in North America, and is thus included on many regional plans as a conservation priority. During migration periods, they are relatively abundant on the Refuge, perching and foraging in flocks in hardwood swamps and young forest where they feed on dogwood berries in fall or in wet leaf litter in spring. As such, rusty blackbirds indicate the presence of forests that are on the wetter end of the wet-mesic forest spectrum. They also indicate the presence other wet-mesic forest species, including reptiles and amphibians that use seasonally-moist forested habitats for breeding and foraging.

The **American woodcock** is another species that is listed as a priority in many regional conservation plans, likely due in part to decline in suitable habitat. On the Refuge, nesting and migrating American woodcocks use forests with open canopies and some shrub cover as stopover habitat, as well as areas that were cut, burned, or underwent herbicide application within recent years. Woodcock are often flushed in areas where phragmites was recently treated with herbicide, but not mowed or burned. These habitats are often within or near mid-successional wet-mesic forests that are in transition from shrub-dominated areas to mature forest. Because these habitats are vital to many migratory and breeding songbirds, the presence of American woodcocks may indicate that those species are present as well.

Blue-winged teal are dabbling ducks that utilize shallow emergent wetland and vegetated mud flats on the Refuge. They were selected as a priority species because they are relatively common and easy to survey for, and they represent other species that use similar habitats. Because they are tied to vegetated mud flats and shallow emergent wetlands, which fluctuate with Great Lakes water levels, they also are indicative of ecological processes associated with water level variability.

Wilson's snipe are migrant shorebirds that forage in grassy, vegetated mudflats on the Refuge. They represent similar habitats as blue-winged teal, but are usually in drier areas with less standing water. Their location and abundance on the Refuge indicate changes in habitat associated with naturally fluctuating or manipulated water levels.

Lesser yellowlegs are shorebirds that forage in mudflats and areas of sparsely-vegetated shallow water on the Refuge during migration. They represent similar ecological processes as Wilson's snipe and blue-winged teal, but generally indicate habitats that are more open and have slightly deeper water, but not as deep as preferred by pied-billed grebes and American black ducks. Their location and abundance on the Refuge indicate changes in habitat associated with naturally fluctuating or manipulated water levels.

Fish

Lake sturgeon, which are listed as threatened in Michigan, are a top regional conservation for many of the Refuge's partners and have been the focus of spawning reef restoration efforts in the Detroit River. Although these reefs largely occur outside of current Refuge units, the open water habitats surrounding the units provide critical habitat for lake sturgeon recovery. The recovery of

lake sturgeon populations and habitat is also indicative of other species that require rocky bottom substrates, including walleye, lake whitefish, and northern madtom.

Walleye, which are an economically-important sportfish in the region, spawn in rocky substrates in the Detroit River and Lake Erie. Walleye benefit from reef construction efforts that are targeted for lake sturgeon, and thus their presence indicates suitable habitat for more conservative species such as sturgeon and northern madtom.

Lake whitefish are also bottom-dwelling fish that prefer relatively fast current over a rocky substrate. Historically abundant, they were fished to near extinction in the late 1800s, and have since shown signs of recovery following improvements to water quality and spawning habitat restoration efforts. Their recovery, like that of lake sturgeon, is indicative of recovery of the Detroit River ecosystem as a whole.

Northern madtom are listed as endangered in Michigan, and occur in areas adjacent to Refuge islands with strong current and a rocky or gravelly surface substrate. It was selected as a priority because the Refuge and waters immediately adjacent to Refuge units provide critical in-stream habitat for northern madtom.

Northern pike are top-level predators that rely heavily on submergent wetlands for all parts of their life cycle. Thus, their presence on the Refuge is an indicator of an abundance of healthy submergent wetlands. Northern pike also represent other fish species that rely on submergent wetlands for all or part of their life cycle, including yellow perch, which is a major sportfish on Lake Erie.

Reptiles

Blanding's turtle, which is listed as threatened in Michigan, requires emergent wetlands with shallow, clear pools with soft, muddy substrate. Good populations occur at Ford Marsh Unit and likely other units. Water levels at the Brancheau Unit may be able to be controlled to benefit Blanding's turtle. Blanding's turtle may be indicative of ecological processes that are important for non-bird species in emergent wetlands.

The **eastern fox snake**, listed as threatened in Michigan, inhabits emergent wetlands, wet prairies, and associated uplands along the Lake Erie shoreline. Conservation of transitional areas between wetlands and uplands, including the conversion of agricultural land to wet prairie vegetation, will be of direct benefit to eastern fox snake populations. Although fox snakes are adaptable to a variety of habitats, their local range is restricted to the western basin of Lake Erie. Thus, changes in eastern fox snake populations is indicative of the availability of natural habitat in the Refuge area.

Plants

The **eastern prairie-fringed orchid** is a federally-threatened species and a conservation priority of many of the Refuge's partners. It occurs within remnant lakeplain prairies within the Refuge area, including at Lake Erie Metropark, a cooperatively-managed unit of the Refuge. The presence of eastern prairie-fringed orchid elsewhere on the Refuge may indicate the presence of remnant lakeplain prairie communities and the occurrence of appropriate soil-hydrology-natural processes necessary for eastern prairie-fringed orchid and other lakeplain prairie species.

Natural Communities

Southern hardwood swamps are maple, ash, and elm-dominated forests that occur in southern Lower Michigan and in small, fragmented patches on the Refuge, especially in riparian areas. Although they are not extensive on the Refuge, they provide critical stopover habitat for warblers and many other migratory songbirds. Southern hardwood swamps that contain a mixture of mid

and late-successional microhabitats benefit the greatest diversity of migratory songbird species by providing a varied physical habitat structure.

Southern hardwood swamp in July at Plum Creek Bay Unit.

Degraded wet-mesic flatwoods in June at Humbug Marsh Unit.

Wet-mesic flatwoods is an uncommon forest type, occurring only on poorly-drained glacial soils in the Maumee lakeplain in southeast Michigan. Wet-mesic flatwoods were selected as a priority resource because of their inherent rarity, but also because they contain populations of Shumard's oak (state special concern) and pumpkin ash (*Fraxinus profunda*, state threatened). Like other wet-mesic forest types, they provide important stopover habitat for migratory songbirds.

Lakeplain wet prairie, once abundant throughout the Refuge area, now cover less than 1% of their original area. Species composition in lakeplain wet prairies is determined by the depth and duration of seasonal flooding on top of clay soils, as was historically maintained by disturbances such as beaver activity and fire. Many lakeplain prairie species, such as eastern prairie-fringed orchid, are now threatened or endangered as a result of habitat loss. Thus, the presence of lakeplain wet prairie communities on the Refuge could represent suitable habitat for a number of species of conservation interest.

Wet prairie in late summer at Fix Unit.

Great Lakes marsh is an herbaceous wetland community that occurs along the Refuge shoreline, and is critically important habitat for a suite of wildlife of many different guilds. Vegetation and habitats within Great Lakes marshes change in response to fluctuating water levels. Thus, changes in vegetation within these wetlands may indicate larger ecological processes associated with Great Lakes water levels.

Great Lakes Marsh in August at Gibraltar Bay Unit.

Table 3-3 summarizes how priority species likely use habitats within the Refuge and the surrounding landscape based on a literature review, professional judgment, and management experience. Several priority species use more than one habitat type at one or more times of the year, thus emphasizing the importance of integrated habitat management. Selected priority species primarily use the Refuge for breeding and/or foraging purposes. Bird abundance significantly drops during the winter time period as many of the priority species have migrated south.

Management activities associated with a priority species has direct and indirect benefits for other species that have similar habitat requirements. Table 3-3 lists the group or guild of species each priority species represents. In many cases, activities to benefit the priority species will likely result in benefits for other species that are conservation priorities. The species listed in the "Other Benefitting Resources" in Table 3-3 is not an all-inclusive list. The species listed were derived from reviewing the previously mentioned regional plans, Refuge staff and researcher observations, and selecting species of conservation concern that are rated as relatively high priority species across the region.

Table 3-3. Priority ROCs and Other Benefiting Resources on Detroit River IWR.

Resources of Concern	Habitat Type	Habitat Structure	Life History	Other Benefiting Resources
American Black Duck	Emergent Wetland	Shallow permanent wetland with emergent vegetation	Migration, foraging	Least Bittern Virginia Rail King Rail Yellow rail American Bittern Common Gallinule American Coot Marsh Wren Great Blue Heron Mink Northern Harrier Swamp Sparrow Green Heron Great Egret Caspian Tern Black Tern Forster's Tern Common Map Turtle Queen Snake Eastern Tiger Salamander Leopard Frog
Wood Duck		Dense emergent with overhead vegetative cover	Brood rearing, foraging	
Black-crowned Night Heron		Variety of plants, structures used	Migration, nesting, brood rearing, foraging	
Pied-billed Grebe		Dense emergent and aquatic vegetation	Migration, nesting, brood rearing, foraging	
Sora		Emergent vegetation interspersed with upland edges	Migration, nesting, brood rearing, foraging	
Blanding's Turtle		Abundant aquatic vegetation with adjacent moist sandy upland	Lifelong nesting, foraging, hibernation	
Great Lakes Marsh		Three distinct zones: wet meadow, emergent marsh, submergent marsh	Not applicable	
Resources of Concern	**Habitat Type**	**Habitat Structure**	**Life History**	**Other Benefiting Resources**
Eastern Fox Snake	Wet Prairie	Sparse to moderate vegetation	Lifelong nesting, foraging, hibernation	Sedge Wren Leconte's sparrow Bobolink Vesper Sparrow Henslow's Sparrow Grasshopper Sparrow Savannah Sparrow Dickcissel Eastern Meadowlark Field Sparrow Northern Bobwhite American Kestrel Least Weasel Northern Red-bellied Snake Red Bat
Eastern Prairie Fringed Orchid		Wet or wet-mesic prairie	Not applicable	
Lakeplain Wet Prairie		Transition between emergent marsh and wet-mesic prairie	Not applicable	
Resources of Concern	**Habitat Type**	**Habitat Structure**	**Life History**	**Other Benefiting Resources**

Northern Flicker	Wet-mesic flatwoods	Forest with openings and riparian edges	Full season, nesting, brood rearing, foraging	Yellow-breasted Chat Canada Warbler Golden-winged Warbler Blue-winged Warbler Wood Thrush Brown Thrasher Yellow-billed Cuckoo Black-billed Cuckoo Orchard Oriole Eastern Towhee Rose-breasted Grosbeak Cooper's Hawk Cape-May Warbler Red-shouldered Hawk Sharp-shinned hawk Willow Flycatcher Warbling Vireo Gray Catbird Indiana Bat Northern Long-eared Bat Big Brown Bat Little Brown Bat Evening Bat Hoary Bat Silver-haired Bat Woodland Vole Red-backed Salamander Small-mouthed Salamander Spotted Salamander Blue-spotted Salamander
Rusty Blackbird		Wet forest with soft mud and loose soil	Migration, foraging	
American Woodcock		Young forest, shrubs, proximity to openings	Migration, nesting, brood rearing, foraging	
Southern Hardwood Swamp		Seasonal standing water, windthrows, pools, sparse ground cover, silver maple dominant	Not applicable	
Wet-mesic Flatwoods		Seasonal standing water, sparse patchy ground cover, diverse tree species, mostly closed canopy	Not applicable	

Resources of Concern	Habitat Type	Habitat Structure	Life History	Other Benefiting Resources
Blue-winged Teal	Moist Soil/Mud	Dense short to moderate grass cover and shallow water	Migration, foraging	Semi-palmated Sandpiper Baird's Sandpiper White-rumped Sandpiper Greater Yellowlegs Hudsonian godwit American Avocet Stilt Sandpiper Least Sandpiper Green-winged Teal Dunlin
Wilson's Snipe		Clumps of vegetation, soft moist organic soil	Migration, foraging	
Lesser Yellowlegs		Shallow flooded mudflats	Migration, foraging	

Great Lakes Marsh		Three distinct zones: wet meadow, emergent marsh, submergent marsh	Not applicable	Short-billed Dowitcher Pectoral Sandpiper Solitary Sandpiper Killdeer Wilson's Phalarope American Golden Plover Black-bellied Plover Semi-palmated Plover Long-billed Dowitcher
Canvasback Lesser Scaup Tundra Swan	Open Water/ Submergent Wetland	Emergent and submergent vegetation in open marshes, lakes, rivers or flooded fields	Migration, foraging	Osprey Ruddy Duck Greater Scaup Trumpeter Swan Redhead Common Goldeneye Hooded Merganser Bufflehead Northern Pintail Common Loon Common Tern Purple Martin Northern Rough-winged Swallow Bank Swallow Cliff Swallow Mudpuppy Spotted Turtle Channel Darter Lake Herring Emerald Shiner Yellow Perch Smallmouth Bass Black Sandshell Eastern Pondmussel Lilliput Kidneyshell Mussell Purple Pimpleback Wavy-rayed Lampmussel
Bald Eagle		Large trees in riparian woodland	Full season, nesting, brood rearing, foraging	
Lake Sturgeon, Lake Whitefish, Walleye		Cool clear water lakes and large rivers	Full season, spawning, foraging	
Northern Pike		Shallow vegetated clear lakes, rivers, creeks, backwaters, marshes	Full season, spawning, foraging	
Northern Madtom		Streams and small rivers with moderate current	Full season, spawning, foraging	
Great Lakes Marsh		Three distinct zones: wet meadow, emergent marsh, submergent marsh	Not applicable	

3.5 Priority Habitat Types and Associated Priority Species

Refuge personnel focus on managing habitats to benefit a suite of priority species, plants, animals, and natural communities. The priority habitat types of the Refuge were identified based on information compiled including historic conditions, current vegetation, site capability, and conservation needs of other benefitting species (Table 3-4).

