



National Fish and Wildlife Foundation

Great Lakes Business Plan

July 2015

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Executive Summary

Purpose

This plan outlines a comprehensive strategy to guide NFWF investments in the Great Lakes basin through 2025. By identifying a clear set of measurable outcomes, it will help ensure that investments are strategically directed, and it will provide a framework to facilitate leveraging of public and private resources. The plan has been developed to advance the priorities of the federal Great Lakes Restoration Initiative (GLRI) and other restoration efforts across the region.

Conservation Need

Containing more than 20 percent of the earth's surface freshwater, the Great Lakes provide drinking water for more than 30 million people and habitat for a vast array of plants and wildlife, including more than 200 globally rare species. The basin's immense network of streams, lakes, wetlands and forests provides critical ecological services, such as water filtration, flood control, nutrient cycling and carbon storage. In addition, the region offers unmatched opportunities for shipping, industry, tourism and recreation. Despite these values, the Great Lakes and the broader basin have been significantly degraded over the past two centuries. Habitat loss and fragmentation, invasive species, and contaminants impair water quality, threaten wildlife populations, and jeopardize the health and economic vitality of the region. Due to an unprecedented infusion of funding from the U.S. government, restoration efforts have accelerated recently, but recovering many of the values lost over time will require a sustained effort that addresses historical impacts as well as new and emerging threats.

Conservation Outcomes

With a focus on building resilience in light of historic and emerging threats, this plan addresses three priority Great Lakes issues: 1) streams; 2) coastal wetlands; and 3) water quality. By improving habitat quality and connectivity, actions implemented under this plan will increase the distribution and abundance of fish, birds and other wildlife, with an emphasis on species that are important indicators of habitat condition. By reducing runoff from agricultural fields, urban areas, and roadways, this plan will also reduce nonpoint source pollution to enhance the many ecological, social and economic values that depend on clean water.

- *Streams*
By improving the quality and connectivity of stream habitats, NFWF programs will: restore fish access to 1,500 stream miles, representing 50% of the projected 2025 GLRI Action Plan target; expand viable brook trout populations by 75 stream miles, representing 10% of brook trout priority restoration areas; and increase lake sturgeon reproduction by 100% in three rivers, representing 10% of U.S. remnant populations.

- Coastal Wetlands**
 NFWF programs will: restore 13,000 acres, representing 11% of the projected 2025 GLRI Action Plan target; provide habitat to support more than 10% of the additional birds needed to achieve priority shorebird and waterfowl regional objectives; and restore access by northern pike and other marsh-spawning fish to 25 coastal wetlands, representing 5% of monitored coastal wetlands identified as impaired for fish.
- Water Quality**
 By restoring habitat, improving agricultural practices, and installing green infrastructure, NFWF programs will reduce phosphorus inputs to surface waters by 100,000 pounds and increase urban stormwater storage capacity by 25 million gallons, representing 4% and 5% of projected 2025 GLRI Action Plan targets, respectively. This work will also reduce sediment inputs to surface waters by 30 million pounds.

Selection of Focal Areas

Figure 1 displays 16 strategic investment areas that contain clusters of high-priority features. Within those areas, investment in a core set of strategies can achieve measurable outcomes that span multiple issues. For example, a road–stream crossing replacement can both improve water quality and help restore fish populations. This plan does not preclude investment in high-priority projects elsewhere in the basin, but key strategies implemented in the highlighted areas are expected to achieve efficiencies that help maximize program impacts. By focusing on these clusters, this plan will help restore resilient habitat networks capable of sustaining species and ecosystem services in the face of accelerating and emerging environmental changes.

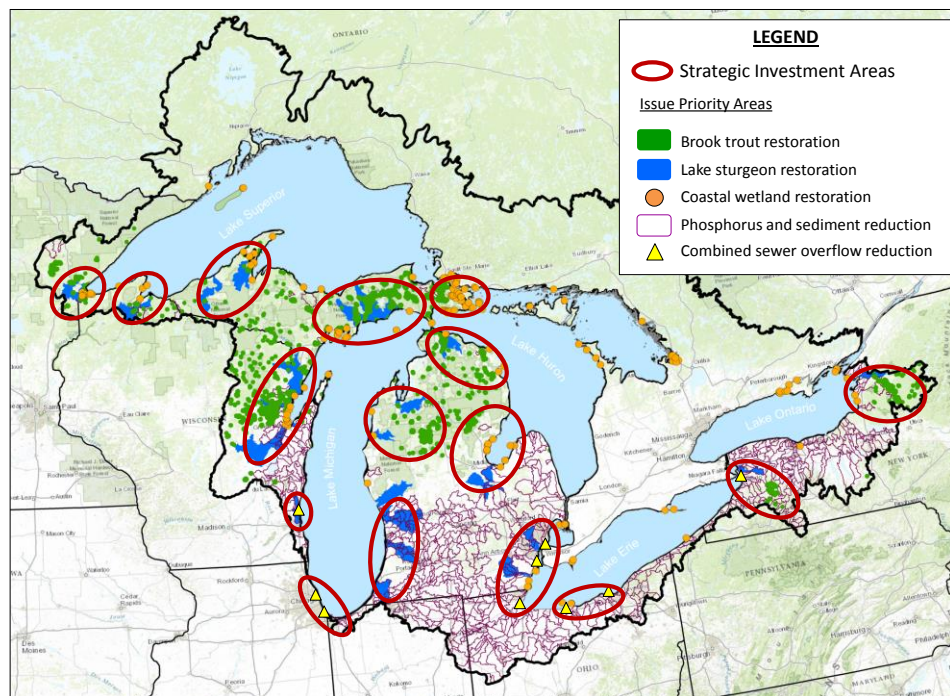


Figure 1. Sixteen strategic investment areas, where investments can achieve outcomes that span multiple priority issues.

Implementation Plan

Streams

- *Restore Connectivity:* NFWF programs will eliminate approximately 200 passage barriers to restore aquatic connectivity along 1,500 stream miles. Barrier removal will focus on a mix of large dams, small dams, and road–stream crossings.
- *Restore Stream Geomorphology:* NFWF programs will restore meander, floodplain connections, and other geomorphological processes along an estimated 20–35 miles of stream. Work will include impoundment removal and channel reconfiguration.
- *Improve In-stream Habitat:* NFWF programs will improve in-stream structure and complexity along 40–70 stream miles. Work will include sediment management and installation of in-stream habitat structures.
- *Improve Riparian Habitat:* NFWF programs will improve stream banks, floodplains, and adjacent wetlands to improve riparian conditions along 100 miles of stream. Work will include bank stabilization, invasive species control, and native plant restoration.

Coastal Wetlands

- *Restore Connectivity:* By eliminating or bypassing 15–25 passage barriers, NFWF programs will improve aquatic access to 1,000–2,000 wetland acres. Work will include installation of passage structures, sediment excavation, and removal of hard structures.
- *Improve Hydrology:* NFWF programs will improve hydrology on 4,000–5,000 acres to control invasive vegetation and provide habitat of appropriate depth for target species. Work will include installation of water control structures and repair of berms and dikes.
- *Improve Habitat Structure:* NFWF programs will improve vegetative structure and diversity on 10,000 acres of coastal wetlands. Work will include control of invasive species and restoration of native vegetation.

Water Quality

- *Reduce Agricultural Nonpoint Source Pollution:* NFWF programs will assist the development of farm nutrient management plans, enrollment in Farm Bill programs, and improvement of management practices on 6,000 acres of agricultural lands.
- *Reduce Urban Stormwater Runoff:* NFWF programs will install approximately 4 million square feet of green infrastructure to increase urban stormwater storage capacity and reduce inputs of nonpoint source pollution associated with large storm events.
- *Reduce Sediment Loading from Roads:* NFWF programs will replace an estimated 150 road-stream crossings to reduce sediment loading associated with road runoff.

Monitoring and Evaluating Performance

Outcomes will be measured through a combination of direct monitoring and modeling. In some cases, progress toward achieving plan outputs and outcomes will be calculated by tallying the results of individual projects. In others, outcome assessments will require information from other sources. Where possible, NFWF will assess those outcomes using data provided by existing regional monitoring efforts. Where data are unavailable, NFWF may direct funds to support specific targeted assessments.

To provide a snapshot of progress for primary conservation outcomes and strategies, NFWF will update a plan scorecard on an annual basis. Every three years, NFWF will conduct an assessment to examine the factors that have facilitated and hindered successful implementation of the plan. Near the end of the plan period, a more comprehensive third-party evaluation may be conducted. Findings from all monitoring and evaluation activities will guide future investment and planning.

Funding Needs

This plan will be implemented primarily with contributions provided by NFWF partners under the Sustain Our Great Lakes program, Chi-Cal Rivers Fund, and Conservation Partners program. Together, these partners are expected to provide more than \$8 million per year in grant funding for work in the Great Lakes basin. To augment funding from existing sources, NFWF will seek new partners to advance the goals of this plan. Full implementation will require approximately \$103 million in NFWF grant funding (Figure 2). This funding is expected to leverage matching contributions from state, municipal and private sources at a minimum ratio of 1:1, generating a total conservation investment of \$206 million.

