Great Lakes Restoration Initiative Report to Congress

March 2023

Fiscal Year 2020 – Fiscal Year 2021

Contents

About This Report

This report presents an overview of progress made under the Great Lakes Restoration Initiative (GLRI). It includes information through Fiscal Year 2021 on funding, project accomplishments, success stories, and actual results compared to planned targets under GLRI Action Plan III. Data on direct spending is taken from the U.S. Environmental Protection Agency financial system. All references to outyear actions are subject to the availability of appropriations. Information on GLRI projects and activities is also available at https://glri.us.

The EPA Administrator is required by Clean Water Act Section 118 (c)(7)(H)(iii) to provide this report to the House Committee on Transportation and Infrastructure and the Senate Committee on Environment and Public Works.

Message From the Chair of the Great Lakes Interagency Task Force

The Great Lakes Restoration Initiative (GLRI) continues to achieve unprecedented results in restoring and protecting the Great Lakes. Between the GLRI's inception in Fiscal Year (FY) 2010 and the end of FY 2021, the U.S. Environmental Protection Agency (EPA) and its partnering federal agencies have invested approximately $3.8 billion from the GLRI to implement more than 6,500 projects across the Great Lakes basin.

In FY 2020 and FY 2021, GLRI-funded projects:

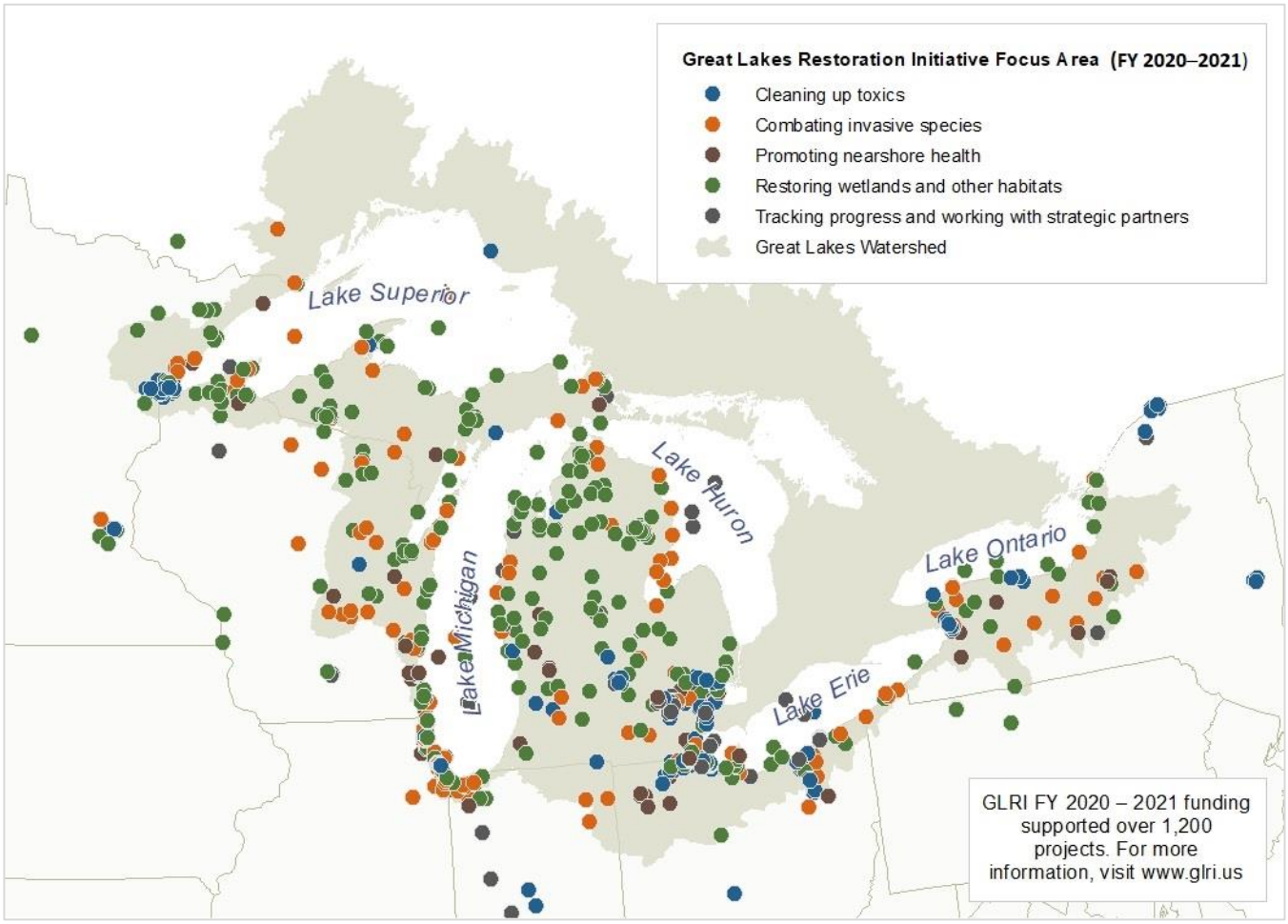
- Cleaned up contaminated "Areas of Concern" (AOCs)—toxic hotspots that had remained untouched and polluted for years but are now being environmentally restored and economically revitalized. Most notably, the GLRI accomplished the removal of two AOCs, the Lower Menominee River AOC in Michigan and Wisconsin and the Ashtabula River AOC in Ohio, from the list of the most polluted areas in the U.S. Great Lakes.
- Kept silver carp, bighead carp, and black carp out of the region, preventing irreversible damage to the ecological and economic integrity of the Great Lakes.
- Reduced the amount of phosphorus (which contributes to harmful algal blooms) and urban runoff (which contributes to unsafe beaches) entering the Great Lakes.
- Restored and enhanced natural habitat across the Great Lakes basin.