Because all potential management activities cannot be concurrently implemented, habitat types have been prioritized based on the following ranking factors:

- Where management actions would provide the greatest conservation benefit to identified priority species,
- Current habitat conditions and the urgency of needs for active management, and
- The ability of a habitat type to be positively affected through management.

Although some habitats may be ranked as Priority 2, this should not be interpreted as meaning they do not provide valuable habitat to a variety of species or contribute to Refuge BIDEH. These habitats may not require active management, represent areas where there is limited management capabilities, or under current conditions, may exhibit a limited response to habitat management. If conditions change in the future and they become degraded, Priority 2 habitats may be elevated to Priority 1 status during the scheduled HMP review.

Table 3-4. Priority Habitats on Detroit River IWR

Habitat Type	Priority Rank	Reasons for Priority Ranking	Limiting Factors/Stressors
Priority 1 Habitats			
Emergent Wetland	**1**	Supports 7 of the 28 priority resources (American black duck, wood duck, black-crowned night heron, pied-billed grebe, sora, Blanding's turtle, Great Lakes marsh). As one of the most abundant habitat types on the Refuge, this habitat type is important to numerous species of breeding, migrating and overwintering birds as well as other wildlife guilds. The Refuge must regularly monitor and actively maintain this habitat in areas of high phragmites or exotic cattail abundance in order to maintain BIDEH.	Fragmentation, water quality, invasive species, particularly phragmites and hybrid cattail. Inability to manipulate water levels on most units.
Moist Soil/Mud	**2**	Supports 4 of the 28 priority resources (blue-winged teal, Wilson's snipe, lesser yellowlegs, Great Lakes marsh). This habitat type exists in many shoreline areas of the refuge and changes in size and character in response to fluctuation of Great Lakes water levels. As such it supports a unique set of shorebirds and waterfowl that depend on shallow waters, sparse vegetation, and bare, saturated soils for foraging and nesting. The Brancheau, Ford Marsh, and Fix units are the only water-level controlled units currently managed by the Refuge.	Invasive species, particularly phragmites, which readily invades sparsely vegetated areas near the shoreline. Inability to manipulate water levels on most units.
Wet Prairie	**3**	Supports 4 of the 28 priority resources (eastern fox snake, eastern prairie-fringed orchid, Great Lakes marsh, lakeplain wet prairie). This once-abundant and species-diverse habitat type occurs in small pockets typically dominated by blue-joint grass. It supports numerous wildlife species, and has the potential to support rare plants including eastern prairie-fringed orchid. Refuge land currently in agricultural production has been seeded with native vegetation to construct a prairie habitat.	Invasive species, particularly phragmites and reed canary grass; small size and fragmentation of wet prairie areas. Potential difficulty of conversion of farmland to wet prairie vegetation.

Wet-Mesic Forest	**4**	Supports 5 of 28 priority resources (northern flicker, rusty blackbird, American woodcock, southern hardwood swamp, wet-mesic flatwoods). This habitat type is heavily used by migratory birds, as well as other old field and forest-dependent wildlife. Birds are particularly drawn to forests with a stratified age structure. Flat sites with seasonally-perched water tables support a unique assemblage of plant species, including two state-listed trees.	Invasive species, particularly buckthorn and honeysuckle. Small patch size of existing forests. Heavy deer herbivory, which reduces plant diversity and alters community structure and composition.
Priority 2 Habitats			
Open Water/ Submergent Wetland	**5**	Supports 10 of the 28 priority resources (canvasback, lesser scaup, tundra swan, bald eagle, lake sturgeon, walleye, northern pike, northern madtom, lake whitefish, Great Lakes marsh). These habitats are heavily used by waterfowl for migration and overwintering. They are also critically important for a variety of ecologically and economically significant fish species in the region. Many of these habitats exist within the Refuge's authorized boundary, but outside of the Refuge's specific unit boundaries.	Water quality, boat traffic, and in-channel dredging operations. Limited ability to directly manage open water habitats, except through cooperation with partners involved in reef construction and other restoration work.

3.6 Conflicting Habitat Needs

Given the diversity of goals, purposes, mandates, and conservation priorities for the NWRS, it is not uncommon to have conflicting management priorities at a refuge. Balancing the types and proportion of habitats (and their management) requires special consideration and a process for determining the best course of action. Detroit River IWR contains habitat and management decisions that require such consideration.

3.7 Adaptive Management

Priority species and their respective habitat attributes were used to develop habitat objectives. Refuge habitat management objectives must be achievable, and factors may reduce or eliminate the ability of the Refuge to achieve objectives. Although these factors were considered during the development of management objectives, conditions may change over the next 15 years and beyond, requiring the use of adaptive management principles as outlined in Chapter 1.

The planning team identified specific management areas where we anticipate ongoing need for adaptive management to maximize the Refuge's biological benefits. These considerations may require an accelerated iteration and alteration of management actions (Steps 9 and 6 respectively of the adaptive management guidance, Chapter 1) outside of the anticipated 5-year HMP review. These include, but are not limited to:

- Changes in anticipated Great Lakes water levels
- Significant changes in the abundance of phragmites or other invasive species
- Conversion of farmed units to constructed wet prairie
- Vegetation and wildlife response to moist soil management in the south impoundment at the Brancheau Unit and future water level management at Fix and Ford Marsh units
- Acquisition of new Refuge lands

Chapter 4.
Habitat Goals and Objectives

Wet prairie after prescribed fire at the Fix Unit.

4.1 Background

The goals of a CCP are to represent broad statements of a refuge's desired future conditions. CCP objectives are to be developed as concise ideas that specify what needs to be achieved, how much needs to be achieved, when and where it needs to be achieved, and who is responsible for the work (602 FW 1.6). Goals and objectives provide a framework for Refuge management over a 15-year timeframe (602 FW 1.4A). CCP goals and objectives for Detroit River IWR were developed in 2005 and are discussed below. Strategies, which are specific actions, tools, or techniques required to achieve objectives, will be discussed in Chapter 5 (602 FW 1.6).

During the development of the HMP, the planning team reviewed the CCP goals and objectives to determine if they were 1) representative of existing Refuge conditions, 2) current with Service policies, and 3) aligned with Refuge management. After review and discussion, the HMP planning team determined that the one habitat-related goal in the CCP (Goal 7, USFWS 2005) was applicable for inclusion in the HMP. However, the planning team determined that it was necessary to refine or replace all of the objectives and strategies contained under that goal within the CCP, in order to better reflect the Refuge's current habitat management emphases.

Service guidance requires that habitat objectives be SMART, i.e., Specific, Measurable, Achievable, Result-oriented, and Time-fixed. The planning team identified objectives needing refinement in order to meet the requirements of SMART criteria. Rationale is provided for each habitat objective in order to summarize the scientific information, expert opinion, and professional judgment used to formulate each objective.

Based on guidance in the Service's Writing Goals and Objectives Handbook (USFWS 2004c), the planning team determined that while some of the original CCP objectives were written as SMART objectives, others were lacking one or more SMART criteria. The newly drafted objectives provide greater specificity, reflect current management emphases, and bring objectives into compliance with policy (601 FW 3).

Section 4.2 details the goal and objective amendments from the CCP to the HMP, including a rationale for the needed changes. Section 4.3 lists goals and objectives as used in the HMP and a rationale for their inclusion as management directives.

4.2 Amendment of CCP Goals and Objectives

CCP Goal 7: Healthy Fish and Wildlife Communities: Fish and wildlife communities are healthy, diverse, and self-sustaining.

Goal Revision: This CCP goal was not revised for this HMP.

Rationale: This goal is compliant with Service policy (601 FW 1), which states that "our first obligation is to fulfill and carry out the purpose(s) of each refuge . . . Any additional efforts will be additive and complementary to the achievement of the refuge purpose(s)." Although the goal is explicitly focused on fish and wildlife communities, "healthy, diverse, and self-sustaining" communities require active habitat management on the Refuge. Therefore, objectives included in this HMP have been revised to focus on the five main habitat types on the Refuge. These objectives were developed to be consistent with Service-provided guidance on writing goals and objectives (USFWS 2004c).

CCP Objective 7.1: By 2015, protect 40 percent of remaining coastal wetland and island habitat on public and private lands through fee, easements, and cooperative agreements.

Objective Revision: This objective is not included in the HMP.

Rationale: The HMP is primarily focused on habitat management on existing Refuge lands. Specific objectives and strategies for additional land acquisition are beyond the scope of the HMP.

CCP Objective 7.2: Establish partnerships to identify and monitor populations of federally listed and state-listed endangered and threatened species within the approved Refuge boundary and work to prevent the listing of additional species.

Objective Revision: This objective is not included in the HMP.

Rationale: This objective does not meet SMART criteria, so it is difficult to assess the degree to which it has been achieved. Several partnerships have been established since the development of the CCP, some of which facilitate the conservation of threatened and endangered species. An inventory and monitoring plan (IMP), which includes monitoring populations of threatened and endangered species, is detailed in chapter 6. Partnerships are included as a strategy under the submergent wetland/open water objective.

CCP Objective 7.3: By 2007, quantify the importance of habitats within the Refuge authorized boundary to migratory waterfowl with an emphasis on Regional Resource Conservation Priority Species such as Canvasback, Black Duck, Mallard and Blue-winged Teal.

Objective Revision: This objective is not included in the HMP.

Rationale: The timeframe for this objective has passed. Furthermore, the process of selecting ROC for this HMP has helped quantify and prioritize the importance of certain habitats for migratory waterfowl, as well as species of other guilds.

CCP Objective 7.4: Participate in the restoration of lake sturgeon spawning beds and riparian and shallow wetland habitats to benefit fish in the Detroit River and Lake Erie within 3 years of acquiring a permanent staff for the Refuge.

Objective Revision: This objective is not included in the HMP.

Rationale: The timeframe for this objective has passed. Also, this objective does not meet SMART criteria, so it is difficult to assess the degree to which it has been achieved. However, this objective is considered to be an ongoing process that will be fulfilled and maintained throughout the implementation of this plan. Partnerships associated with spawning bed restoration are included as a strategy under the submergent wetland/open water objective.

CCP Objective 7.5: Working with others, identify and prioritize additional areas best suited for restoration through partnership efforts (e.g. coastal wetlands, lakeplain prairies, forested wetlands, oak openings, and riparian buffers).

Objective Revision: This objective is not included in the HMP.

Rationale: This objective does not meet SMART criteria. Also, specific objectives for developing partnerships and acquiring additional Refuge lands are outside the scope of this HMP, although partnerships are included as a strategy under the submergent wetland/open water objective. Prioritization of existing Refuge lands for restoration was undertaken as part of the HMP development process.

CCP Objective 7.6: Work cooperatively with all local governmental jurisdictions to advocate zoning and comprehensive land use planning that promotes no net loss and protection of existing habitat.

Objective Revision: This objective is not included in the HMP.

Rationale: This objective does not meet SMART criteria. Also, objectives for advocacy and land use planning are outside the scope of this HMP.

4.3 HMP Goals and Objectives

Goal: Healthy Fish and Wildlife Communities.

Fish and wildlife communities are healthy, diverse, and self-sustaining.

To meet this goal, the planning team has re-written the objectives originally presented within the CCP. One objective has been written for each of the five major habitat types found on the Refuge that were identified in Chapter 3: emergent wetlands, moist soil/mud, wet prairie, wet-mesic forest, and submergent wetlands/open water. The objectives are presented in order of priority for management as identified in Chapter 3.

Emergent Wetlands Objective

Over the life of the HMP, protect the integrity of Great Lakes Marsh, and provide breeding and migratory stopover for Refuge priority resources such as wood duck, sora, Blanding's turtle, and pied-billed grebe. Wetlands with hydrological connection to Lake Erie and governed by its water levels and natural disturbances (seiches, ice-scour, storm surges) will be conserved in their natural state. A total of 270-acres of impoundments will be manipulated to maintain seasonally inundated to shallow (less than two feet) semi-permanently flooded marsh conditions with a varying range of total emergent vegetated cover. Phragmites within priority 1 units (as defined in Table 5-1) will be reduced to a maximum of 10 percent of the total area in the emergent wetland zones or impoundments. Narrow-leaved and hybrid cattail, along with other exotic species, will be reduced to no more than 80 percent of the total area. This equates to up to 400 acres that will annually receive water level manipulation in impoundments, intensive phragmites/cattail re-treatment, mowing, and prescribed fire in both coastal wetlands and impoundments.

Rationale

Emergent wetlands are the most abundant habitat type on the Refuge and are the Refuge's top management priority. They include Great Lakes Marsh, a rare habitat type that is ranked as S3 (vulnerable) in Michigan. Since the 1800s, 97% of the coastal wetlands along the Detroit River have been lost to shoreline development and channel modifications (Hartig et al. 2007). Shoreline hardening prevented the inland shift of emergent wetland plant communities during a period of high water and storms in fall of 1972 and spring of 1973, which led to the decrease in emergent wetland habitat within the Refuge area. Coastal emergent wetlands on the Refuge have been in recovery since that time. Great Lakes Marshes and associated emergent wetlands are inherently rare within the Refuge area, and are thus the top Refuge management priority.