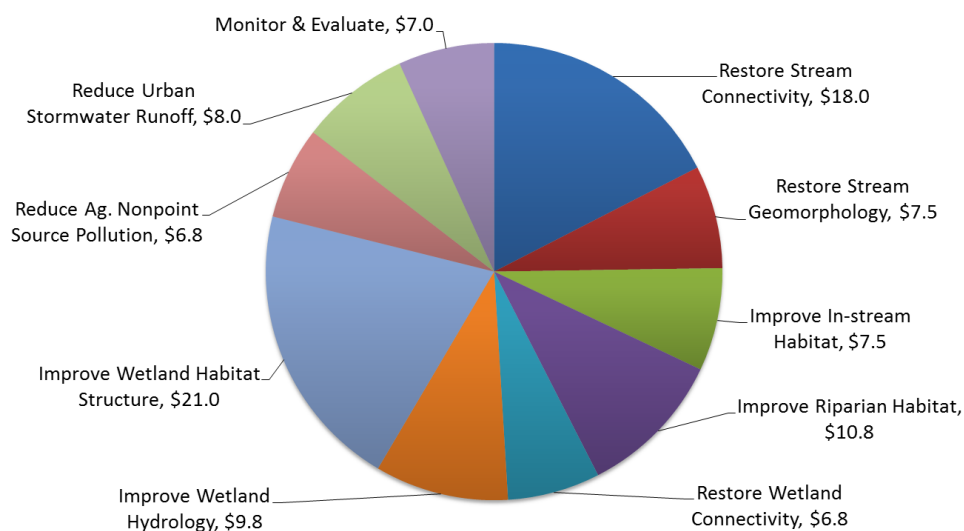


Figure 2. NFWF grant funding needs by strategy, in millions of dollars.

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Business Plan Purpose

The National Fish and Wildlife Foundation (NFWF) developed this business plan (Appendix A) in collaboration with many partners (Appendix B) to advance the priorities of the Great Lakes Restoration Initiative (GLRI) and other restoration efforts across the region. It reflects a vision of the Great Lakes basin characterized by clean water, healthy fish and wildlife populations, robust sustainable economies, and strong cultural connections with the natural features of the region. As a tool for guiding NFWF investments in the Great Lakes basin through 2025, this plan outlines the early outcomes NFWF programs are expected to generate as part of a long-term restoration effort for achieving that vision. By identifying a clear set of measurable outcomes, it will help ensure that investments are strategically directed, and it will provide a framework to facilitate additional leveraging of public and private resources.

This plan builds on ten years of NFWF investment in the Great Lakes region through the Sustain Our Great Lakes program, the Chi-Cal Rivers Fund, and the Conservation Partners program. In that time, NFWF has directed \$57 million in partner funding to 255 projects that have leveraged \$63 million in matching contributions, for a total investment of \$120 million. By improving the quality and connectivity of more than 1,700 stream miles and 33,000 wetland acres, these investments have improved water quality, improved habitat for many species of concern, and contributed to the removal of ecological impairments in urban and industrial areas. This plan will magnify the impacts of future investments by further strengthening the linkage between NFWF grant-making and the achievement of meaningful conservation goals. In this way, the plan moves beyond reporting success in terms of miles and acres restored, and brings a new emphasis to the important ecological and social benefits generated by program investments.

Success will require efforts not only to remediate past contamination and habitat degradation, but also to address new and interrelated accelerating threats, such as climate change, invasive species, and nonpoint source pollution. To sustain or improve biodiversity and ecological services in the face of these challenges, Great Lakes natural systems will need the ability to absorb impacts while retaining their ecological integrity and function. An underlying goal of this plan is to maximize this resilience by anticipating and planning for impacts, focusing on networks of high-value habitats, and enhancing pathways for reestablishing system values following inevitable disturbances.



Apostle Islands on Lake Superior. Photo: Todd Hogrefe

Conservation Need

An unmistakable geographic feature from land and air, the Great Lakes comprise the largest chain of lakes in the world. Containing more than 20% of the earth's surface freshwater and 95% of the surface freshwater in the continental United States, they provide drinking water for more than 30 million people, facilitate commercial trade, and enable countless recreational opportunities. Altogether, the lakes hold six quadrillion gallons of freshwater, a volume that could submerge the continental United States to a depth of ten feet. They encompass a surface area of 94,000 square miles and include 30,000 islands. The U.S. portion of Great Lakes shoreline alone stretches the full length of the Eastern Seaboard and beyond, prompting references to the 'Third Coast.'



Great Lakes satellite image. Photo: U.S. Geological Survey

Spanning more than 295,000 square miles, the basin includes an immense network of streams, lakes, inland wetlands, coastal marshes, and forests. These habitats support more than 3,500 species of plants and animals, including more than 200 globally rare species and 46 species found nowhere else in the world. With more than 180 species of fish, the Great Lakes support a world-class fishery valued at more than \$7 billion annually. A critical stopover region for more than 350 migratory bird species, the basin provides resources to sustain hundreds of millions of birds along their migratory routes each year. In addition to supporting fish and wildlife populations, the diverse habitats of the basin provide critical ecological services, including water filtration and storage, flood control, nutrient cycling, and carbon storage.

Despite their importance, the Great Lakes and the broader basin have been significantly degraded by human activity over the past two centuries. Habitat loss and fragmentation, invasive species, and biological and chemical pollutants present substantial environmental challenges that impair water quality, threaten wildlife populations, and jeopardize the health and economic vitality of the region.

In response to these threats, the U.S. federal government enhanced its commitment to the Great Lakes by launching the GLRI in 2010. Administered by the U.S. Environmental Protection Agency and led by a task force representing 11 federal agencies, the GLRI has provided an unprecedented level of funding and focused attention on restoring the key values and services of the Great Lakes. From 2010 through 2015, the GLRI directed \$1.9 billion to this effort, including \$47 million administered by NFWF as part of the Sustain Our Great Lakes program. In that time, the GLRI significantly accelerated progress toward improving the physical, chemical and biological integrity of the basin. However, recovering many of the values lost during the past two centuries will require a sustained and concerted long-term bi-national effort (see Appendix C) by numerous public and private actors committed to Great Lakes restoration.

To help advance goals of that long-term effort, this plan focuses on conservation needs associated with three priority issues adapted from the GLRI Action Plan II (White House Council on Environmental Quality 2014) and the five Lake Biodiversity Conservation Strategies (e.g., Pearsall et al. 2012). They include: 1) streams; 2) coastal wetlands; and 3) water quality.

Streams

The Great Lakes basin encompasses more than 150,000 miles of streams. As conduits that connect the landscape, streams facilitate the dispersal of aquatic organisms, and they are critical to the transport of energy and nutrients throughout aquatic systems. They support a vast assemblage of fish, amphibians, mollusks, insects, and other wildlife. A majority of the 180 fish species in the basin, including many species of conservation concern such as brook trout (*Salvelinus fontinalis*) and lake sturgeon (*Acipenser fulvescens*), depend on streams to complete their life cycles. In addition to their ecological role, Great Lakes streams provide important social and economic benefits by supplying drinking water to tens of millions of people, providing transportation estimated to be worth more than \$2 billion annually, and contributing to a multi-billion dollar sport fishery (Krantzberg and de Boer 2006).



Northern Michigan stream

Past and present land uses have degraded many of the streams in the basin by altering hydrology, raising water temperatures, increasing sediment loading, disrupting the downstream transport of large woody debris, and obstructing animal movements. For example, more than 170,000 dams and road–stream crossings block the passage of fish and other aquatic organisms (Januchowski-Hartley et. al 2013) in the basin, and many Great Lakes fish species are unable to access the vast majority of their historic spawning habitats. In addition to threatening many aquatic organisms, these changes have adversely affected human residents of the basin by degrading water quality, reducing recreational opportunities, and increasing the risk of property damage due to flooding. The higher temperatures and increased frequency of severe storms associated with climate change have exacerbated many of these impacts.

Coastal Wetlands

The 535,000 acres of coastal wetlands in the Great Lakes basin sustain hundreds of species. Centrally located along the Mississippi and Atlantic Flyways, they provide critical stopover habitat for hundreds of millions of birds during their seasonal migrations. Approximately 90% of fish species in the basin use coastal wetlands during their life cycles, and coastal wetlands contribute as much as one-third of the primary production that drives the Great Lakes food web. In addition, coastal wetlands provide irreplaceable ecosystem services such as flood water



Ohio coastal wetland. Photo: Todd Hogrefe

storage, water filtration, nutrient cycling and carbon sequestration. They also drive economically important activities, such as fishing, hunting and bird-watching. In Ohio alone, spring migrants attract more than 68,000 bird watchers each year, generating an estimated \$40 million in local economic activity (Upper Midwest–Great Lakes Landscape Conservation Cooperative 2013).

The Great Lakes basin has lost more than 50% of its wetlands, and declines in coastal areas are often much higher; in the western Lake Erie basin, for example, coastal wetlands have declined by more than 80% (International Joint Commission 2014). The wetlands that remain are often degraded by invasive species, hydrological alteration, and lack of connectivity with adjacent waters. These impacts have threatened several species of migratory birds and fish, and they have reduced the capacity of coastal systems to protect communities against many intensifying climate-related threats, such as storm surges, flooding, and harmful algal blooms.