Emergent wetlands provide important habitat for wildlife, as evidenced by the inclusion of emergent wetlands in several regional bird conservation plans (e.g., Knutson et al. 2001, Potter et al. 2007b, Soulliere et al. 2007). In the context of the HMP, emergent wetlands support six priority species of concern: American black duck, wood duck, black-crowned night heron, pied-billed grebe, sora, and Blanding's turtle. Together, these species use a range of habitat characteristics that exist within this habitat type. For example, soras require dense stands of vegetation (often near monotypic stands of cattail) for nesting and rearing young (Melvin et al. 2012). Blanding's turtles require open, clear, shallow pools with aquatic vegetation and muddy bottoms for foraging (Lee 1999). Wood ducks utilize a diverse mixture of open and vegetated wetlands for foraging and rearing young (Denton et al. 2012). Thus, the Refuge emphasizes providing a range of emergent wetland conditions – from sparse to dense emergent vegetation –

that is obtained through natural water level fluctuations and by reducing the abundance of dense, monospecific stands of phragmites within this habitat type to no more than 10% cover within the emergent zone in each of the priority 1 units. This strategy provides habitats for these and other priority species, as well as the host of other wildlife that use emergent wetlands for all or part of their life cycle.

Most emergent wetlands on the Refuge have direct hydrological connections to the Detroit River or Lake Erie, so are subject to natural fluctuations in water levels that occur on daily, seasonal, and inter-annual time scales. Thus, the management for specific vegetative conditions on the Refuge by means of controlling water levels is neither possible nor desirable, except within impoundments at the Brancheau (65 acres), Fix (50 acres), and Ford Marsh (170 acres) units. These units will be managed to create inundated to shallow (less than two feet) semi-permanently flooded marsh conditions and deliberately manipulated to provide a wide range of percent cover of emergent vegetation. The 15-acre south impoundment at the Brancheau Unit will be managed for moist soil habitat. The effects of climate change on long-term patterns of water level fluctuation are largely unknown (Kling et al. 2003, Gronewold et al. 2011), potentially complicating any efforts to manage for specific plant community types. Most importantly natural water level fluctuation naturally maintains a diversity of water depths on the landscape, which benefits a variety of focal species, including fish.

A major focus of the management of emergent wetlands on the Refuge is the control of invasive phragmites, which began infesting many areas of what is now the Refuge in the late 1990s. Phragmites can create monotypic stands that displace native vegetation. Recent herbicide applications, used in combination with mowing and/or burning, have been effective at reducing phragmites abundance in order to maintain the integrity of Great Lakes Marsh. The reduction of phragmites abundance also improves the availability of food and cover for focal wildlife species. In addition to the ecological benefits of phragmites management, the reduction of phragmites also increases public access, improves views, and also reduces the risk of wildfire. Based on observations by Refuge staff in recent years, management that is successful in reducing the density and overall vigor of a stand, as opposed to complete eradication, is often sufficient to achieve these objectives. Refuge staff have been successful at reducing phragmites to less than 10 percent coverage within the emergent wetland zone at Humbug Marsh, Gibraltar Wetlands (Brownstown Creek), Strong, Fix, and Plum Creek Bay. Most importantly, staff time, cost, and herbicide continues to be reduced annually while meeting the 10% objective.

Controlling narrow-leaved and hybrid cattail (*Typha angustifolia* and *Typha x glauca*) is also a focus of emergent marsh management. Cattail is the dominant vegetation in nearly every emergent wetland, but unlike phragmites, cattail provides habitat for focal wildlife such as rails, moorhens, and marsh wrens. However, a greater diversity and abundance of wildlife will utilize wetlands that have a higher diversity of vegetation or interspersion with open water. Thus, this objective limits the abundance of narrow-leaved and hybrid cattail, along with other exotic species, to no more than 80 percent of existing vegetated cover. This threshold is never expected to be reached in natural, coastal wetlands due to the apparent persistence of native species such as bulrushes, arrowhead, and bur-reed. Natural marshes also experience frequent disturbance from fluctuating water levels, storms, and ice scour which can set back cattail and phragmites without intervention. However, artificial impoundments may require herbicide application or mowing/burning/water level control if emergent vegetation is represented by over 80% narrow-leaved and hybrid cattail or other exotic species.

Moist Soil/Mud Objective

Over the life of the HMP, maintain a minimum of 15 acres of managed moist soil habitat during spring and fall migration at the south impoundment of the Brancheau Unit. Managed moist soil areas will maintain a dominance of annual native vegetation. Other coastal units will maintain shoreline mudflat with sparse vegetation (<25% total area) as water levels allow. These habitats

will provide migratory stopover for Refuge priority resources such as blue-winged teal, Wilson's snipe, and lesser yellowlegs.

Rationale

Moist soil or mud habitats provide habitat for three priority species (blue-winged teal, Wilson's snipe, and lesser yellowlegs). Great Lakes Marsh, another Refuge priority resource, contains mudflats and areas of bare soil or very shallow water following daily or seasonal drops in water level. These habitats are particularly important for shorebirds, which forage for terrestrial and benthic invertebrates, plants, seeds, and small fish that occur in sparsely-vegetated mudflats and areas of very shallow water (Mueller 1999, Potter et al. 2007b). They also support large numbers of waterfowl, including blue-winged teal, on the Refuge at certain times of the year. Because of their importance for migratory birds, mudflats and moist soil areas are identified as being important habitats in regional plans (e.g., Knutson et al. 2001, Potter et al. 2007b). After emergent wetlands, moist soil and mud habitats are the second highest priority habitat for management on the Refuge.

Management of mudflats on the Refuge is mostly passive because they are maintained by natural processes on the lakeshore such as seiches, storm surges, and ice scour. However, because phragmites readily invades areas of bare, wet soil in mudflats during the growing season, phragmites control could be appropriate.

The impoundments at the Brancheau, Fix, and Ford Marsh units are the only locations where Refuge staff can control water levels. Only the 15-acre south impoundment at the Brancheau Unit will be managed specifically for moist soil and native annual wetland plants to provide optimal stopover habitat during spring and fall migration for priority species (blue-winged teal, Wilson's snipe, and lesser yellowlegs). Although relatively small in acreage, these 15 acres will provide a regionally significant amount of this critical habitat for these species during migration. Because moist soil management is costly in terms of staff time, fuel, and equipment, this limit is in place to ensure there is sufficient staff time and funding for other Refuge priorities each year. Peak bird use on moist soil units typically occur in the year immediately following soil disturbance, likely due to the abundance of annual vegetation and invertebrates. Therefore, in addition to water level manipulation, vegetation will be managed through the use of mowing, disking, or other disturbances in order to reduce cattail and other perennial vegetation and promote a predominance of annual native vegetation and moist soil.

Wet Prairie Objective

Over the life of the HMP, annually protect and rehabilitate all approximately 100 acres of the Refuge's wet prairies adjacent to natural Great Lakes Marsh and any remnant Lakeplain Wet Prairie if found. These areas should maintain dominance of native vegetation within their natural range of variability such as blue-joint grass, bulrushes, sedges, and cordgrass. These habitats will support eastern fox snake and protect any remaining populations of eastern prairie fringed orchid. Large, monotypic stands of reed canary grass and phragmites in existing, natural wet prairies will be managed to less than 10 percent of the total wet prairie area.

Constructed wet prairies from approximately 118 acres of former agricultural land will be managed to promote a grassland and early successional shrubland with a diversity of forbs to benefit a wide range of native pollinating invertebrates and migratory grassland birds. Woody species will be managed to less than 25 percent in constructed wet prairies. This equates to up to 118 acres of active management per year through prescribed fire and mowing. Invasive species will be controlled enough to maintain a dominance (>50% total area) of native vegetation as opposed to a dominance of non-native species.

Rationale

In the context of this HMP, wet prairie refers to three distinct habitats. First, it refers to a zone in the Refuge's natural Great Lakes marshes that is at an elevation on the landscape slightly above emergent marsh and demonstrates characteristic plant communities totaling approximately 100 acres. They vary widely in diversity and species composition, but often contain an abundance of blue-joint grass, sedges (especially *Carex stricta*), and reed canary grass. Secondly, wet prairie habitat also includes Lakeplain Wet Prairie, a rare natural community that is ranked as S1 (critically imperiled) in Michigan and is not known to be represented on the Refuge, but may be identified in the future. The highest quality remaining Lakeplain Wet Prairie within the Refuge acquisition boundary is at the Pointe Mouillee State Game Area former shooting range, which is less than 7 km from the Strong, Brancheau, and Fix Units. These communities represent unusually high diversity with single remnants often containing over 200 plant species. Wet prairies are associated with four priority resources of concern: eastern prairie fringed orchid, eastern fox snake, Lakeplain Wet Prairie, and Great Lakes Marsh. In Michigan, eastern prairie fringed orchid occurs almost exclusively in Lakeplain Wet Prairies along Lake Erie and Saginaw Bay, except for a few smaller populations that occur in bogs further inland (Penskar and Higman 2000). The eastern fox snake is a habitat generalist, but often utilizes wet prairies for cover and foraging (Lee 2000). Because of the scarcity of both of these wet prairie natural communities and the ability to provide habitat for species of conservation concern including eastern fox snake and the federally-threatened eastern prairie fringed orchid, the management of these wet prairie habitats is a priority for the Refuge.

Natural wet prairies often occur on the inland side of Great Lakes marshes in areas of sandy or clay soil that are at slightly higher elevation than emergent wetlands. Thus, as with emergent wetlands and moist soil/mud habitats, wet prairie communities are subject to changes associated with natural Great Lakes water level fluctuations, as plant species respond differentially to prevailing water depth and storm surges. For example, eastern prairie fringed orchid may not flower and produce seed in low water years (Penskar and Higman 2000). Thus, a long-term decline in Great Lakes water levels, as predicted by some climate change models (Kling et al. 2003, Gronewold et al. 2011), would shift plant communities lakeward.

Management of existing wet prairie habitats is guided by a recognition of natural processes that drive the formation and persistence of the healthiest wet prairie habitats. All natural wet prairies will be managed to restore their biological integrity and diversity, emphasizing protection of natural hydrological cycles and, where necessary, prescribed fire, and invasive species control. Where natural processes have been destroyed, Refuge staff will mimic them by manipulating hydrology and/or using combinations of prescribed fire and mowing. The spread of native shrubs, particularly willows and dogwoods, in the absence of fire or regular inundation can degrade wet prairie plant communities. Phragmites and reed canary grass invasion may be a concern in some wet prairies on the Refuge. For instance, areas of dominated by *Carex stricta* have such dense sod that invasives cannot become dominant if the community is simply protected. Conversely, some blue-joint dominated wet prairies appear susceptible to invasion if the prairie's hydrology is significantly different from the natural range of hydrological cycles. Because reed canary grass and phragmites often occurs intermixed with blue-joint grass and other native vegetation and may be difficult to eradicate from existing areas of wet prairie, a 10 percent tolerance threshold for monotypic stands of reed canary grass has been set in this objective. Areas interspersed with both phragmites and native plants may not be treated without negatively impacting the native plant communities; therefore, phragmites will be best left untreated.

In the context of this HMP, the third category of wet prairie includes approximately 118 acres of former agricultural fields that are managed as early successional habitats with less than 25% woody cover. These fields are present at the Strong, Brancheau, and Fix units and were farmed for many generations. Wet-forest would develop on these lands through natural ecological

succession, yet would be too small to support a significant diversity or number of forest interior breeding bird species. Mature forest is also not a requirement of most neo-tropical passage migrants, which is a priority for Refuge habitat. Therefore, these fields will be managed at a persistent early successional stage to support a wide-range of pollinating invertebrate species by containing a broad range of forbs within a native grassland. All but the Fix Unit has been seeded with native (although not local genotype) forbs and grasses. Dogwoods (*Cornus* sp.), especially rough-leaved dogwood (*Cornus drummondii*), eastern cottonwood (*Populus deltoides*), and willow (*Salix* spp.) will readily establish in these fields without prescribed fire or periodic mowing. Prescribed fire and mowing should be incorporated to maintain no greater than 25% shrub cover in these fields. The intent with this threshold is to provide managers the flexibility to assess how the plant community develops and determine what emphasis should be established to maximize conservation benefit at multiple spatial scales. More frequent prescribed fire and mowing would inhibit any shrub development and promote more habitat for certain pollinators. While grassland birds will likely nest in these fields, especially when core breeding areas experience drought, breeding populations are not an objective because the areas are small and would support a limited number of breeding pairs. Less frequent prescribed fire and mowing would conserve shrubland for nesting birds and provide habitat for pollinators associated with shrubs. American woodcock is a Resource of Concern that would benefit, as well as species such as brown thrasher, blue-winged warbler, and eastern towhee.

The 53 acres of former agricultural fields at the Fix Unit will be managed with the assistance of a pump and water control structure to be installed in 2016. Management of water levels is intended to emulate hydrological cycles and patterns in more intact wet prairies of Great Lakes Marsh, and in particular, provide for early successional prairie that is consistently wetter than the other constructed prairies on the Refuge. After periodic disturbance through prescribed fire, mowing, and discing, these areas will support high quality habitat for yellowlegs, Wilson's snipe, and blue-winged teal. The maximum threshold for conducting a disturbance is 25% woody cover, although Refuge staff can incorporate these disturbances before that time if resources allow.

After the 15-year period of this HMP, managers can consider whether to continue this persistent early successional state or to allow succession to proceed with tree cover. Allowing all the stages of succession to proceed through the establishment of dogwoods, willows, red cedars, hawthorns, cottonwoods, ashes, oaks, has many benefits – that decision should be made when this HMP is revisited in 15 years.

Wet-Mesic Forest Objective

Over the life of the HMP, allow succession to proceed in all of the Refuge's existing forests to provide for American woodcock, rusty blackbird, northern flicker, and maintain the ecological integrity of southern hardwood swamp and wet-mesic flatwoods. Remaining woody invasive species will be controlled annually at Humbug Marsh north of the Handler Drain (79 acres) and prevented from establishing in high quality areas south of this drain where they are not already well-established.