Water Quality

With a volume of six quadrillion gallons, the Great Lakes are an unmatched freshwater resource. This water is the foundation for the Great Lakes food web, and it helps support the hundreds of globally rare species that inhabit the basin. Clean water is necessary not only to sustain basin ecosystems, but also to provide irreplaceable services to basin residents. For example, Great Lakes waters provide drinking water and sport-fishing opportunities for millions of people, and recreation associated with Great Lake beaches generate more than \$200 million in economic value annually (Krantzberg and de Boer 2006). Water pollution in the Great Lakes and their tributaries has a significant impact on all of these values.

Improvements under the Clean Water Act have significantly reduced point source pollution in the Great Lakes. Today, pollution from nonpoint sources, such as agricultural lands, urban areas, and roadways, is a far greater threat to water quality in the basin. Runoff from these sources impairs water quality and aquatic habitats by delivering excess nutrients, sediments and other contaminants into basin surface waters. Impacts of this pollution include reduced dissolved oxygen concentrations, increased turbidity, smothering of stream substrates, and harmful algal blooms that threaten fish populations and human health.



2011 Lake Erie algal bloom. Photo: MERIS/NASA

Phosphorus loading from agricultural and urban areas is the primary cause of more-frequent and severe harmful algal blooms in the basin. For example, phosphorus inputs to western Lake Erie created large algal blooms in 2013 and 2014 that led to high levels of toxic microcystin and suspended water treatment plant operations in the Toledo, Ohio area, depriving hundreds of thousands of residents access to safe drinking water.

Higher runoff volumes associated with major storm events pose significant threats in urban areas with combined sewer systems. Due to flows that exceed municipal sewer capacities, combined sewer overflows discharge tens of billions of gallons of untreated sewage and stormwater into Great Lakes waters each year. In addition to threatening aquatic communities, these events pose significant public health risks due to dangerous flooding and bacterial contamination.



Combined sewer overflow in Chicago

Conservation Outcomes

With a focus on building resilience in light of historic and emerging threats, this plan is designed to generate outcomes focused on three priority issues: 1) streams; 2) coastal wetlands; and 3) water quality. By improving habitat quality and connectivity, actions implemented under this plan will increase the distribution and abundance of fish, birds and other wildlife, with an emphasis on species that are important indicators of habitat condition. By reducing runoff from agricultural fields, urban areas, and roadways, this plan will also reduce nonpoint source pollution to enhance the many ecological, social and economic values that depend on clean water. Where appropriate, outcomes have been related to GLRI Action Plan targets extrapolated through 2025 (see Appendix B).

Streams

NFWF programs will improve the quality and connectivity of coldwater streams and large rivers, with an emphasis on priority brook trout restoration areas and watersheds with known remnant lake sturgeon populations.

Coldwater streams across the world are vulnerable to changes associated with a changing climate. With an abundance of ground-water fed streams and temperatures somewhat moderated by enormous water bodies, the Great Lakes basin has the potential to remain a stronghold for this habitat type. As a species of concern that requires cold temperatures, clean water, and passage within and between streams, brook trout is an important indicator of coldwater stream condition, and investments will focus on the priority brook trout restoration

areas shown in Figure 3. Those areas include catchments with a high natural potential to support brook trout and other coldwater fish, but where populations may be limited due to sources of anthropogenic stress (Clingerman et al. 2012). In many cases, the priority areas are adjacent to high-quality stream reaches that can serve as sources for recolonization following stream restoration.

Often used for shipping, power generation, and urban and industrial development, most of the large rivers in the basin have suffered significant impairments. As a species of concern that requires access to Great Lakes tributaries with clean substrates for spawning and rearing, lake sturgeon is an important indicator of the quality and connectivity of this habitat type. Investments will focus on the 29 U.S. rivers with known remnant populations (Figure 4), as these rivers represent the best opportunities to restore complete large-river native fish assemblages in the U.S. portion of the basin. The number of spawning sturgeon in many of these rivers is currently unknown. Where estimates are available, sturgeon spawning runs often include fewer than 100 adult fish (Zollweg et al. 2003). With the presence of small spawning populations, habitat improvements in these rivers have the potential to increase rates of reproduction and recruitment that will ultimately contribute to larger adult populations.

Stream Outcomes:

- Restore fish access to 1,500 stream miles, representing 50% of the projected 2025 GLRI Action Plan target
- Restore viable populations of brook trout and other coldwater fish in 75 stream miles, representing 10% of brook trout stream restoration priority areas
- Increase lake sturgeon reproduction by 100% in three large rivers, representing 10% of U.S. remnant sturgeon populations



Brook trout. Photo: Conservation Resource Alliance

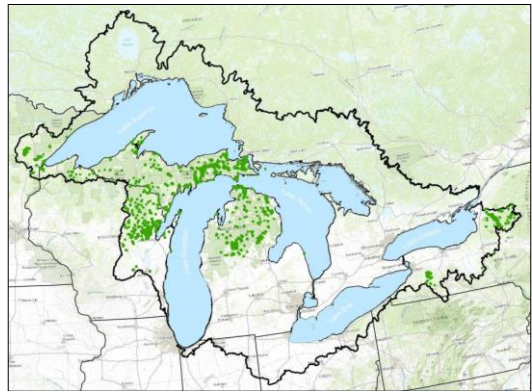


Figure 3. Priority brook trout restoration areas. (Adapted from Clingerman et al. 2012)



Lake sturgeon. Photo: U.S. Fish and Wildlife Service

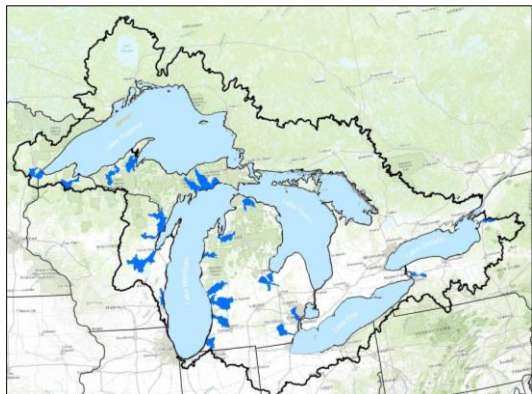


Figure 4. U.S. watersheds with remnant lake sturgeon populations. (adapted from Zollweg et al. 2003)

Coastal Wetlands

NFWF programs will restore coastal wetlands, with an emphasis on improving populations of high-priority shorebirds, waterfowl, and marsh-spawning fish such as northern pike.

The Great Lakes Coastal Wetlands Monitoring Consortium (Burton et al. 2008) has completed monitoring of more than 1,000 coastal wetlands larger than 10 acres, providing a baseline to evaluate future restoration. NFWF programs will restore a subset of these coastal wetlands, with an emphasis on high-priority migratory bird stopover areas and native fish spawning habitat (Figure 5).

By focusing in priority bird wetlands identified as degraded or moderately impacted, this plan will help improve populations of 19 shorebird and waterfowl species that fall below regional Joint Venture population objectives (Soulliere et al. 2007, Potter et al. 2007) as well as many other birds that depend on those habitats.

By focusing in priority fish wetlands identified as degraded and moderately impacted, this plan will benefit many marsh-spawning fish, amphibians, mussels, and macroinvertebrates that depend on this habitat type. As a declining species that requires passage between wetlands, streams and open water, northern pike (*Esox lucius*) will be used as an important indicator of coastal wetland condition.

Coastal Wetland Outcomes:

- Restore 13,000 acres, representing 11% of the projected 2025 GLRI Action Plan target
- Support 80,000 additional priority shorebirds during fall migration, or 10% of the increase needed to meet regional population objectives
- Support 150,000 additional priority waterfowl during spring migration, or 10% of the increase needed to meet regional population objectives
- Restore access by northern pike and other marsh-spawning fish to 25 coastal wetlands larger than 10 acres, representing 5% of monitored priority fish wetlands



Short-billed dowitcher



Northern pike

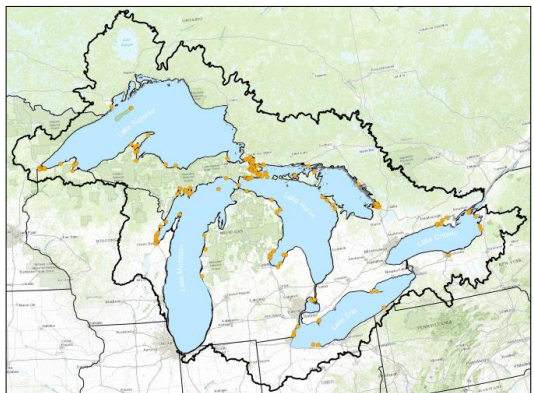


Figure 5. Great Lakes coastal wetlands identified as degraded or moderately impacted for birds and fish.

Water Quality

NFWF programs will reduce inputs of nonpoint source pollution to basin surface waters, with a focus in watersheds with high levels of phosphorus and sediment loading and frequent combined sewer overflows.

Pollution in the Great Lakes and their tributaries has a significant impact on the many values and services that depend on clean water. For example, it poses a risk to the health of millions of people that depend on the Great Lakes for their drinking water. It degrades the aquatic environment that sustains hundreds of fish species comprising a multi-billion dollar fishery. It compromises the appeal of many beach and shoreline areas that rely on tourism and recreation for their economic vibrancy.



Lake Erie algal bloom: Photo: WI Sea Grant

NFWF programs will improve water quality in basin surface waters by improving agricultural management practices, installing green infrastructure, and improving road–stream crossings. Investments to reduce algal blooms and improve water quality will focus in watersheds with high levels of phosphorus and sediment loading (Figure 6), with particular emphasis on western Lake Erie, Saginaw Bay, and Green Bay. Investments in green infrastructure to reduce combined sewer overflow events will focus in cities with the highest levels of combined sewer overflow discharge (Figure 7), with a particular emphasis on the Chicago and Calumet region.

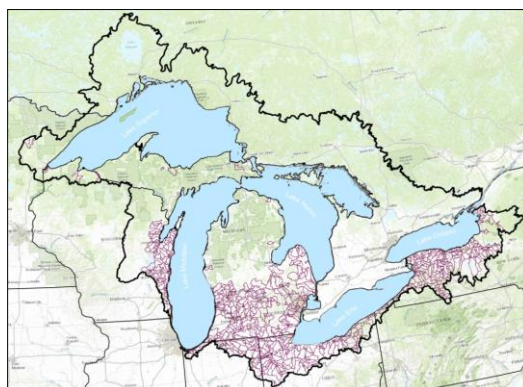


Figure 6. Priority phosphorus and sediment reduction areas.

Water Quality Outcomes:

- Reduce phosphorus inputs to basin waterways by 100,000 pounds, representing 4% of the projected 2025 GLRI Action Plan target
- Increase urban stormwater retention capacity by 25 million gallons, representing 5% of the projected 2025 GLRI Action Plan target
- Reduce sediment inputs to basin waterways by 30 million pounds

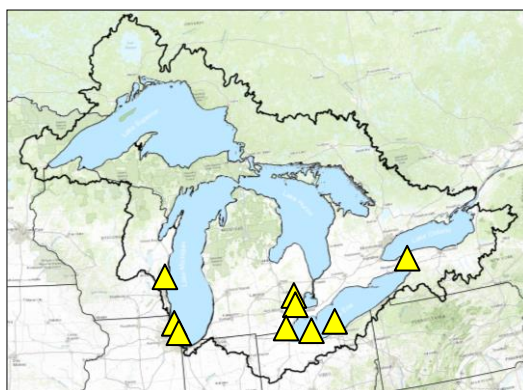


Figure 7. Priority combined sewer overflow reduction areas.

Selection of Focal Areas

Overlaying the areas highlighted in the preceding sections reveals 16 strategic investment areas that contain clusters of high-priority features (Figure 8). Within those areas, investment in a core set of strategies can achieve measurable outcomes that span multiple issues. For example, a road–stream crossing replacement can simultaneously improve water quality and help restore fish populations. This plan does not preclude investment in high-priority projects elsewhere in the basin, but key strategies implemented in the highlighted areas are expected to achieve efficiencies that help maximize program impacts. By focusing on these clusters of high-priority features, this plan will help restore resilient habitat networks capable of sustaining species and ecosystem services in the face of accelerating and emerging environmental changes in the basin.

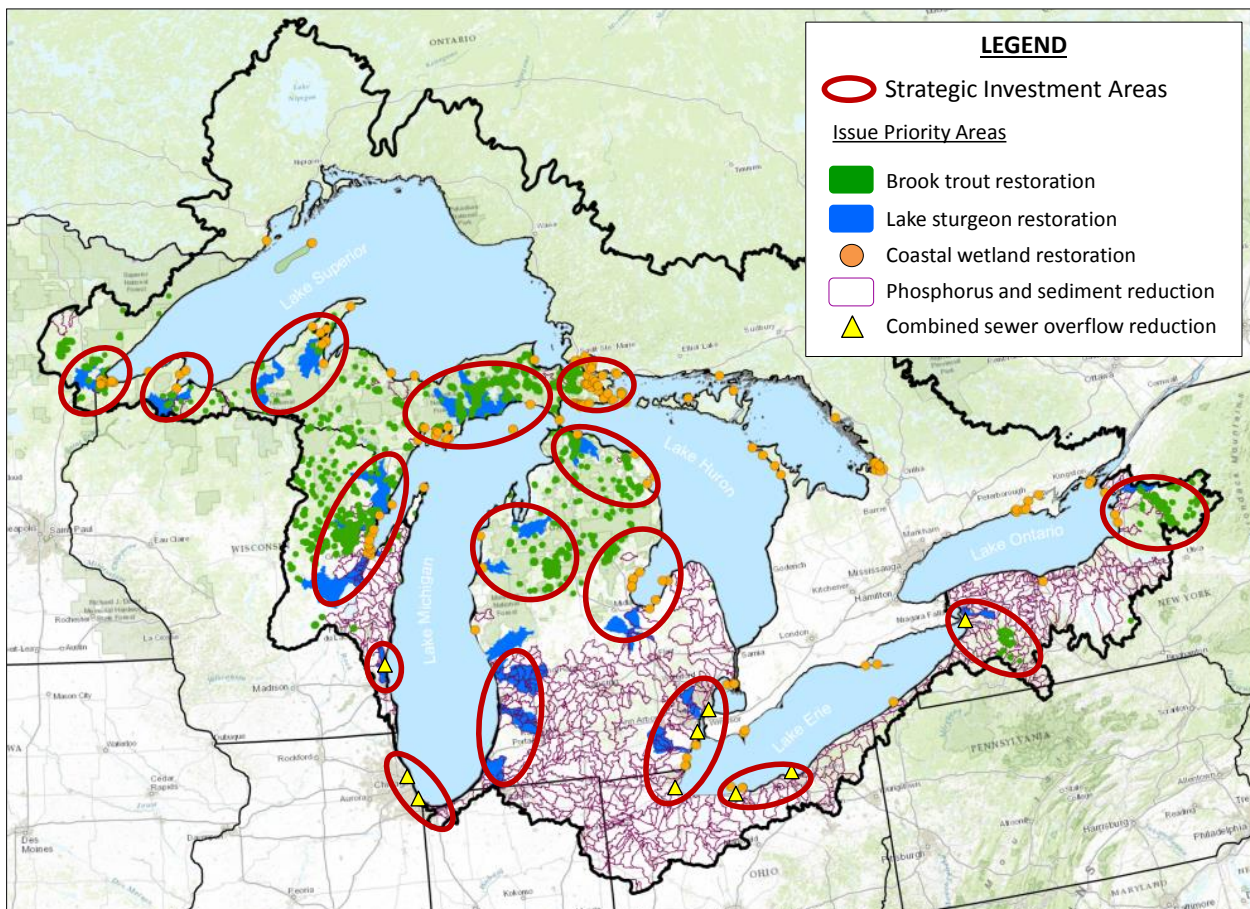
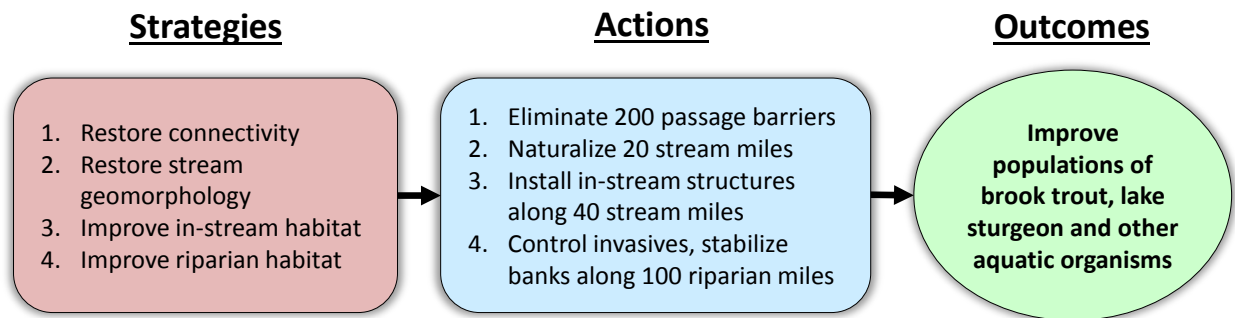


Figure 8. Sixteen strategic investment areas, where investments can achieve outcomes that span multiple priority issues.

Implementation Plan

Streams

NFWF programs will reconnect an estimated 1,500 miles of upstream habitat and improve 150 miles of in-stream and riparian habitat. Key strategies include restoration of aquatic connectivity, restoration of stream geomorphology, improvement of in-stream habitat, and improvement of riparian habitat.



Strategy 1: Restore Aquatic Connectivity

An estimated 275,902 dams and road–stream crossings occur within the basin, and more than 170,000 of them block the passage of fish and other aquatic organisms (Januchowski-Hartley et al. 2013). As a result, many Great Lakes fish species are unable to access the vast majority of their historic spawning habitats. For example, in the Lake Michigan basin, dams located near river mouths separate Great Lakes fish from 83% of historic upstream spawning habitats (Pearsall et al. 2012).