Approximately 100 acres of forested areas are identified for active forest management in combination with suppression of invasive woody plants once during the period of this HMP (see Appendix D; Disturbance Types 2 and 3). Once management occurs, annual spot-treatment of woody invasive plants will occur annually. Management is intended only in areas within the 100 acres where it will promote increased compositional and structural heterogeneity, retain mature native canopy trees, large-diameter coarse woody debris, and snags.

Rationale

Wet-mesic forests on the Refuge provide habitat for three priority species: American woodcock, rusty blackbird, and northern flicker. These species represent a range of successional conditions that occur naturally in the Refuge's wet-mesic forests and also do not require large contiguous

forest tracts, which do not exist on the Refuge. Open, early- and mid-successional woodlands provide nesting and foraging habitat for American woodcock. Mid- and relatively late-successional forests provide nesting and foraging habitat for northern flicker and perching and foraging habitat for flocks of rusty blackbirds during spring and fall migration. Each successional stage, from old field to mature forest, attracts neotropical migratory songbirds moving through the lower Great Lakes during spring and fall migration. The Refuge is more important as a migratory stopover site than a breeding site for almost all neotropical migrants.

The wet-mesic forest habitat type includes wet-mesic flatwoods, a rare forest type that contains Shumard's oak, which is state-special concern, and pumpkin ash, which is state-threatened. The connection of forest stands via forested corridors is important to increase the available habitat and the movement of wet-mesic forest species between forest patches, particularly as those patches shift from one successional stage to another. However, the creation of corridors between habitat patches is in part dependent on future land acquisition and may require timeframes beyond the life of this HMP.

Given the inclusion of American woodcock and rusty blackbird in regional conservation plans, the inherent scarcity of wet-mesic flatwoods, and the presence of plant species of conservation concern, the management of wet-mesic forests is a priority for the Refuge. However, given the small patch size of these forests and the relatively low management effort needed to sustain these habitats, wet-mesic forest management is lower priority than management of emergent wetlands, moist soil/mud areas, and wet prairie.

The focus of wet-mesic forest management on the Refuge is on the maintenance and improvement of ecological integrity of the largest existing forest patches, which contain two natural communities – wet-mesic flatwoods and southern hardwood swamp. The three units (Gibraltar Bay, Humbug Marsh [mainland], and Gibraltar Wetlands) were chosen for active management because they contain quality forest relative to what exists in the region and they are easily accessible. They contrast to the Refuge's forested islands, which are difficult to access with equipment and are smaller in size. Plum Creek Bay Unit contains a rich southern hardwood swamp natural community, but is extremely infested by glossy buckthorn (*Frangula alnus*) and is relatively small. Invasive shrub control and periods with low deer numbers (to allow regeneration of native trees) at these three priority forest units will improve their ecological integrity and biological resilience to future stress.

Management of invasive shrubs is intended to be very limited on the Refuge. The priority is to prevent them from impacting areas where they are not currently present and to prevent their reestablishment in Humubg Marsh north of the Handler Drain where they have been initially removed. The objective narrows management focus to relatively small, easily accessible areas where volunteers and the public are engaged. This is expected to result in annual commitments to follow-up treatments and long-term success, as opposed to wavering commitments in other woodlands of the Refuge ultimately resulting in persistent invasives. Success in these objectives should be indicated by decreasing amounts of herbicide necessary to maintain or increase woody invasives control.

Submergent Wetlands/Open Water Objective

Over the life of the HMP, protect submergent wetlands and open water that sustain the integrity of Great Lakes coastal marsh, and sustain spawning, nursery, migratory stopover, and overwintering habitat for Refuge priority resources such as canvasback, lake sturgeon, and northern pike.

Rationale

Open water and submergent wetland habitats on and adjacent to the Refuge provide habitat for nine priority species and support one priority natural community. Many of these species are

included in regional conservation plans and have been the focus of long-term restoration efforts (e.g., Knutson et al. 2001, Ryan et al 2003, MacLennan et al. 2003). For example, the construction of lake sturgeon spawning reefs in the Detroit River has been a high-profile restoration focus for the region (Manny and Kennedy 2002). These habitats are heavily used by waterfowl for migration and overwintering. They are also critically important for a variety of ecologically and economically valuable fish species in the region by providing areas of relatively fast-flowing water over rocky bottoms, which several of these fish species need for spawning. Submergent wetland and open water habitats, as with other habitats on the Refuge, are affected by changes in Great Lakes water levels. Flow and water depth will alter species composition and structure.

As alluded to in the CCP, the Refuge's primary management of submergent wetland and open water habitats is focused on protection of coastal wetlands of which they are part. Improvements in water quality in the Detroit River and western Lake Erie will have many environmental benefits, including better health of the sumergent wetland and open water habitats.

Chapter 5.
Management Strategies and Prescriptions

Prescribed fire at the Fix Unit.

5.1 Development of Management Strategies and Prescriptions

This chapter outlines management strategies and prescriptions to address the habitat management goals and objectives outlined under Chapter 4. Management strategies identify the tools and techniques utilized to achieve the habitat objectives. Prescriptions provide the details such as sequence, timing, and location, by which the strategies will be implemented. The identified strategies and prescriptions were selected by reviewing past Refuge practices and their effectiveness in supporting management priorities, as well as consultation with other Refuge biologists and other ecologists and practitioners. Many factors, including wildlife populations, seasonal variations, and habitat conditions affect the selected prescriptions and their ability to achieve objectives from year to year. As such, many of the details of prescriptions will be identified in the Annual Work Plan. Prescriptions outlined herein are discussed on a conceptual level. Importantly, major knowledge gaps remain for every restoration practitioner, and it is no different at Detroit River IWR. We stress that Refuge staff should foster an environment where learning is a part of everyday operations. Uncertainty in management outcomes must be dealt with through adaptive management where learning is valued. Management actions should be done conservatively, and where uncertainty is high, should be structured so that staff and partners can find out how to better manage these natural communities. Time should be spent reading, communicating, reflecting, and planning how to apply new knowledge.

The work outlined within this HMP is intended to be feasible given the currently available resources of Refuge staff and current community support. As such, additions of biological technicians and other staff may help in achieving these management objectives over the next several years. The management prescriptions outlined here represent a comprehensive effort to guide management primarily over the next five years. However, it is impossible to predict the full suite of management strategies and prescriptions required over this period. Thus, some strategies may need to be amended or added as available resources change over time. These will be identified in the Annual Work Plan as needed. Appendix D provides a map of future Refuge habitats that are the desired result of the implementation of the outlined management strategies and prescriptions.

5.2 Prioritization of Management Units

Management strategies herein are described at the Refuge level. However, not all management strategies will be implemented within every unit. Table 5-1 provides a prioritization of Refuge units in order to help guide management efforts. Priority 1 units are largely units that contain critical habitat and have a high likelihood of being managed successfully due to their ease of accessibility. Priority 2 units are mostly Detroit River islands which contain important habitat, but are more difficult to manage and monitor successfully because of the effort required to access these units. Priority 3 units are largely cooperatively-managed units where management will be undertaken primarily by partners. Refuge personnel will support management efforts to the extent practical, but will likely not be directly involved in habitat management.

Table 5-1 Refuge Unit Prioritization

Unit	Habitats	Rationale
Priority 1 Units		
Brancheau Unit	Emergent wetland Wet prairie Moist soil/Mud	Phragmites/cattail management needed in coastal wetland; moist soil and hemi-marsh management needed in diked units; contains constructed wet prairie
Fix Unit	Emergent wetland Wet prairie Wet-mesic forest	Phragmites/reed canary grass management needed; contains agricultural area slated for wet prairie creation and pump structure
Ford Marsh Unit	Emergent wetland Wet-mesic forest Moist soil/Mud	Phragmites management needed. Pump structure is planned to enable water level control in 2016.
Gibraltar Bay	Emergent wetland Wet prairie Wet-mesic forest Open water/Submergent wetland	Phragmites/reed canary grass management needed
Gibraltar Wetlands	Wet-mesic forest Wet prairie Emergent wetland	Phragmites/reed canary grass/cattail management needed along Brownstown Creek only, as well as invasive shrub management and forest improvement in 40 acres.
Holloway Unit	Wet prairie Emergent wetland	Phragmites/reed canary grass management needed
Humbug Marsh	Emergent wetland Wet-mesic forest Open water/Submergent wetland	Adjacent to Refuge Gateway; invasive shrub management in forest needed, Phragmites/reed canary grass/cattail management in two coastal wetlands needed; deer management needed
Plum Creek Bay Unit	Emergent wetland Wet-mesic forest Moist soil/Mud	Phragmites/cattail management needed in emergent wetland areas
Refuge Gateway	Wet prairie Wet-mesic forest	Future site of visitor center, management of planted prairie needed
Strong Unit	Wet prairie Moist soil/Mud Wet-mesic forest	Phragmites/reed canary grass/cattail, needed; contains constructed wet prairie
Priority 2 Units		
Calf Island	Open water/Submergent wetland Wet-mesic forest	Difficult access; no active management; many invasive shrubs
Mud Island	Open water/Submergent wetland Wet-mesic forest	Difficult access; no active management; many invasive shrubs
Sugar Island	Wet-mesic forest	Difficult access; no active management; many invasive shrubs

Port of Monroe	Emergent wetland	Relatively low site quality
Priority 3 Units		
Erie Marsh Preserve Unit	Emergent wetland Wet prairie Wet-mesic forest Moist soil/Mud Open water/Submergent wetland	Cooperatively managed unit
Gard Island Unit	Emergent wetland Wet-mesic forest	Cooperatively managed unit
Grassy Island	Open water/Submergent wetland Wet-mesic forest	Difficult access; no active management; high abundance of phragmites
Lady of the Lake Unit	Emergent wetland	Cooperatively managed unit
Lagoona Beach Unit	Emergent wetland Wet-mesic forest	Cooperatively managed unit
Lake Erie Metropark	Emergent wetland Wet prairie Wet-mesic forest	Cooperatively managed unit

5.3 Management Strategies and Prescriptions by Habitat Objective

Emergent Wetlands Objective

Over the life of the HMP, protect the integrity of Great Lakes Marsh, and provide breeding and migratory stopover for Refuge priority resources such as wood duck, sora, Blanding's turtle, and pied-billed grebe. Wetlands with hydrological connection to Lake Erie and governed by its water levels and natural disturbances (seiches, ice-scour, storm surges) will be conserved in their natural state. A total of 270-acres of impoundments will be manipulated to maintain seasonally inundated to shallow (less than two feet) semi-permanently flooded marsh conditions with a varying range of total emergent vegetated cover. Phragmites within priority 1 units (as defined in Table 5-1) will be reduced to a maximum of 10 percent of the total area in the emergent wetland zones or impoundments. Narrow-leaved and hybrid cattail, along with other exotic species, will be reduced to no more than 80 percent of the total area. This equates to up to 400 acres that will annually receive water level manipulation in impoundments, intensive phragmites/cattail re-treatment, mowing, and prescribed fire in both coastal wetlands and impoundments.

Strategies

In order of priority, Refuge staff will:

1. Over the life of the HMP, maintain or restore hydrologic connection of coastal marshes to Lake Erie to the extent practical.

2. Annually, plan work strategies and prescriptions for specific Refuge units based on monitoring results:

    a. Acquire herbicide application (aquatic nuisance control) permits by July 1.

b. Plan and communicate prescribed burn plans with appropriate partners and neighboring landowners.
c. Plan water level manipulations in Brancheau, Fix, and Ford Marsh impoundments in Annual Work Plan.

3. At the Brancheau Unit, annually manage the surrounding ditch and impoundments:

    a. Set flash-boards and pump as necessary to prevent flooding to adjacent landowners.
    b. Protect perimeter dikes and water control structures from burrowing muskrats by lowering winter water levels below the base of the perimeter dikes before ice-cover.
    c. Manage vegetation to create hemi-marsh conditions in the north unit. Marsh vegetation will increase over time, thus will require cycles when water is drawn-down and the vegetation is mowed, disced, and sometimes treated with herbicide. This is then followed by re-flooding which should result in a number of growing seasons with approximately half of the marsh covered in vegetation and the rest in open water.

4. At the Ford Marsh Unit, annually manage the impoundment:

    a. Manage vegetation to create hemi-marsh conditions. Marsh vegetation will increase over time, thus will require cycles when water is brought up to maximum pool level to set back marsh succession

5. At Fix Unit, annually manage the impoundment:

    b. Manage vegetation to emulate water levels and hydrological cycles in natural wet prairies and marshes, creating a range of open to dense emergent marsh and constructed wet prairie vegetation.

6. Annually, implement invasive phragmites and cattail reduction measures across priority 1 Refuge units:

    a. Apply herbicide to phragmites/cattail stands based on Annual Work Plan, ensuring no significant damage to desirable vegetation.
    b. Conduct mowing for prescribed fire control lines in preparation for prescribed fire.
    c. Burn or mow previously sprayed phragmites stands anytime to remove thatch if it is too excessive to allow growth of regenerating marsh vegetation.

<u>Moist Soil/Mud Objective</u>

Over the life of the HMP, maintain a minimum of 15 acres of managed moist soil habitat during spring and fall migration at the south impoundment of the Brancheau Unit. Managed moist soil areas will maintain a dominance of annual native vegetation. Other coastal units will maintain shoreline mudflat with sparse vegetation (<25% total area) as water levels allow. These habitats will provide migratory stopover for Refuge priority resources such as blue-winged teal, Wilson's snipe, and lesser yellowlegs.

Strategies

In order of priority, Refuge staff will:

1. Over the life of the HMP, maintain water control structures and levees to sustain moist soil management capabilities at the 15-acre south impoundment at the Brancheau Unit.

2. Annually, complete early detection and rapid response inspections of large mudflat areas to prevent phragmites colonization.

3. Maintain a dominance (50% of cover or more) of annual plant species (e.g., *Bidens* sp., *Cyperus* sp., *Persicaria* sp.) in the 15-acre south impoundment at the Brancheau Unit by implementing water level control, mowing, prescribed fire, discing, and re-flooding as necessary. This could include herbicide application in August or September. Mowing should be done as necessary after July 15th. Discing could then be performed. A prescribed fire could replace mowing and discing and should occur in winter or before approximately May 15th (to reduce negative impact to nesting birds).

4. Within 5 years (2020), evaluate results of moist soil management and determine future course of management for the 15-acre south impoundment at the Brancheau Unit. Success is achieved if wetland annual plants make up approximately 50% or more of the plant cover. If they do not most years, management should be less intensive to achieve a hemi-marsh condition as in the north unit.

Wet Prairie Objective

Over the life of the HMP, annually protect and rehabilitate all approximately 100 acres of the Refuge's wet prairies adjacent to natural Great Lakes Marsh and any remnant Lakeplain Wet Prairie if found. These areas should maintain dominance of native vegetation within their natural range of variability such as blue-joint grass, bulrushes, sedges, and cordgrass. These habitats will support eastern fox snake and protect any remaining populations of eastern prairie fringed orchid. Large, monotypic stands of reed canary grass and phragmites in existing, natural wet prairies will be managed to less than 10 percent of the total wet prairie area.

Constructed wet prairies from approximately 118 acres of former agricultural land will be managed to promote a grassland and early successional shrubland with a diversity of forbs to benefit a wide range of native pollinating invertebrates and migratory grassland birds. Woody species will be managed to less than 25 percent in constructed wet prairies. This equates to up to 118 acres of active management per year through prescribed fire and mowing. Invasive species will be controlled enough to maintain a dominance (>50% total area) of native vegetation as opposed to a dominance of non-native species.

Strategies

In order of priority, Refuge staff will:

1. Over the life of the HMP, protect the approximately 100 acres of existing, natural wet prairies from alterations, such as draining or artificial wetland creation.

2. Annually, work to reduce invasive species populations to no more than 10% through herbicide application of phragmites and monotypic stands of reed canary grass in the 100 acres of existing, natural wet prairies.

3. Refrain from treating phragmites when it will result in unreasonable damage to native plant communities.

4. In Winter 2017, broadcast a diversity of native and locally representative wet prairie forbs (e.g., *Symphyotrichum* sp., *Helianthus giganteus, Coreopsis tripteris, Vernonia gigantean,* and *Veronicastrum virginicum*), and native grasses (*Spartina pectinata*, *Calamagrostis canadensis*, and *Elymus*) within drier sections of the 53-acre Fix Unit wetland enhancement.

5. Maintain a dominance (50% cover or more) of native species in the 118 acres of constructed wet prairies with herbicide application and/or mowing of new infestations (i.e., thistle [*Cirsium arvense*], reed canary grass, phragmites).

6. In 2017, flood the Fix Unit fields using the pump and water control structure to be installed in 2016, sufficient to maximize coverage of native wetland plants.

7. Maintain no more than 25% woody cover on the 118 acres of constructed wet prairies during the life of this HMP using prescribed fire and mowing.

8. Selectively cut any invasive shrubs in the Gibraltar Bay prairie installation. Mow a maximum of twice during the 15-year period according to Type 2 disturbance guidance (Appendix D).

Wet-Mesic Forest Objective

Over the life of the HMP, allow succession to proceed in all of the Refuge's existing forests to provide for American woodcock, rusty blackbird, northern flicker, and maintain the ecological integrity of southern hardwood swamp and wet-mesic flatwoods. Remaining woody invasive species will be controlled annually at Humbug Marsh north of the Handler Drain (79 acres) and prevented from establishing in high quality areas south of this drain where they are not already well-established.

Approximately 100 acres of forested areas are identified for active forest management in combination with suppression of invasive woody plants once during the period of this HMP (see Appendix D; Disturbance Types 2 and 3). Once management occurs, annual spot-treatment of woody invasive plants will occur annually. Management is intended only in areas within the 100 acres where it will promote increased compositional and structural heterogeneity, retain mature native canopy trees, large-diameter coarse woody debris, and snags.

Strategies

In order of priority, existing Refuge resources will:

1. Within 2 years, work with Federal, State, and local partners to develop and implement a deer control strategy for Humbug Marsh (mainland).
    a. maintain annual aerial deer survey with MDNR
    b. work with Visitor Services staff to conduct the planned public deer hunt beginning in 2016.
    c. establish herd-size target with MDNR and implement public hunting appropriately

2. Annually spot-treat woody invasive plants north of the Handler Drain within the Humbug Marsh Unit amounting to 79 acres receiving active management each year. Utilize stewardship crew to remove garlic mustard at Humbug Marsh (mainland) in high quality areas only.

3. Annually survey and prevent establishment of invasive woody plants in high quality areas south of the Handler Drain within the Humbug Marsh Unit (102 acres).

4. Suppress woody invasive species at 40 acres within Gibraltar Wetlands Unit (see Appendix D) when trail system is developed and annually spot-treat.

5. Promote compositional and structural heterogeneity in the 100 acres of managed stands (see Appendix D).

With the input of additional resources (added staff, partner involvement, or funding allocation), Refuge staff will:

1. Quantify desired future stand conditions for managed forests by establishing benchmarks based on the highest quality remaining stands of wet-mesic flatwoods and southern hardwood swamp in similar physiographic contexts as Refuge land. This should primarily be data on stand composition and structure (i.e., tree species, density, size, health, and amount and size of snags and coarse woody debris).

Submergent Wetlands/Open Water Objective

Over the life of the HMP, protect submergent wetlands and open water that sustain the integrity of Great Lakes coastal marsh, and sustain spawning, nursery, migratory stopover, and overwintering habitat for the presence of Refuge priority resources such as canvasback, lake sturgeon, and northern pike.

Strategies

1. Over the life of the HMP, partner with State and Federal Fisheries staff in the construction of at least three spawning reefs on or near Refuge shoals focusing on lake sturgeon, lake whitefish, northern madtom, and walleye (placing large rock in fast flowing areas).

2. Annually, partner to the extent practical with Michigan DNR on spring and fall diving duck surveys of the lower Detroit River to obtain wildlife population data.

3. Assess participation in partnerships to develop a long-term fish inventory and monitoring plan with multiple gear types for all fish habitat and created spawning reefs in the Detroit River that will assess trends in abundance and distribution of fish species over time.

4. Continue to participate in multi-agency initiatives to improve water quality in the lower Detroit River and the western Lake Erie basin.

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Appendix A.

Potential Resources of Concern

BIRDS

Common Name	Scientific Name
Waterbirds	
Great blue heron	*Ardea herodias*
American bittern	*Botaurus lentiginosus*
Green heron	*Butorides virescens*
Least bittern	*Ixobrychus exilis*
Black-crowned night-heron	*Nycticorax nycticorax*
Common loon	*Gavia immer*
Whooping crane	*Grus americana*
Black tern	*Chlidonias niger*
Least tern	*Sterna antillarum*
Caspian tern	*Sterna caspia*
Forster's tern	*Sterna forsteri*
Common tern	*Sterna hirundo*
Horned grebe	*Podiceps auritus*
Pied-billed grebe	*Podilymbus podiceps*
Yellow rail	*Coturnicops noveboracensis*
American coot	*Fulica americana*
Common moorhen	*Gallinula chloropus*
Black rail	*Laterallus jamaicensis*
Sora	*Porzana carolina*
King rail	*Rallus elegans*
Virginia rail	*Rallus limicola*
Shorebirds	
Piping Plover	*Charadrius melodus*
Semipalmated Plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
American Golden Plover	*Pluvialis dominica*
Black-bellied Plover	*Pluvialis squatarola*
Spotted Sandpiper	*Actitis macularia*
Ruddy Turnstone	*Arenaria interpres*
Upland Sandpiper	*Bartramia longicauda*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpina*
White-rumped Sandpiper	*Calidris fuscicollis*
Pectoral Sandpiper	*Calidris melanotos*
Least Sandpiper	*Calidris minutilla*
Semipalmated Sandpiper	*Calidris pusilla*
Wilson's Snipe	*Gallinago delicata*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*

Marbled Godwit	*Limosa fedoa*
Hudsonian Godwit	*Limosa haemastica*
Whimbrel	*Numenius phaeopus*
Wilson's Phalarope	*Phalaropus tricolor*
American Woodcock	*Scolopax minor*
Lesser Yellowlegs	*Tringa flavipes*
Greater Yellowlegs	*Tringa melanoleuca*
Solitary Sandpiper	*Tringa solitaria*
Waterfowl	
Wood Duck	*Aix sponsa*
Northern Pintail	*Anas acuta*
American Wigeon	*Anas americana*
Blue-winged Teal	*Anas discors*
Mallard	*Anas platyrhynchos*
American Black Duck	*Anas rubripes*
Lesser Scaup	*Aythya affinis*
Redhead	*Aythya americana*
Canvasback	*Aythya valisineria*
Canada Goose	*Branta canadensis*
Common Goldeneye	*Bucephala clangula*
Trumpeter Swan	*Cygnus buccinator*
Tundra Swan	*Cygnus columbianus*
Landbirds	
Cooper's Hawk	*Accipiter cooperii*
Northern Goshawk	*Accipiter gentilis*
Red-shouldered hawk	*Buteo lineatus*
Northern Harrier	*Circus cyaneus*
Bald Eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Whip-poor-will	*Caprimulgus vociferous*
Common Nighthawk	*Chordeiles minor*
Dickcissel	*Spiza americana*
Yellow-billed Cuckoo	*Coccyzus americanus*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Henslow’s Sparrow	*Ammodramus henslowii*
Grasshopper Sparrow	*Ammodramus savannarum*
Savannah Sparrow	*Passerculus sandwichensis*
Eastern Towhee	*Pipilo erythrophthalmus*
Vesper Sparrow	*Pooecetes gramineus*
Field Sparrow	*Spizella pusilla*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Evening Grosbeak	*Coccothraustes vespertinus*

Red Crossbill	*Loxia curvirostra*
White-winged Crossbill	*Loxia leucoptera*
Purple Martin	*Progne subis*
Bobolink	*Dolichonyx oryzivorus*
Rusty Blackbird	*Euphagus carolinus*
Orchard Oriole	*Icterus spurius*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Northern Shrike	*Lanius excubitor*
Loggerhead shrike, Migrant	*Lanius ludovicianus migrans*
Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*
Northern Bobwhite	*Colinus virginianus*
Canada Warbler	*Cardellina canadensis*
Kentucky Warbler	*Geothlypis formosus*
Worm-eating warbler	*Helmitheros vermivorum*
Yellow-breasted Chat	*Icteria virens*
Connecticut Warbler	*Oporornis agilis*
Louisiana Waterthrush	*Parkesia motacilla*
Prothonotary Warbler	*Protonotaria citrea*
Black-throated Blue Warbler	*Setophaga caerulescens*
Northern Parula	*Setophaga americana*
Cerulean Warbler	*Setophaga cerulea*
Hooded Warbler	*Setophaga citrina*
Prairie Warbler	*Setophaga discolor*
Yellow-throated Warbler	*Setophaga dominica*
Blackburnian Warbler	*Setophaga fusca*
Kirtland's Warbler	*Setophaga kirtlandii*
Palm Warbler	*Setophaga palmarum*
Golden-winged warbler	*Vermivora chrysoptera*
Blue-winged Warbler	*Vermivora cyanoptera*
Northern Flicker	*Colaptes auratus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Ruby-crowned Kinglet	*Regulus calendula*
Short-eared Owl	*Asio flammeus*
Long-eared Owl	*Asio otus*
Marsh Wren	*Cistothorus palustris*
Sedge Wren	*Cistothorus platensis*
Wood thrush	*Hylocichla mustelina*
Olive-sided Flycatcher	*Contopus cooperi*
Least Flycatcher	*Empidonax minimus*
Willow Flycatcher	*Empidonax traillii*

Acadian Flycatcher	*Empidonax virescens*
Eastern Kingbird	*Tyrannus tyrannus*
Barn Owl	*Tyto alba*
Bell's Vireo	*Vireo bellii*
White-eyed Vireo	*Vireo griseus*

MAMMALS

Common Name	**Scientific Name**
Least Weasel	*Mustela nivalis*
Silver-haired Bat	*Lasionycteris noctivagans*
Red Bat	*Lasiurus borealis*
Hoary Bat	*Lasiurus cinereus*
Northern Long-eared Bat	*Myotis septentrionalis*
Indiana Bat	*Myotis sodalis*
Evening Bat	*Nycticeius humeralis*
Eastern Pipistrelle	*Pipistrellus subflavus*
Southern Bog Lemming	*Synaptomys cooperi*
Prairie Vole	*Microtus ochrogaster*
Woodland Vole / Pine Vole	*Microtus pinetorum*
Least Shrew	*Cryptotis parva*