- *Action 1a: Remove large dams*
In large streams, NFWF programs will remove or bypass an estimated three large dams (height >25 feet or height >6 feet with storage >50 acre-feet) to restore runs of lake sturgeon and other lake-run fish that require tributary habitat for spawning. Strategic opportunities for large dam removals will be sought in 29 U.S. watersheds where remnant sturgeon populations currently occur.
- *Action 1b: Remove small dams*
Thousands of small dams occur along small streams in the Great Lakes basin. Many of them no longer serve their intended functions but still obstruct passage of fish and other organisms. To improve the accessibility and quality of habitat for brook trout and other fish, NFWF programs will remove an estimated 45 small dams.

- *Action 1c: Replace road–stream crossings*
More than 95%, of the 170,000 passage barriers in the basin are road–stream crossings, such as bridges, culverts and shallow trail crossings. In addition to blocking fish movements, these road-stream crossings are also significant sources of road runoff that contribute sediment to waterways. NFWF programs will replace an estimated 150 road-stream crossings to improve passage for fish and other organisms.
- *Action 1d: Install fish passage structures*
In some cases, barrier removal is not feasible and other solutions to restore fish passage are required. Fish ladders, fish lifts, rock ramps, and other bypass structures are options in these situations, and NFWF programs will install an estimated five structures during the span of this plan.

Strategy 2: Restore Stream Geomorphology

Dams typically inundate floodplains immediately upstream, transforming lotic habitats to large, slow-flowing reservoirs. In addition, many stream channels were straightened and simplified historically to facilitate drainage, shipping, and other land uses. These changes affect stream temperature profiles and flow regimes, often raising temperatures, affecting flow velocities and volumes, and prohibiting natural fluvial geomorphic processes.

- *Action 2a: Remove impoundments*
Typically associated with dam removals, impoundment removals often generate the most dramatic improvements in stream habitat. Among many other benefits, this work creates lotic habitat previously inundated by large reservoirs, restores natural stream processes, and lowers water temperatures. By removing approximately 48 impoundments, NFWF programs will restore an estimated 10–20 stream miles.
- *Action 2b: Naturalize stream channel configuration*
Channel realignment and installation of hard structures will restore natural stream meander, floodplain connections, and stream function. Through naturalizing stream channels, NFWF programs will restore an estimated 10–15 stream miles.

Strategy 3: Improve In-stream Habitat

The habitat values of many streams have been impaired due to high sediment loads and a lack of in-stream structure. The clean gravel or cobble spawning substrates preferred by many fish species are now rare because many of them have been buried by sediment. The large woody debris that provides foraging, cover and resting habitat in many streams has been reduced due to the loss of forested riparian buffers and dam-related disruption of downstream transport

- *Action 3a: Manage existing sediment loads*
To increase the availability of suitable spawning habitat, sediment will be excavated or otherwise managed along 10–20 stream miles. Work may involve the removal and disposal of approximately 100,000–200,000 cubic yards of sediment.
- *Action 3b: Install in-stream habitat structures*
To improve habitat complexity, NFWF programs will install in-stream structures along an estimated 40 stream miles. Structures to be installed include a mix of rock cross vanes, toe wood, and root wads.

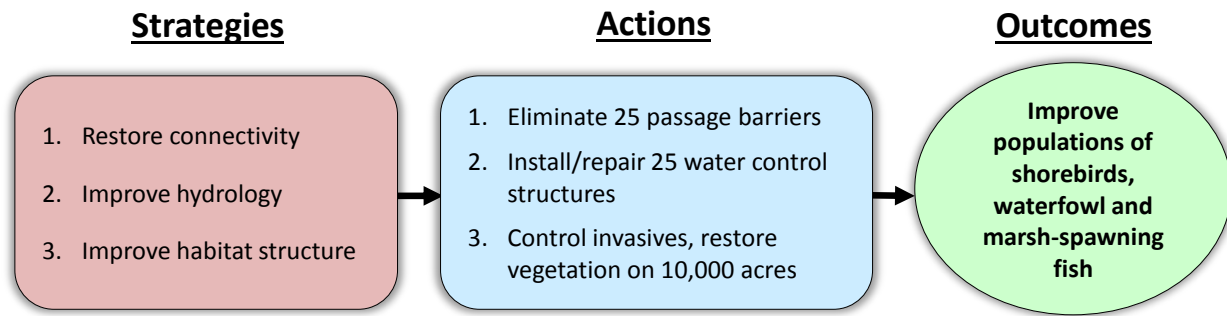
Strategy 4: Improve Riparian Habitat

Past land uses and a lack of forest regeneration have eliminated riparian buffers along many streams. Overhanging canopy cover is virtually absent in many areas, providing little shade for moderating water temperatures. Invasive vegetation dominates many riparian areas, providing poor habitat structure for birds and other wildlife. In some places, stream banks consist of riprap or vertical walls that separate riparian areas from their watercourses. These conditions often contribute to degradation of in-stream conditions by increasing erosion and sediment loading and amplifying destructive peak flows during large storm events.

- *Action 4a: Stabilize stream banks*
To reduce erosion and sediment loading, NFWF programs will stabilize stream banks along approximately 50 miles of stream. Work will involve grade control, j-hook vanes, toe wood, and root wads.
- *Action 4b: Control invasive vegetation*
NFWF programs will control invasive species along approximately 70 stream miles. Control techniques will include prescribed burning, herbicide application, and mechanical removal.
- *Action 4c: Restore native vegetation*
Restoration of native vegetation will occur along an estimated 45 miles of riparian areas, often following invasive species control efforts. Work will include planting and seeding native trees and shrubs and protecting them from herbivore browsing with fencing and tubing.

Coastal Wetlands

NFWF programs will restore 13,000 acres of coastal wetlands and associated uplands to enhance populations of migratory waterfowl and shorebirds, marsh-spawning fish, and many other species. Key strategies include restoration of connectivity with adjacent waterways, hydrological improvement, and improvement of habitat structure.



Strategy 1: Restore Connectivity

Seawalls, riprap, earthen berms, and sediment accumulations separate many wetlands from adjacent waterways. In addition to preventing natural hydrologic dynamics, these barriers impede movements by fish and other aquatic organisms and prevent access to shallow marsh habitats needed for spawning and rearing.

- *Action 1a: Install passage structures*
Often less expensive than hard structure removal and disposal, installation of passage structures can be an alternative way to allow fish and other aquatic organisms to move between coastal wetlands and open water or tributaries. NFWF programs will install approximately 20 passage structures to improve access to 1,000–2,000 wetland acres.
- *Action 1b: Excavate sediment*
Gradual sediment accumulation or rapid deposition associated with large storm events can block connections between wetlands and adjacent waterways. Projects may excavate and dispose of approximately 25,000–50,000 cubic yards of sediment.
- *Action 1c: Remove hard structures*
Hard structures such as seawalls and dikes can represent absolute barriers to the passage of fish and other aquatic organisms. Often cost-prohibitive, this action will be used sparingly, and NFWF programs may remove 3–5 structures comprising less than 1 mile.

Strategy 2: Improve Hydrology

Physical separation from the Great Lakes and their tributaries often impedes natural water level fluctuations and alters the hydroperiod in ways that are detrimental to wetland function. For example, static water levels tend to favor invasive species, such as common reed (*Phragmites australis*), at the expense of native vegetation adapted to more-dynamic conditions. In addition, loss of natural variability reduces the capacity to support diverse wildlife assemblages.

- *Action 2a: Install water control structures*
Active management of water levels in large wetlands is often necessary to control invasive vegetation and provide habitat of appropriate depth for target wildlife species. NFWF programs will install 20–30 water control structures to manage water levels on 4,000–5,000 wetland acres.
- *Action 2b: Repair berms and dikes*
Although berms and dikes sometimes have detrimental effects by separating wetlands from adjacent waterways and altering hydrology, they are sometimes important for protecting vegetation against destructive storm surges, enabling management of water levels, and providing habitats of varying depth in different wetland units. NFWF programs will improve management of 1,000–3,000 wetland acres by repairing 5–10 miles of these structures.

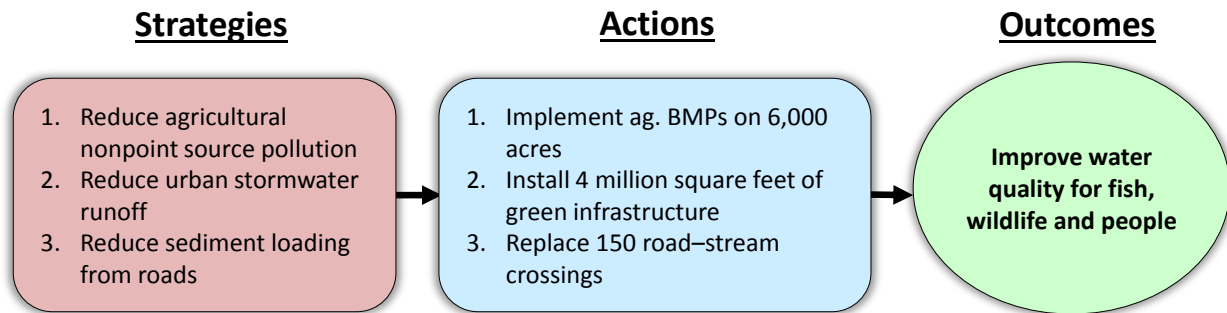
Strategy 3: Improve Habitat Structure

Infestations of invasive species, such as common reed, have degraded vast wetland areas by reducing complexity, altering hydrology, and reducing plant diversity. The dense monocultures formed by these species have rendered many coastal wetlands unsuitable for many birds, fish, and amphibians.