REPTILES & AMPHIBIANS

Common Name	**Scientific Name**
Amphibians	
Blanchard’s Cricket Frog	*Acris crepitans blanchardi*
Pickerel Frog	*Lithobates palustris*
Northern Leopard Frog	*Lithobates pipiens*
Western Chorus Frog	*Pseudacris triseriata*
Blue-spotted Salamander	*Ambystoma laterale*
Spotted Salamander	*Ambystoma maculatum*
Small-mouthed Salamander	*Ambystoma texanum*
Eastern Tiger Salamander	*Ambystoma tigrinum*
Four-toed Salamander	*Hemidactylium scutatum*
Reptiles	
Kirtland's Snake	*Clonophis kirtlandii*
North American Racer	*Coluber constrictor*
Ring-necked Snake	*Diadophis punctatus*
Eastern Hog-nosed Snake	*Heterodon platirhinos*
Copper-bellied Watersnake	*Nerodia e. neglecta*
Lake Erie Watersnake	*Nerodia sipedon insularum*
Smooth Greensnake	*Opheodrys vernalis*

Eastern Foxsnake	*Pantherophis gloydi*
Gray ratsnake	Pantherophis spiloides
Queen Snake	*Regina septemvittata*
Massasauga	*Sistrurus catenatus*
Spotted Turtle	*Clemmys guttata*
Blanding's Turtle	*Emydoidea blandingii*
Eastern Box Turtle	*Terrapene carolina*

FISH

Common Name	**Scientific Name**
Buffalo, Black	*Ictiobus niger*
Redhorse, Golden	*Moxostoma erythrurum*
Chubsucker, western creek	*Erimyzon claviformis*
Sucker, Spotted	*Minytrema melanops*
Redhorse, River	*Moxostoma carinatum*
Redhorse, Black	*Moxostoma duquesnei*
Goldfish	*Carassius auratus*
Dace, redside	*Clinostomus elongatus*
Carp, Common	*Cyprinus carpio*
Minnow, Brassy	*Hybognathus hankinsoni*
Shiner, striped	*Luxilus chrysocephalus*
Chub, Silver	*Macrhybopsis storiana*
Chub, Bigeye	*Notropis amblops*
Shiner, silver	*Notropis photogenis*
Dace, southern redbelly	*Phoxinus erythrogaster*
Dace, finescale dace	*Phoxinus neogaeus*
Chub, River	*Nocomis micropogon*
Minnow, Pugnose	*Opsopoeodus emiliae*
Pickerel, grass	*Esox americanus*
Muskellunge	*Esox masquinongy*
Goby, Round	*Neogobius melanostomus*
Mooneye	*Hiodon tergisus*
Bullhead, Brown	*Ameiurus nebulosus*
Stonecat	*Noturus flavatus*
Madtom, Tadpole	*Noturus gyrinus*
Madtom, brindled	*Noturus miurus*
Madtom, northern	*Noturus stigmosus*
Smelt, Rainbow	*Osmerus mordax*
Darter, orangethroat	*Etheostoma spectabile*
Sauger	*Sander canadense*
Darter, Eastern sand	*Ammocrypta pellucida*
Darter, fantail	*Etheostoma flabellare*

Darter, Least	*Etheostoma microperca*
Perch, Yellow	*Perca flavescens*
Darter, Channel	*Percina copelandi*
Darter, River	*Percina shumardi*
Lamprey, Sea	*Petromyzon marinus*
Cisco or lake herring	*Coregonus artedi*
Whitefish, Lake	*Coregonus clupeaformis*
Trout, Rainbow	*Oncorhynchus mykiss*
Trout, Brook	*Salvelinus fontinalis*

MUSSELS & SNAILS

Common Name	**Scientific Name**
Mussels	
Black sandshell	*Ligumia recta*
Eastern pondmussel	*Ligumia nasuta*
Lilliput	*Toxolasma parvus*
Kidneyshell mussel	*Ptychobranchus fasciolaris*
Purple pimpleback	*Cyclonaias tuberculata*
Wavy-rayed lampmussel	*Lampsilis fasciola*
Clubshell	*Pleurobema clava*
Northern riffleshell	*Epioblasma rangiana*
Purple lilliput mussel	*Toxolasma lividus*
Rayed Bean	*Vilosa fabalis*
round hickorynut	*Obovaria subrotunda*
Salamander mussel	*Simpsonaias ambigua*
Snuffbox	*Epioblasma triquetra*
threehorn wartyback	*Obliquaria reflexa*
White cat's paw pearlymussel	*Epioblasma obliquata perobliqua*
Elktoe	*Alasmidonta marginata*
Rainbow Shell	*Villosa iris*
Round pigtoe	*Pleurobema sintoxia*
Scaleshell mussel	*Leptodea leptodon*
Fawnsfoot	*Truncilla donaciformis*
round lake floater	*Pyganodon subgibbosa*
Slippershell	*Alasmidonta viridis*
Creek heelsplitter	*Lasmigona compressa*
Cylindrical papershell	*Anodontoides ferussacianus*
Pimpleback	*Quadrula pustulosa pustulosa*
Hickorynut	*Obovaria olivaria*
Paper Pondshell (floater)	*Anodonta (Utterbackia) imbecilis*
Asian clam	*Corbicula fluminea*
Zebra mussel	*Dreissena polymorpha*

Snails	
banded globe	*Anguispira kochi*
mud bithynia, faucet snail	*Bithynia tentaculata*
Chinese mystery snail	*Cipangopaludina chinensis malleata*
Japanese mystery snail	*Cipangopaludina japonica*
domed disc	*Discus patulus*
proud globe	*Mesodon elevatus*
brown walker	*Pomatiopsis cincinnatiensis*
gravel pyrg	*Pyrgulopsis letsoni*
European ear snail	*Radix auricularia*
Crustaceans	
devil crawfish	*Cambarus diogenes*
digger crayfish	*Fallicambarus fodiens*
scud	*Echinogammarus ischnus*
amphipod	*Gammarus tigrinus*
spiny waterflea	*Bythotrephes longimanus*
fishhook waterflea	*Cercopagis pengoi*
waterflea	*Daphnia lumholtzi*
waterflea	*Eubosmina coregoni*
a calanoid copepod	*Eurytemora affinis*
Cyclopoid copepod	*Megacyclops viridis*
a parasitic copepod	*Neoergasilus japonicus*
a harpacticoid copepod	*Nitokra incerta*
rusty crayfish	*Orconectes rusticus*
bloody red shrimp	*Hemimysis anomala*

INSECTS - LEPIDOPTERA

Common Name	**Scientific Name**
Persius Duskywing	*Erynnis persius*
Gray Hairstreak	*Strymon melinus*
Dusted Skipper	*Atrytonopsis hianna*
Wild Indigo Duskywing	*Erynnis baptisiae*
Dukes' Skipper	*Euphyes dukesi*
Frosted Elfin	*Callophrys irus*
Karner Blue	*Lycaeides melissa samuelis*
Regal fritillary	*Speyeria idalia*
Pipevine Swallowtail	*Battus philenor*
magdalen underwing	*Catocala illecta*
Robinson's underwing	*Catocala robinsoni*
riley's lappet moth	*Heteropacha rileyana*
"Northern" Oak Hairstreak	*Satyrium favonius*

Newman's brocade	*Meropleon ambifusca*
corylus dagger moth	*Acronicta falcula*
blazing star borer	*Papaipema beeriana*
maritime sunflower borer	*Papaipema maritima*
Culvers root borer	*Papaipema sciata*
silphium borer moth	*Papaipema silphii*
regal fern borer	*Papaipema speciosissima*
Mitchell's satyr butterfly	*Neonympha mitchellii mitchellii*
Swamp metalmark	*Calephelis mutica*
pine imperial moth	*Eacles imperialis pini*
barrens buckmoth	*Hemileuca maia*
Poweshiek skipperling	*Oarisma powesheik*

INSECTS - ODONATA AND OTHERS

Common Name	**Scientific Name**
Dragonflies and Damselflies	
Elusive clubtail	*Stylurus notatus*
laura's snaketail	*Stylurus laurae*
splendid clubtail	*Gomphus lineatifrons*
riverine snaketail	*Stylurus amnicola*
russet-tipped clubtail	*Stylurus plagiatus*
spatterdock darner	*Aeshna mutata*
ocellated darner	*Boyeria grafiana*
Smoky Rubyspot	*Hetaerina titia*
arrowhead spiketail	*Cordulegaster obliqua*
Beetles	
a tiger beetle	*Cicindela hirticollis rhodensis*
a tiger beetle	*Cicindela limbalis*
a tiger beetle	*Cicindela macra*
American burying beetle	*Nicrophorus americanus*
black lordithon rove beetle	*Lordithon niger*
little white tiger beetle	*Cicindela lepida*
six-banded longhorn beetle	*Dryobius sexnotatus*
Cantrall's bog beetle	*Liodessus cantralli*
Mayflies	
a sand minnow mayfly	*Siphloplecton basale*
Stoneflies	
eastern willowfly	*Taeniopteryx burksi*
spinyleg willowfly	*Taeniopteryx maura*
Canadian willowfly	*Capnia vernalis*
a stonefly	*Paracapnia opis*
a stonefly	*Helopicus nalatus*

a stonefly	*Isogenoides doratus*
a stonefly	*Perlesta shubuta*
Grasshoppers and Crickets	
a spur-throat grasshopper	*Melanoplus eurycercus*
Atlantic-coast locust	*Psinidia fenestralis fenestralis*
barrens locust	*Orphulella pelidna pelidna*
blue-legged locust	*Melanoplus flavidus*
bog conehead	*Neoconocephalus lyristes*
conehead grasshopper	*Neoconocephalus retusus*
delicate meadow katydid	*Orchelimum delicatum*
Hebard's green-legged locust	*Melanoplus viridipes*
Hoosier locust	*Paroxya hoosieri*
Lake Huron locust	*Trimerotropis huroniana*
melodious ground cricket	*Eunemobius melodius*
pine katydid	*Scudderia fasciata*
pine tree cricket	*Oecanthus pini*
post-oak grasshopper	*Dendrotettix quercus*
red-faced meadow katydid	*Orchelimum concinnum*
tamarack tree cricket	*Oecanthus laricis*
woodland camel cricket	*Ceuthophilus silvestris*
woodland camel cricket	*Ceuthophilus uhleri*
woodland meadow katydid	*Conocephalus nemoralis*
Cicadas and Hoppers	
a leafhopper	*Dorydiella kansana*
a leafhopper	*Flexamia delongi*
a leafhopper	*Flexamia reflexus*
a spittlebug	*Philaenarcys killa*
angular spittlebug	*Lepyronia angulifera*
great plains spittlebug	*Lepyronia gibbosa*
Huron River leafhopper	*Flexamia huroni*
red-legged spittlebug	*Prosapia ignipectus*
Caddisflies	
a caddisfly	*Rhyacophila sp.*
True Bugs	
a belostoman bug	*Belostoma lutarium*
Alderflies, Dobsonflies & Fishflies	
a dobsonfly	*Nigronia fasciatus*
Other Insects	
Fiery searcher	*Calosoma scrutator*
Meadow spittlebug	*Philaenus spumarius*
Unknown dobsonfly	*Corydalus spp.*

PLANTS

Common Name	Scientific Name
Water willow	*Justicia americana*
Hairy wild petunia	*Ruellia humilis*
Smooth ruellia	*Ruellia strepens*
Arrowhead	*Sagittaria montevidensis*
Hairy angelica	*Angelica venenosa*
Ginseng	*Panax quinquefolius*
Virginia snakeroot	*Aristolochia serpentaria*
Tall green milkweed	*Asclepias hirtella*
Purple milkweed	*Asclepias purpurascens*
Sullivant's milkweed	*Asclepias sullivantii*
Forked aster	*Aster furcatus*
Willow aster	*Aster praealtu*
Purple coneflower	*Echinacea purpurea*
Downy sunflower	*Helianthus mollis*
Woodland lettuce	*Lactuca floridana*
Plains blazing star	*Liatris squarrosa*
Nodding rattlesnake-root	*Prenanthes crepidinea*
Compass plant	*Silphium laciniatum*
Cup plant	*Silphium perfoliatum*
Twinleaf	*Jeffersonia diphylla*
Gray birch	*Betula populifolia*
Missouri rock-cress	*Arabis missouriensis* var. *deamii*
Field Chickweed	*Cerastium velutinum*
Fire pink	*Silene virginica*
Wahoo	*Euonymus atropurpurea*
Least pinweed	*Lechea minor*
Leggett's pinweed	*Lechea pulchella*
Gentian-leaved St. John's-wort	*Hypericum gentianoides*
Round-fruited St. John's-wort	*Hypericum sphaerocarpum*
Virginia spiderwort	*Tradescantia virginiana*
Knotweed dodder	*Cuscuta polygonorum*
Raven's-foot sedge	*Carex crus-corvi*
Davis's sedge	*Carex davisii*
Fescue sedge	*Carex festucacea*
Sedge	*Carex squarrosa*
Engelmann's spike rush	*Eleocharis engelmannii*
Dwarf-bulrush	*Hemicarpha micrantha*
Clinton's bulrush	*Scirpus clintonii*
Few-flowered nut rush	*Scleria pauciflora*
Tinted spurge	*Euphorbia commutata*

White or prairie false indigo	*Baptisia lactea*
Wild bean	*Phaseolus polystachios*
Trailing wild Bean	*Strophostyles helvula*
Wisteria	*Wisteria frutescens*
American chestnut	*Castanea dentata*
Shumard's oak	*Quercus shumardii*
Climbing fumitory	*Adlumia fungosa*
Stiff gentian	*Gentianella quinquefolia*
Blue-eyed-grass	*Sisyrinchium hastile*
Short-fruited rush	*Juncus brachycarpus*
Vasey's rush	*Juncus vaseyi*
Virginia water-horehound	*Lycopus virginicus*
Hairy mountain mint	*Pycnanthemum pilosum*
Wild hyacinth	*Camassia scilloides*
Nodding mandarin	*Prosartes maculata*
Prairie trillium	*Trillium recurvatum*
Meadow beauty	*Rhexia virginica*
Red mulberry	*Morus rubra*
American lotus	*Nelumbo lutea*
Pumpkin ash	*Fraxinus profunda*
Showy orchis	*Galearis spectabilis*
Purple twayblade	*Liparis liliifolia*
Orange- or yellow-fringed orchid	*Platanthera ciliaris*
Prairie white-fringed orchid	*Platanthera leucophaea*
Violet wood sorrel	*Oxalis violacea*
Eastern prairie fringed orchid	*Platanthera leucophaea*
Three-awned grass	*Aristida longespica*
Side-oats grama grass	*Bouteloua curtipendula*
Beak grass	*Diarrhena obovata*
Leiberg's panic grass	*Dichanthelium leibergii*
Small love grass	*Eragrostis pilosa*
Wild rice	*Zizania aquatica* var. *aquatica*
Wild sweet William	*Phlox maculata*
Cross-leaved milkwort	*Polygala cruciata*
Swamp candles	*Lysimachia hybrida*
Goldenseal	*Hydrastis canadensis*
Pale avens	*Geum virginianum*
Sand cinquefoil	*Potentilla paradoxa*
Canadian burnet	*Sanguisorba canadensis*
Gattinger's gerardia	*Agalinis gattingeri*
Mullein-foxglove	*Dasistoma macrophylla*
Conobea	*Leucospora multifida*

Winged monkey flower	*Mimulus alatus*
Pale beard tongue	*Penstemon pallidus*
Smooth carrion-flower	*Smilax herbacea*
Corn salad	*Valerianella umbilicata*
Green violet	*Hybanthus concolor*

Appendix B.

ROCSTAR Scoring Evaluation

Open Water/Submergent Wetland							**7.8**
Species	**# of priority rankings or listings in Federal, State, or regional plans**	**Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)**	**Abundance on Refuge (See scoring scale B)**	**Responds well to habitat management? (See scoring scale C)**	**Ability to represent a larger guild or group of species? (See scoring scale D)**	**Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)**	**Scoring**
Lake Sturgeon	11	8	10	10	10	10	9.3
Wood Duck	4	10	10	10	10	10	8.6
Ring-necked Duck	4	10	8	10	10	10	8.3
Osprey	3	10	10	10	7	7	7.6
Lesser Scaup	8	7	8	3	10	10	7.3
Canvasback	7	7	8	3	10	10	7.1
Tundra Swan	4	7	8	3	10	10	6.7
Weight	*0.15*	*0.20*	*0.20*	*0.15*	*0.15*	*0.15*	*1.00*

Emergent Wetland							**8.2**
Species	**# of priority rankings or listings in Federal, State, or regional plans**	**Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)**	**Abundance on Refuge (See scoring scale B)**	**Responds well to habitat management? (See scoring scale C)**	**Ability to represent a larger guild or group of species? (See scoring scale D)**	**Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)**	**Scoring**
Black-crowned Night-Heron	13	10	10	10	10	8	9.7
American Black Duck	7	10	8	10	10	10	8.8
Pied-billed Grebe	8	10	10	10	10	5	8.5
Great Blue Heron	4	10	10	10	10	8	8.3
Sora	6	10	10	10	10	3	7.9
Eastern Fox Snake	14	10	7	3	7	7	7.7
Blanding's Turtle	14	8	8	8	3	7	7.6
Marsh Wren	3	10	10	10	10	3	7.4
Weight	*0.15*	*0.20*	*0.20*	*0.15*	*0.15*	*0.15*	*1.00*

Moist Soil/Mud							**7.8**
Species	**# of priority rankings or listings in Federal, State, or regional plans**	**Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)**	**Abundance on Refuge (See scoring scale B)**	**Responds well to habitat management? (See scoring scale C)**	**Ability to represent a larger guild or group of species? (See scoring scale D)**	**Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)**	**Scoring**
Wilson's Snipe	8	7	7	10	10	10	8.2
Short-billed Dowitcher	10	7	7	7	10	10	8.0
Blue-winged Teal	8	7	9	10	10	7	8.0
Dunlin	7	7	7	10	10	10	8.0
Pectoral Sandpiper	4	7	7	10	9	10	7.4
Northern Shoveler	1	8	8	10	10	7	7.0
Weight	*0.15*	*0.20*	*0.20*	*0.15*	*0.15*	*0.15*	*1.00*

Wet Prairie							**6.9**
Species	**# of priority rankings or listings in Federal, State, or regional plans**	**Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)**	**Abundance on Refuge (See scoring scale B)**	**Responds well to habitat management? (See scoring scale C)**	**Ability to represent a larger guild or group of species? (See scoring scale D)**	**Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)**	**Scoring**
Monarch	3	10	10	10	10	10	9.2
Eastern Foxsnake	14	10	7	3	7	7	7.0
Field Sparrow	8	10	3	10	10	5	7.6
Prairie white-fringed orchid	5	3	1	10	10	10	6.5
Central Cordgrass Wet Prairie	2	3	1	10	10	10	6.4
Lakeplain Prairie	2	3	1	10	10	10	6.4
Blue-joint Wet Meadow	1	5	4	8	7	7	5.7
Weight	*0.15*	*0.20*	*0.20*	*0.15*	*0.15*	*0.15*	*1.00*

Wet-Mesic Forest							**8.2**
Species	**# of priority rankings or listings in Federal, State, or regional plans**	**Ability to be supported by current or restorable refuge capabilities? (See scoring scale A)**	**Abundance on Refuge (See scoring scale B)**	**Responds well to habitat management? (See scoring scale C)**	**Ability to represent a larger guild or group of species? (See scoring scale D)**	**Ability to represent on-refuge ecological processes, or broader ecosystem processes? (See scoring scale E)**	**Scoring**
Northern Flicker	8	10	10	10	10	10	9
Wood Duck	8	10	8	10	8	10	9
Bald Eagle	10	10	10	5	7	10	8
eastern wood-pewee	4	10	10	10	10	8	8
Warbling Vireo	4	7	10	10	10	10	8
Rusty Blackbird	8	7	7	5	5	10	7
American woodcock	4	7	10	10	10	10	8
Weight	*0.15*	*0.20*	*0.20*	*0.15*	*0.15*	*0.15*	*1.00*

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

Scoring Scale B - Assign values based on refuge I&M records and professional judgment.			
Birds		**Plants, Communities, Herps, Fish**	
Common throughout breeding season	10	State or regionally listed, but common on refuge	10
Common during migration only	7	State or regionally listed, but occasional on refuge	7
Occassional during breeding	5	State or regionally rare (S1-S3, not listed), but common on refuge	5
Occassional during migration	3	State or regionally rare (not listed), but occasional or rare on refuge	3
Uncommon/rare	1	Common in region and on refuge	1

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

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

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

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

Appendix C.

Current Refuge Habitats

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Project No. 070759.18

Figure A: Mud Island Unit

Current Refuge Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 250 500 Feet
0 75 150 Meters

Date Created: 1/10/2014 Date Revised: 1/10/2014
File Path: R:\Projects\07\070759_USFWS_IDIQ\18_DetroitRiverHMP\Data\GIS\Habitat Maps\20130426_MudIsland_Unit.mxd

GIS Analyst: erin.ferrante-cook

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Project No. 070759.18

Figure B: Grassy Island Unit

Current Refuge Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 1,500 3,000 Feet
0 400 800 Meters

U.S. FISH & WILDLIFE SERVICE

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Service Layer Credits: (c) OpenStreetMap and contributors, Creative Commons-Share Alike License (CC-BY-SA)
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

GIS Analyst: erin.ferrante-cook

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Figure C: Humbug Marsh and Calf Island Units

Current Refuge Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 900 1,800 Feet
0 250 500 Meters

U.S. FISH & WILDLIFE SERVICE

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Figure D: Gibraltar Bay and Sugar Island Units

Current Refuge Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 625 1,250 Feet
0 150 300 Meters

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GIS Analyst: erin.ferrante-cook

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Project No. 070759.18

Figure E: Gibraltar Wetlands Unit

Current Refuge Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 750 1,500 Feet
0 200 400 Meters

Date Created: 1/10/2014 Date Revised: 1/10/2014
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Figure F: Lake Erie Metropark Unit

Current Refuge Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 1,750 3,500 Feet
0 500 1,000 Meters

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Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

GIS Analyst: erin.ferrante-cook

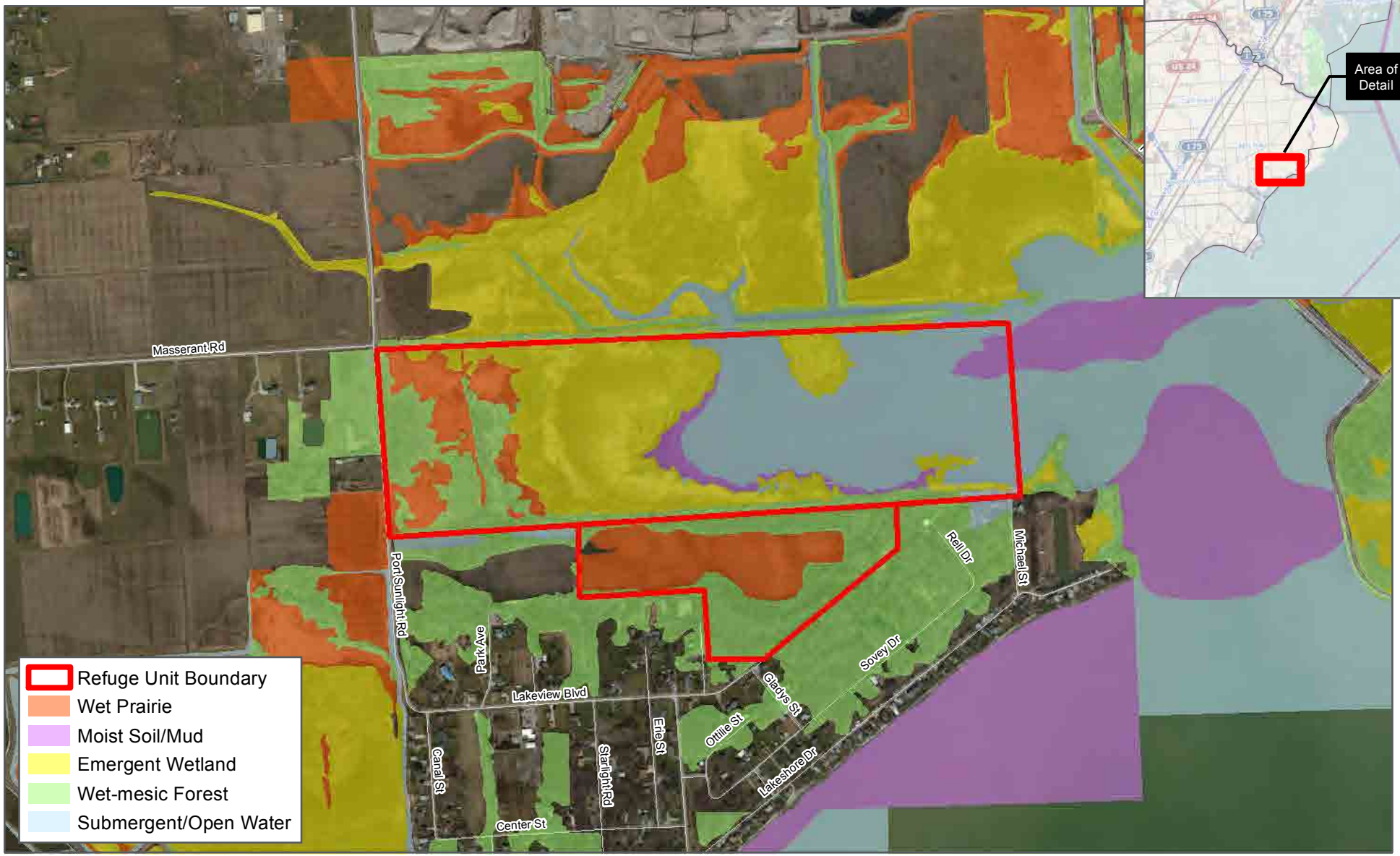

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Figure G: Strong Unit

Current Refuge Habitats
US Fish & Wildlife Service
Monroe County, Michigan

0 500 1,000 Feet
0 150 300 Meters

Date Created: 1/10/2014 Date Revised: 1/10/2014
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Project No. 070759.18

Figure H: Brancheau Unit

Current Refuge Habitats
US Fish & Wildlife Service
Monroe County, Michigan

0 500 1,000 Feet
0 150 300 Meters

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Figure I: Lagoona Beach and Fix Units

Current Refuge Habitats
US Fish & Wildlife Service
Monroe County, Michigan

0 1,250 2,500 Feet
0 300 600 Meters

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File Path: R:\Projects\07\070759_USFWS_IDIQ\18_DetroitRiverHMP\Data\GIS\Habitat Maps\20130426_LagoonaBeach_Fix.mxd

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Figure J: Ford Marsh Unit

Current Refuge Habitats
US Fish & Wildlife Service
Monroe County, Michigan

0 625 1,250 Feet
0 150 300 Meters

Date Created: 1/12/2014 Date Revised: 1/12/2014
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Figure K: Plum Creek Bay Unit

Current Refuge Habitats
US Fish & Wildlife Service
Monroe County, Michigan

0 625 1,250 Feet
0 150 300 Meters

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Figure L: Lady of the Lake Unit

Current Refuge Habitats
US Fish & Wildlife Service
Monroe County, Michigan

0 500 1,000 Feet
0 150 300 Meters

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GIS Analyst: erin.ferrante-cook

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Figure M: Holloway, Gard Island, and Erie Marsh Preserve Units

Current Refuge Habitats
US Fish & Wildlife Service
Monroe County, Michigan

0 1,250 2,500 Feet
0 350 700 Meters

Date Created: 1/12/2014 Date Revised: 1/12/2014
File Path: R:\Projects\07\070759_USFWS_IDIQ\18_DetroitRiverHMP\Data\GIS\Habitat Maps\20130426_Holloway_ErieMarsh_GardIsland.mxd

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GIS Analyst: erin.ferrante-cook

Appendix D.