- *Action 3a: Control invasive species*
NFWF programs will improve wetland habitat by controlling invasive vegetation on 10,000 acres. Control techniques will include flooding, prescribed burning, herbicide application, and mechanical removal.
- *Action 3b: Restore native vegetation*
In some cases, dormant seed banks enable passive restoration of native vegetation following invasive species control and other restoration actions. However, active restoration of native vegetation is sometimes required, and NFWF programs will support this work on approximately 4,000 acres. Work will include planting and seeding forbs, grasses, and other native vegetation.

Water Quality

NFWF programs will reduce agricultural, urban and road runoff to reduce inputs of nutrients and sediment to basin surface waters by a total of 30 million pounds. Key strategies include improving management practices on agricultural lands, installing green infrastructure, and improving road–stream crossings.



Strategy 1: Reduce Agricultural Nonpoint Source Pollution

Phosphorus inputs from agriculture have led to more-frequent and severe harmful algal blooms in several areas of the basin, including western Lake Erie, Saginaw Bay and Green Bay. In 2011, for example, phosphorus inputs to western Lake Erie created an algal bloom that degraded fish habitat and impaired recreational uses over an area spanning nearly 2,000 square miles (International Joint Commission 2014).

- *Action 1a: Provide technical assistance to agricultural producers*
Many private landowners want to improve ecological conditions on their properties but currently do not have access to the necessary information and resources. NFWF programs will assist an estimated 150 landowners with the development of farm nutrient management plans and enrollment in Farm Bill programs.
- *Action 1b: Implement agricultural best management practices*
NFWF programs will support the implementation of best management practices on an estimated 6,000 acres of agricultural lands. Practices may involve construction of on-farm riparian buffers and wetlands, drainage and tillage practices, and application of soil health concepts.

Strategy 2: Reduce Urban Stormwater Runoff

Combined sewer overflows associated with major storm events threaten aquatic communities and pose significant public health risks due to dangerous flooding and bacterial contamination. As one example, from 2010 through mid-2015, storm events in the Chicago region alone led to the release of 43 billion gallons of untreated stormwater and wastewater into Lake Michigan (Metropolitan Water Reclamation District 2015).

- *Action 2a: Install green infrastructure*
NFWF programs will install approximately 4 million square feet of green infrastructure to increase urban stormwater storage capacity and reduce inputs of nonpoint source pollution associated with large storm events. Green infrastructure installations will include rain gardens, green roofs, pervious surfaces, and rain barrels.

Strategy 3: Reduce Sediment Loading from roads

The Great Lakes basin includes more than 268,000 road–stream crossings, such as bridges, culverts and shallow trail crossings (Januchowski-Hartley et al. 2013). In addition to blocking fish movements, these road-stream crossings are also significant sources of road runoff that contribute billions of pounds of sediment to basin waterways each year.

- *Action 3a: Replace road–stream crossings*
NFWF programs will replace approximately 150 poorly performing road–stream crossings. In addition to improving passage for fish and other aquatic organisms, this work will also reduce sediment loading associated with road runoff.

Monitoring and Evaluating Performance

Assessing performance under this plan requires an evaluation process that focuses on the results of individual projects as well as the cumulative outcomes they generate. At both levels, NFWF will determine whether planned actions are achieving desired results.

NFWF will initially evaluate each individual project by considering the anticipated outcomes identified in the full proposal. At a minimum, proposals will: 1) indicate the metrics that will be used to track progress and quantify outcomes; 2) outline the approach for establishing baseline conditions against which post-implementation conditions will be compared; and 3) demonstrate plans and resources for post-implementation monitoring. Upon project completion, grantees will provide project reports that summarize results and outcomes, and NFWF will use those reports to assess project performance.

In some cases, progress toward achieving plan outputs and outcomes will be calculated by tallying the results of individual projects. In others, outcome assessments will require information from other sources. Where possible, NFWF will assess those outcomes using data provided by existing regional monitoring efforts. Where data are unavailable, NFWF may direct funds to support specific targeted assessments.

To provide a snapshot of progress for primary conservation outcomes and strategies, NFWF will update a plan scorecard on an annual basis (preliminary Great Lakes scorecard shown in Figure 9). Every three years, NFWF will conduct an assessment to examine the factors that have facilitated and hindered successful implementation of the plan. Near the end of the plan period, a more comprehensive third-party evaluation may be conducted. Findings from all monitoring and evaluation activities will guide future investment and planning.



Sustain Our Great Lakes

Scorecard: July 2015

Program Duration: 2016 - 2025 (yr 0 of 10)	Program Investment: NFWF Funding \$0k / \$103 M (0%) Grantee Match	Program Coverage:
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Conservation Outcomes:	Goal	Progress
Stream and Riparian		
 Eastern Brook Trout <i>Salvelinus fontinalis</i>	Expand viable brook trout populations by 75 stream miles	0% Updated 2015
 Lake Sturgeon <i>Acipenser fulvescens</i>	Increase lake sturgeon reproduction by 100% in 3 priority rivers	0% Updated 2015
Coastal Wetlands		
 Shorebirds	Support 80,000 additional priority shorebirds	0% Updated 2015
 Waterfowl	Support 150,000 additional priority waterfowl	0% Updated 2015
 Northern Pike <i>Esox lucius</i>	Restore northern pike access to 25 coastal wetlands larger than 10 acres	0% Updated 2015
Water Quality		
 Phosphorus	Reduce phosphorus inputs to basin waterways by 100,000 pounds	0% Updated 2015
 Urban Stormwater	Increase urban stormwater storage capacity by 25 million gallons	0% Updated 2015
 Sediment	Reduce sediment inputs to basin waterways by 30 million pounds	0% Updated 2015

Figure 9a. Page 1 of the Great Lakes scorecard for tracking conservation outcomes.

Initiative Strategies	Progress	Conservation and Funding Goals	
Habitat Restoration:			
Conservation goal	0%	200	Fish passage improvements: # fish passage barriers rectified
	0%	1,500	Fish passage improvements: Miles of stream opened
	0%	80	Miles of stream/channel restored or naturalized
	0%	100	Riparian restoration: Miles restored
	0%	1,500	Acres of coastal wetland reconnected with adjacent waterways
	0%	4,000	Acres with restored hydrology
	0%	10,000	Acres of habitat structure improved
Funding goal	0%	\$88.2M	
Habitat Management:			
Conservation goal	0%	150	Road-stream crossings replaced/improved
	0%	4M	Square feet of green infrastructure installed
	0%	100,000	Lbs of phosphorous prevented from entering system
	0%	30M	Lbs of sediment prevented from entering system
	0%	6,000	Acres under improved management
Funding goal	0%	\$14.8M	
NOTES:			
Total number of grants awarded to date: 0			

Figure 9b. Page 2 of the Great Lakes scorecard for tracking conservation outcomes.

Stream Monitoring

Improvements in stream connectivity will be assessed using barrier inventory data and barrier removal optimization tools developed by the University of Wisconsin, Wisconsin Department of Natural Resources, and The Nature Conservancy. To the extent possible, NFWF will assess stream habitat and fish population improvements using data provided by grantees and existing regional monitoring efforts. Where data for assessing outcomes are unavailable, NFWF may contract with state agencies, universities, or consultants to conduct targeted assessments.

Coastal Wetlands Monitoring

Coastal wetland outcomes will be measured through a combination of direct monitoring and modeling. Monitoring conducted by the Coastal Wetland Monitoring Consortium (Burton et al. 2008) will provide information on wetland condition for birds and fish. Outcomes for priority shorebird and waterfowl species will be estimated using energetics models that define

relationships between habitat availability and carrying capacity for individual priority bird species (Soulliere et al. 2007, Potter et al. 2007).

Water Quality Monitoring

Direct measurements of phosphorus and sediment inputs may be made at a small number of individual project sites, but those data are typically difficult and expensive to obtain. NFWF will more often rely on modeling (e.g., Spreadsheet Tool for Estimating Pollutant Load) to estimate the cumulative phosphorus and sediment reductions achieved by program investments. The design retention capacity specified in engineering plans for green infrastructure installations will be used to determine the volume of urban stormwater storage added by NFWF projects.

Funding Needs

Fully restoring and continuing to protect the Great Lakes will cost billions of dollars over several decades. Sustained investments on the part of government agencies and many private actors will be crucial for restoring and maintaining a healthy Great Lakes region. This plan will be implemented primarily with contributions and other support provided by NFWF partners under the Sustain Our Great Lakes program, Chi-Cal Rivers Fund, and Conservation Partners program. Together, these programs are expected to direct more than \$8 million per year in grant funding for work in the Great Lakes basin. To augment funding from existing sources, NFWF will seek new partners, and it may develop other programs that can advance the goals of this plan. Full implementation of this plan over 10 years will require approximately \$103 million in NFWF funding (Figure 10, Table 1). This funding is expected to leverage matching contributions from state, provincial, municipal and private sources at a minimum ratio of 1:1, generating a total conservation investment of \$206 million.

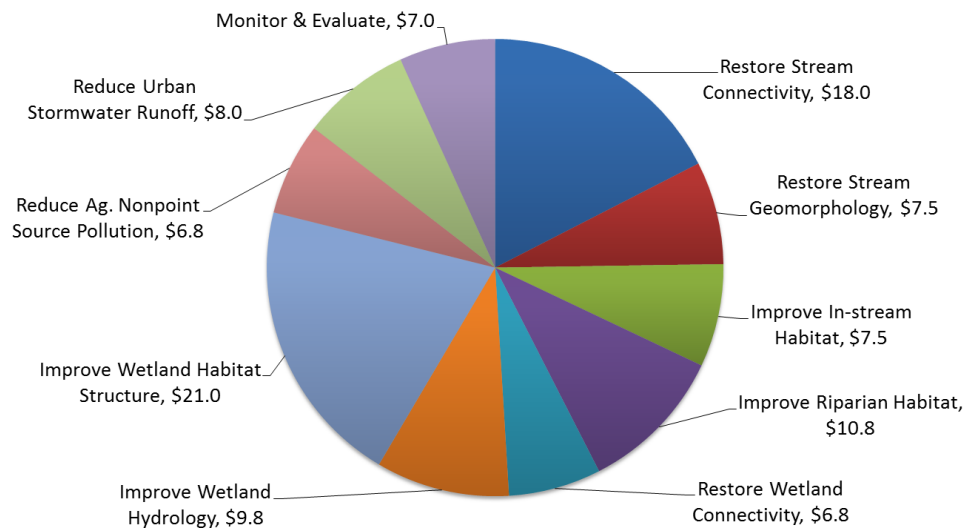


Figure 10. NFWF grant funding needs by strategy, in millions of dollars.

Table 1. NFWF grant funding needs to implement the plan, millions of dollars 2016–2025.

BUDGET CATEGORY	2016–2020	2021–2025	Total
STREAM & RIPARIAN HABITAT	\$17.5	\$26.3	\$43.8
1. Restore Connectivity	\$7.2	\$10.8	\$18.0
1a. Remove large dams	\$1.8	\$2.7	\$4.5
1b. Remove small dams	\$1.8	\$2.7	\$4.5
1c. Replace road-stream crossings	\$3.0	\$4.5	\$7.5
1d. Install fish passage structures	\$0.6	\$0.9	\$1.5
2. Restore Stream Geomorphology	\$3.8	\$3.8	\$7.5
2a. Remove impoundments	*	*	*
2b. Naturalize stream channel configuration	\$3.8	\$3.8	\$7.5
3. Improve In-stream Habitat	\$3.8	\$3.8	\$7.5
3a. Manage existing sediment loads	\$0.8	\$0.8	\$1.5
3b. Install in-stream habitat structures	\$3.0	\$3.0	\$6.0
4. Improve Riparian Habitat	\$5.4	\$5.4	\$10.8
4a. Stabilize stream banks	\$2.5	\$2.5	\$5.0
4b. Control invasive vegetation	\$1.8	\$1.8	\$3.5
4c. Restore native vegetation	\$1.1	\$1.1	\$2.3
COASTAL WETLANDS	\$22.5	\$15.0	\$37.5
1. Restore Connectivity	\$4.1	\$2.7	\$6.8
1a. Install passage structures	\$1.8	\$1.2	\$3.0
1b. Excavate sediment	\$0.5	\$0.3	\$0.8
1c. Remove hard structures	\$1.8	\$1.2	\$3.0
2. Improve Hydrology	\$5.9	\$3.9	\$9.8
2a. Install water control structures	\$4.5	\$3.0	\$7.5
2b. Repair berms and dikes	\$1.4	\$0.9	\$2.3
3. Improve Habitat Structure	\$12.6	\$8.4	\$21.0
3a. Control invasive species	\$9.0	\$6.0	\$15.0
3b. Restore native vegetation	\$3.6	\$2.4	\$6.0
WATER QUALITY	\$7.4	\$7.4	\$14.8
1. Reduce Agricultural Nonpoint Source Pollution	\$3.4	\$3.4	\$6.8
1a. Provide technical assistance	\$0.4	\$0.4	\$0.8
1b. Implement best management practices	\$3.0	\$3.0	\$6.0
2. Reduce Urban Stormwater Runoff	\$4.0	\$4.0	\$8.0
2a. Install green infrastructure	\$4.0	\$4.0	\$8.0
3. Reduce Sediment Runoff from Roads	†	†	†
3a. Replace road–stream crossings*	†	†	†
MONITORING & EVALUATION	\$2.5	\$4.5	\$7.0
TOTAL ESTIMATED BUDGET	\$49.9	\$53.1	\$103.0

*Costs for removing impoundments are included in the costs for removing large and small dams.

†Costs for reducing sediment runoff from roads are included in the costs for replacing road–stream crossings.

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Acknowledgments

This business plan has benefited from the engagement of dozens of agencies, foundations, corporations, universities, and non-governmental organizations across the Great Lakes basin, and we thank them for their insights and input. In particular, we thank our Sustain Our Great Lakes, Chi-Cal Rivers Fund, and Conservation Partners funding partners (Figure 11), including:

- ArcelorMittal
- The Chicago Community Trust
- Crown Family Philanthropies
- Gaylord and Dorothy Donnelley Foundation
- Illinois Department of Natural Resources
- The Joyce Foundation
- Metropolitan Water Reclamation District of Greater Chicago
- National Oceanic and Atmospheric Administration
- U.S.D.A. Natural Resources Conservation Service
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- Wrigley Company Foundation

The goals outlined in this plan reflect the shared priorities of these partners, and this plan will be implemented largely with their generous support.

We also thank our grantees. Their past work provided a baseline to gauge what can be accomplished over the next 10 years and helped us set goals that are ambitious yet realistic. We will continue to rely on their expertise and dedication to help us achieve the goals of our Great Lakes program.



Figure 11. Logos of NFWF Great Lakes funding partners (Crown Family Philanthropies logo not shown).

Appendix A: Overview of NFWF Business Plans

Background

The purpose of a NFWF business plan is to provide a detailed blueprint of the strategies and resources required to achieve desired conservation outcomes. Each plan describes the conservation need, expected outcomes, potential risks to success, metrics for gauging progress, and the monetary costs involved. The strategies discussed in this plan do not represent solely NFWF's view of the actions necessary to achieve the identified conservation goals. Instead, they reflect the view of many federal, state, academic, and organizational experts consulted during plan development. This plan does not duplicate ongoing initiatives but rather identifies strategic priorities for investment to complement broader efforts. Hence, the aim of the work described in the business plan is to support the efforts of the larger conservation community.

NFWF Monitoring and Evaluation Approach

To better demonstrate results and improve the effectiveness of its conservation investments, NFWF has incorporated a comprehensive monitoring and evaluation strategy into its conservation initiatives. At initiative inception, NFWF works with scientists and practitioners to develop a business plan that identifies clear conservation goals, strategies to achieve these goals, and metrics for assessing progress. During proposal review, proposals are prioritized based on how well they align with the initiative's priority strategies. At the project level, individual grantees will monitor and provide updates on key project activity and outcome metrics in annual and final reports.

Duration of NFWF Support

This business plan outlines a strategy to achieve conservation outcomes within a specified time frame. As noted above, NFWF will periodically evaluate progress toward initiative goals to learn from its grant-making and respond adaptively. In some cases, these course corrections may warrant increased investment by NFWF and other partners. However, it is also possible that NFWF would reduce or eliminate support for this initiative if periodic evaluation indicates that further investments are unlikely to be productive in the context of the intended outcomes.

About NFWF

NFWF protects and restores our nation's wildlife and habitats. Chartered by Congress in 1984, NFWF directs public conservation dollars to the most pressing environmental needs and matches those investments with private contributions. NFWF works with government, nonprofit and corporate partners to find solutions for the most intractable conservation challenges. Over the last three decades, NFWF has funded more than 4,000 organizations and committed more than \$2.9 billion to conservation projects. Learn more at www.nfwf.org.

Appendix B: Collaboration and Plan Development

Hundreds of organizations are supporting and implementing restoration work across the Great Lakes basin. In addition to numerous federal agencies, they include tribal, state, provincial and local governments, large and small conservation organizations, corporations, foundations, and educational institutions. NFWF plays a unique and important role within the basin by bringing many of these groups together for common conservation purposes. Through its Sustain Our Great Lakes, Chi-Cal Rivers Fund, and Conservation Partners programs, NFWF coordinates funding decisions among 13 agencies and organizations (Figure 11), and it has supported the work of more than 130 grantee organizations. Through this collaboration, NFWF helps achieve strategic investments that reflect the shared priorities of a host of diverse partners.

NFWF prepared this business plan in collaboration with its program partners and other subject matter experts. Several documents provided guidance for setting priorities and outcomes. The business plan aligns most closely with the GLRI Action Plan II (White House Council on Environmental Quality 2014), which is the guiding document for federal investments in the U.S. portion of the Great Lake basin. To the extent possible, this plan presents outcomes and outputs in terms of the GLRI Action Plan II measures of progress, which will facilitate assessment of NFWF program contributions to progress under the GLRI.