Desired Future Habitats

Desired Future Habitats

The desired future habitats in each of the Refuge's fee-simple units are provided in Figures A-M. No desired future habitats are indicated for cooperatively-managed units because future conditions will be determined through ongoing collaboration with relevant partners.

In addition to desired future habitats, the type of management (i.e., Type 1, Type 2, Type 3, and Type 4) that will be implemented in each unit or area is indicated on the maps. Based on standard disturbance types that are often used in the context of disturbance ecology theory (e.g., Pickett and White 1985), the use of these categories emphasizes that Refuge habitat management should strive to emulate natural disturbance regimes so that ecosystem function is valued as much as existing structure. Invasive species control should be done in conjunction with these disturbances, whose frequencies, intensities, and temporal variations are understood and applied from the scientific literature. The four categories of management are described below.

Type 1: Fire (or limited mowing if fire is not possible)

Type 1 management is to be used primarily in habitats where fire is a natural disturbance (most notably wet prairie) and in constructed wet prairies. Prescribed fire should be used across a relatively large spatial scale to kill a variable amount of shrubs, remove biomass from herbicide-treated invasive species, and create the many effects of fire. Prescribed fire is preferred to mowing because fire has important effects on the landscape that mowing does not, and allows the survival of fire-tolerant trees and shrubs, which were historically abundant in Refuge units. If the use of fire is not feasible, mowing should be conducted to encourage heterogeneity to the extent possible by leaving some areas unmowed. Desirable trees, snags, or downed woody material should never be removed.

Type 2: Intensive disturbance in areas with trees

Type 2 management is to be used sparingly in habitats where fire is a natural disturbance or to emulate windthrow, causing relatively larger canopy gaps. Type 2 disturbance should only be conducted to increase compositional and structural heterogeneity, where invasive woody plants will be reduced and permanently managed, and where deer abundance will allow native tree regeneration. This disturbance can be mechanical removal of trees via chain saws or heavy equipment and should strive to emulate a windthrow to create variable age classes and light availability. Prescribed fire can also be used to thin woody vegetation and promote fire tolerant species. In all areas, desirable canopy species such as American elm, black walnut, hickories, and oaks should be left uncut, along with any snags and downed woody material. This management should result in a seral pathway that is more tolerant of existing stressors such as invasive species or future pathogens due to restored complexity.

Type 3: Small-scale disturbance

Type 3 management is to be used sparingly in habitats where a single tree or small groups of trees would die or fall to create a gap in the canopy. Type 3 disturbance should only be conducted to increase compositional and structural heterogeneity, where invasive woody plants will be reduced and permanently managed, and where deer abundance will allow native tree regeneration. Cutting particular trees using chain saws should promote compositional and structural heterogeneity, which includes the maintenance of large-diameter snags and coarse woody debris. Artificial disturbances should emulate single-mortality events (e.g., windthrow) or increase the size of existing gaps to promote habitat diversity within relatively mature wet-mesic forests. This disturbance includes prescribed fire where the impact will be mostly the ground-layer in closed canopies and will be more intense in light gaps with herbaceous vegetation. This management should result in a seral pathway that is

more tolerant of existing stressors such as invasive species or future pathogens due to restored complexity.

Type 4: Passive management

Type 4 management is to be used where active management would be ineffective or cost-prohibitive at restoring desirable structure and composition. It involves no active management except retains the option for prescribed fire (emulating natural patterns) and invasive species control. This management emphasizes protection and allowance of natural disturbances (and its effects) such as windthrow, herbivory, pathogen outbreaks, and fluctuating water levels to occur without intervention.

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Sheet: 1 of 13
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Figure A: Mud Island Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 250 500 Feet
0 75 150 Meters

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Sheet: 2 of 13
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Figure B: Grassy Island Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 1,500 3,000 Feet
0 450 900 Meters

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Sheet: 3 of 13
Project No. 070759.18

Figure C: Humbug Marsh and Calf Island Units

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 700 1,400 Feet
0 200 400 Meters

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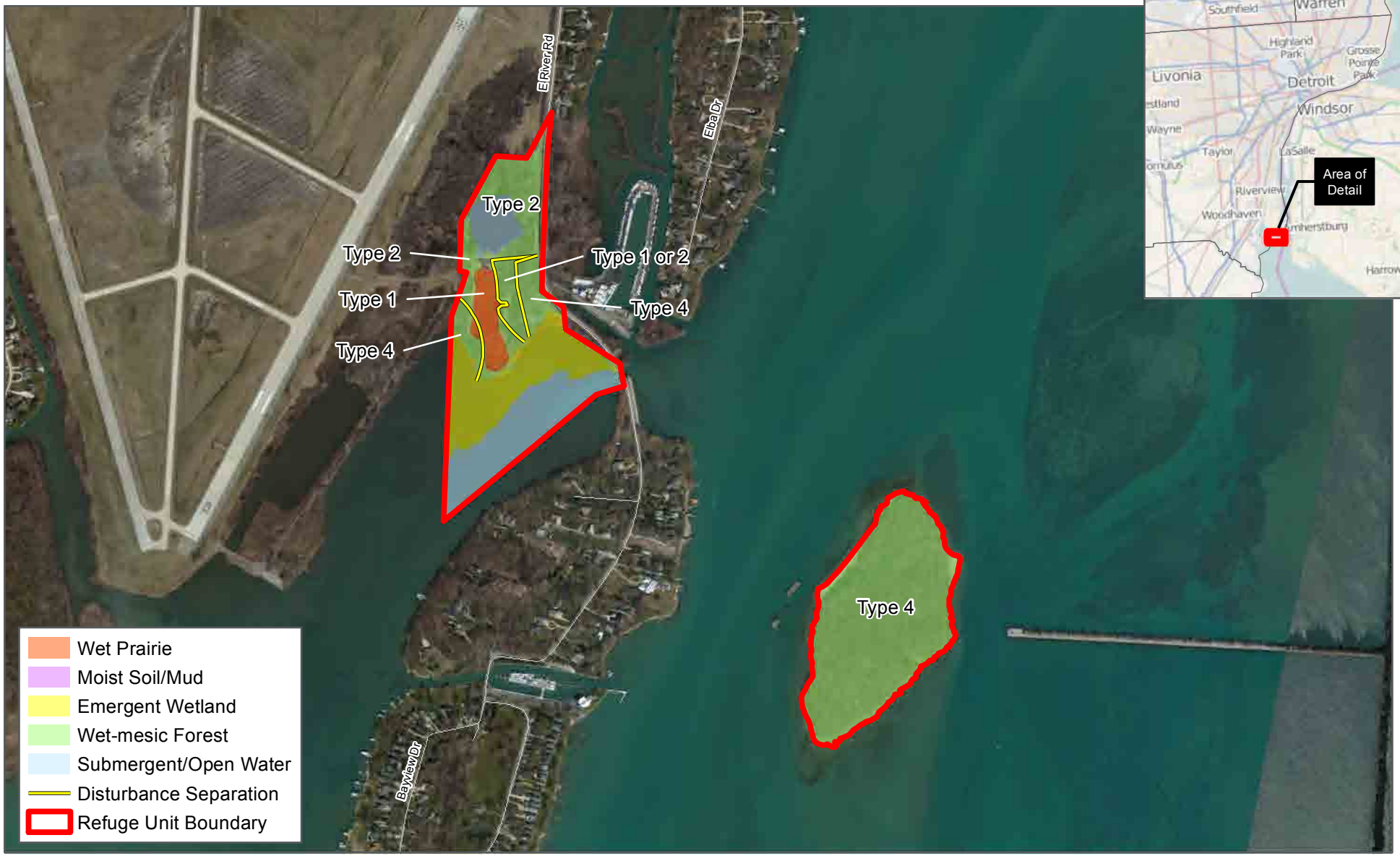

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Figure D: Gibraltar Bay and Sugar Island Units

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 500 1,000 Feet
0 150 300 Meters

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Sheet: 5 of 13
Project No. 070759.18

Figure E: Gibraltar Wetlands Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 625 1,250 Feet
0 200 400 Meters

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Figure F: Lake Erie Metropark Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 1,000 2,000 3,000 Feet
0 300 600 900 Meters

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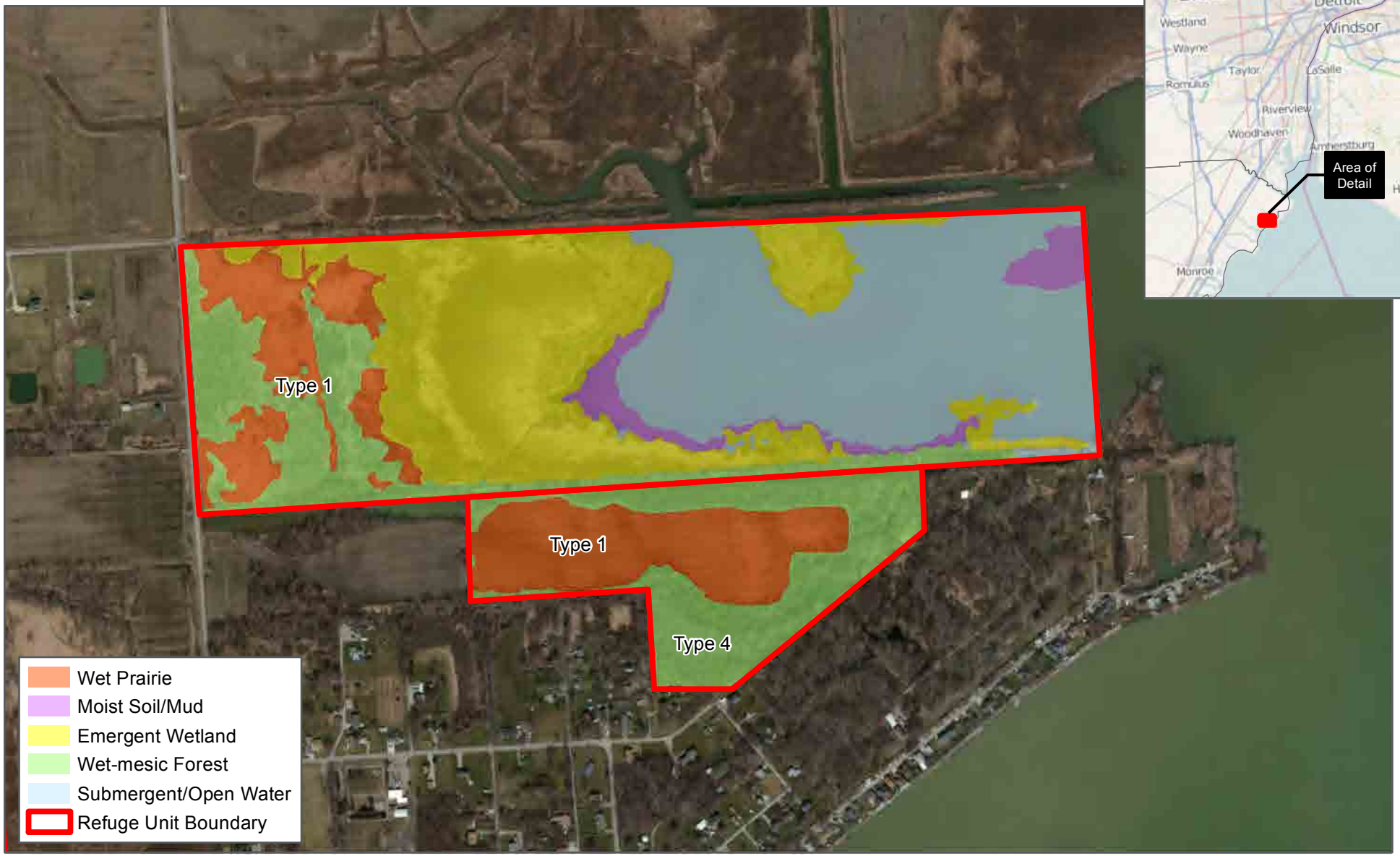

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Sheet: 7 of 13
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Figure G: Strong Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 350 700 Feet
0 100 200 Meters

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Sheet: 8 of 13
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Figure H: Brancheau Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 500 1,000 Feet
0 150 300 Meters

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Figure I: Lagoona Beach and Fix Units

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 1,000 2,000 Feet
0 300 600 Meters

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Sheet: 10 of 13
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Figure J: Ford Marsh Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 500 1,000 Feet
0 150 300 Meters

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Sheet: 11 of 13
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Figure K: Plum Creek Bay Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 350 700 Feet
0 100 200 Meters

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Figure L: Lady of the Lake Unit

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 250 500 Feet
0 75 150 Meters

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Sheet: 13 of 13
Project No. 070759.18

Figure M: Holloway, Gard Island, and Erie Marsh Preserve Units

Desired Future Habitats
US Fish & Wildlife Service
Wayne County, Michigan

0 1,250 2,500 Feet
0 350 700 Meters

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GIS Analyst: erin.ferrante-cook

Appendix E.

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