The GLRI Action Plan II spans the years 2015–2019, and this business plan spans the years 2016–2025. Due to the timing differences, the outcomes of these plans cannot be aligned directly. Rather, as relevant, outcomes of this business plan have been related to GLRI Action Plan II targets extrapolated through 2025 (Table 2).

Table 2. GLRI measures of progress, targets for years 2016–2019, and extrapolated targets for 2025.*

GLRI Action Plan II Measure of Progress	2016	2017	2018	2019	2025 Extrapolation
Miles of Great Lakes tributaries reopened	300	1,500	900	1,200	3,000
Acres of Great Lakes coastal wetlands protected, restored and enhanced	8,000	23,000	45,000	53,000	120,000
Phosphorus reductions in targeted watersheds (pounds)	180,000	395,000	665,000	940,000	2,350,000
Volume of untreated urban runoff captured or treated (millions of gallons)	40	90	155	220	550

*For ease of presentation, this table shows the cumulative measures achieved by year starting with the year 2016. As they occur outside the period of this business plan, the baseline (pre-2015) values and 2015 values shown in the GLRI Action Plan II are omitted.

Some of the other resources that served as a basis for plan development include the Lake Biodiversity Conservation Strategies (e.g., Pearsall et al. 2012), Lakewide Area Management Plans (e.g., Lake Superior Binational Program 2008), Great Lakes Area of Concern Remedial Action Plans (e.g., Michigan Department of Environmental Quality 2012), 2014 Lake Erie Ecosystem Priority report (International Joint Commission 2014), draft Great Lakes Basin Fish Habitat Partnership Strategic Plan (GLBFHP 2009), Great Lakes Coastal Wetlands Monitoring Plan (Burton et al. 2008), and Upper Mississippi River and Great Lakes Joint Venture waterfowl and shorebird habitat conservation strategies (Soulliere et al. 2007, Potter et al. 2007).

Appendix C: Bi-national Collaboration

Comprising more than one-third of the Great Lakes surface area and the entire basin, Canadian waters and lands are critical to the health of the region. With an appreciation that conservation needs do not adhere to political boundaries, the Sustain Our Great Lakes program has supported 16 projects in Canada in consultation with provincial and federal Canadian agencies. However, with lower levels of government funding and fewer non-profit organizations, Great Lakes funding available for use in Canada is relatively small. Based on a realistic outlook of what can be achieved with anticipated funding, focal investment areas outlined in this plan occur on the U.S. side of the border. Recognizing that a Great Lakes strategy cannot be comprehensive without more-balanced investment across the basin, NFWF will continue its efforts to engage new funding partners and expand its investments in Canada.

Appendix D: Risk Analysis

Risk is the probability that an event detrimental to a desired outcome will occur. This appendix describes seven categories of risk for the purpose of identifying strategies to mitigate, minimize or avoid obstacles that could impede plan implementation and achievement of plan outcomes.

Regulatory Risk

State (and sometimes municipal) permits will be required for the implementation of some plan actions, including dam removal, culvert replacement, sediment removal, and placement of large woody debris. The relevant State agencies regularly grant approvals for these types of activities, but each project will need to be considered on a case-by-case basis. Information about permitting status and timing provided in proposals will facilitate the selection of projects expected to be permitted in a timely manner.

Compliance with the National Environmental Policy Act, Endangered Species Act, and National Historic Preservation Act will also be required for many projects supported with federal funds.

These regulatory requirements may lengthen the time required for project completion, but they are not expected to be significant barriers to achieving plan goals. When compliance reviews indicate a project has the potential to adversely impact endangered species or cultural resources, the project may be redesigned to avoid such impacts and prevent delays in compliance document approval.

Financial Risk

The GLRI has directed more than \$1.9 billion to Great Lakes restoration activities since 2010, and billions more are necessary to restore the basin to ecological health. Although the basinwide need is vast, the comparatively small budget for this plan is expected to be sufficient to achieve plan outcomes.

Spanning 13 federal and state agencies, special government districts, private corporations, and foundations, the diversity of funding partners helps stabilize NFWF program budgets by dampening fluctuations in annual funding from individual sources. However, approximately 70% of NFWF Great Lakes funding derives from the GLRI, and reductions in funding from this source could have significant consequences for the NFWF Great Lakes budget. NFWF funding from the GLRI has been fairly consistent from 2010 through 2015, but changes in presidential administrations, composition of Congress, and agency priorities could negatively affect the amount of funding directed to the GLRI and to NFWF. Some of the uncertainty in annual GLRI funding levels could be mitigated by establishing a long-term funding source for Great Lakes restoration. A bill for this purpose, called the Great Lakes Ecological and Economic Protection Act, is currently being weighed by Congress. In addition, NFWF will seek to mitigate financial risk by securing funding from new program partners.

Another financial risk involves the high cost of some conservation activities. For example, fish passage projects involving large dams are often expensive, with comprehensive costs sometimes exceeding \$10 million. Based on estimates of available funding, NFWF programs will be able to support large dam projects in only a few places during the span of this plan. Poor performance by any of those projects would not only waste significant resources but preclude investment in other areas where program funds could have been better applied. This risk will be minimized through careful project evaluations by internal and external reviewers.

Environmental Risk

Climate change poses significant risk and uncertainty pertinent to the outcomes of this plan. More intense storm events are expected to increase runoff from agricultural and urban areas, exacerbating the challenges of managing inputs of nutrients, sediments and wastewater (International Joint Commission 2014). Warmer water temperatures will also threaten many populations of fish, such as brook trout, that require coldwater stream habitats. In addition, larger volumes of runoff discharged during storms will further degrade fish habitat by scouring channels and eroding stream banks. Longer growing seasons and persistent low lake levels could exacerbate encroachment of invasive vegetation in coastal wetlands. Higher average

storm intensity could lead to more-severe damage to native vegetation and increased sedimentation in coastal wetlands. To mitigate these risks, riparian buffers and bank stabilization will be emphasized to reduce destructive peak flows and prevent erosion. Efforts to restore brook trout and other coldwater species will focus in the northern portion of the U.S. range, where coldwater stream habitats are more likely to persist. Climate-related impacts to coastal wetlands may be mitigated by increasing capacity to actively manage water levels and buffer native vegetation against storm surges.

Other environmental risks include invasive species and contaminants. Sea lamprey (*Petromyzon marinus*) is a major threat to the Great Lakes fishery, and some dams are not eligible for removal because they prevent upstream movement and reproduction of this invasive species. In addition, there is concern about the upstream movement and deposition of contaminants present in the tissues of large-bodied Great Lakes fish. Due to these risks, dams will not necessarily be removed in order of their priority for native fish passage alone. Rather, many ecological factors will be considered in the removal of any dam.

Scientific Risk

Lack of information and monitoring for many species in the Great Lakes basin poses a challenge for measuring success under this plan. For example, minimal distribution and abundance data are available for many species of native fish, and grantees are typically not equipped nor permitted to conduct the types of electro-shocking fish surveys required to generate fish population estimates. Evaluation of outcomes will rely heavily on data collected by State Department of Natural Resources stream surveys and the Great Lakes Coastal Wetlands Monitoring Consortium (Burton 2008). However, to obtain the data needed to track progress under this plan, NFWF may need to contract with a state agency, university, or consultant to conduct targeted surveys.

Social Risk

Residents of the Great Lakes basin are generally supportive of habitat restoration, but some actions have the potential to be controversial. For example, some dams still provide community benefits and segments of the public may oppose their removal. In some cases, public engagement and education may help generate support and allow projects to advance. In others, opposition may represent a significant obstacle. As a result, social constraints may prevent NFWF programs from removing dams in order of their conservation priority. To mitigate this risk, the best dam removal solutions will be identified by assessing opportunities across a large number of watersheds. Information gathered from proposals and project leaders about the public engagement process will allow the selection of projects where efforts to generate community support have already been successful.

Economic Risk

The profitability of dam operation is one factor that could affect the feasibility of removing some dams. The cost of maintaining a dam can be more expensive than removing it, often providing an economic incentive for removal. In some cases, though, the economic benefits of operating a dam outweigh the costs, and dam owners desire to maintain their structures. In those situations, options for bypass may be considered or opportunities will be sought elsewhere, depending on the conservation priority any particular dam represents.

Institutional Risk

The priority issues addressed by this plan align well with the missions of many conservation organizations in the basin. However, institutional capacity has the potential to slow plan implementation for three reasons. First, the GLRI has provided funding that has enabled many organizations to initiate many significant projects during the past five years. As a result, some organizations have maximized the work loads of existing staff and may be unable to manage new projects adequately without adding positions. Second, some projects, such as dam removals and installation of water control structures, require specific expertise, and some organizations are not well-suited to that work. Third, organizational capacity and expertise varies by geographic region. As one example, proposal submissions have indicated greater capacity in the northern Lower Peninsula compared to the western Upper Peninsula. To mitigate these challenges, NFWF programs may need to approve project budgets that include added funding for staff and consultants.