I am proud of EPA's role in leading the implementation of the GLRI while recognizing the essential roles performed by our federal, Tribal, state, local, and private partners. These well-established, strong, and continuing partnerships have been the linchpin of the GLRI's success and, along with the environmental benefits, are a key reason for the Initiative's strong and widespread support.

The Biden-Harris Administration will continue to support the Great Lakes not only by restoring and protecting the Great Lakes environment, but also by recognizing and emphasizing the relationship between a restored environment and opportunities for economic, social, and cultural revitalization and environmental justice. Every person in the United States has the right to clean air, clean water, and a healthier life—no matter how much money they have in their pockets, the color of their skin, or their zip code. Across the Great Lakes, formerly degraded and economically abandoned waterfront areas are coming back to life as people of all races and income levels take advantage of the recreational, social, and economic opportunities that these restored areas provide—opportunities made possible by the GLRI and the partnerships and hard work that are necessary to implement it.

The GLRI is proof that environmental protection and economic prosperity go hand in hand. In 2018, an independent economic study found that every GLRI dollar spent produces $3.35 of additional economic activity. EPA is committed to building on the GLRI's tremendous success, and I look forward to achieving even greater results in upcoming years.

Michael S. Regan



Section 1 – Executive Summary

The Great Lakes Restoration Initiative, or the GLRI, has greatly accelerated efforts to protect and restore the Great Lakes—the largest system of fresh surface water in the world. Since its 2010 inception, the GLRI has continued to address the historically challenging environmental problems and imminent threats facing this indispensable ecosystem.

Under the U.S. Environmental Protection Agency's (EPA's) leadership, the GLRI has been a catalyst for unparalleled coordination among the federal agencies or departments that make up the GLRI Interagency Task Force and the GLRI Regional Working Group. Through Fiscal Year (FY) 2021, GLRI has funded over 6,500 projects that focus on the most important Great Lakes environmental issues, including cleaning up highly contaminated Areas of Concern (AOCs), protecting and restoring native habitat and species, and preventing and controlling invasive species.

Section 118 of the Clean Water Act authorizes GLRI funding and directs efforts across five priority areas, including: (i) the remediation of toxic substances and areas of concern; (ii) the prevention and control of invasive species and the impacts of invasive species; (iii) the protection and restoration of nearshore health and the prevention and mitigation of nonpoint source pollution; (iv) habitat and wildlife protection and restoration, including wetlands restoration and preservation; and (v) accountability, monitoring, evaluation, communication, and partnership activities.

The five priority areas correspond directly with the Action Plan III Focus Areas described below. This report provides an overview of progress during FY 2020–FY 2021 for each Focus Area within Action Plan III.

GLRI Action Plan III Focus Areas

1) Toxic Substances and Areas of Concern

During FY 2020–FY 2021, GLRI federal agencies[1] and their partners made significant progress remediating contaminated sediment and restoring habitat in AOCs. A total of 17 Beneficial Use Impairments (BUIs) were removed, bringing the cumulative total of BUIs removed to 106, which surpasses the FY 2021 target set in GLRI Action Plan III (see Appendix A, Table A-1). Two AOCs were delisted: the Lower Menominee River and the Ashtabula River, representing the fifth and sixth U.S. AOCs ever delisted. Through the end of FY 2021, GLRI federal agencies and their partners also completed all management actions necessary for delisting at an additional three AOCs (Manistique River, Eighteen Mile Creek, and Muskegon Lake), bringing the total of AOCs either delisted or with completed management actions to about half of the original number of U.S. AOCs (i.e., 15 out of 31). The GLRI federal agencies and their partners also continued their work to protect human health from contaminants in Great Lakes fish and assess the impacts of chemicals of emerging concern on fish and wildlife populations in the Great Lakes basin.

2) Preventing and Controlling Invasive Species

During FY 2020–FY 2021, GLRI federal agencies and their partners continued efforts to prevent introductions of new invasive species and to control existing invasive species throughout the Great Lakes ecosystem. Ongoing work continued to prevent the migration of silver carp, bighead carp, and black carp into the Great Lakes. Since the GLRI began, federal agencies and their partners have taken actions to control invasive species on over 216,000 terrestrial and aquatic acres, including over 38,000 acres in FY 2020–FY 2021.

3) Nonpoint Source Pollution Impacts on Nearshore Health

During FY 2020–FY 2021, GLRI federal agencies and their partners implemented conservation activities to reduce nonpoint sources of pollution that threaten Great Lakes nearshore regions. These partners worked collaboratively to target nonpoint sources of excess phosphorus runoff that contribute to harmful algal blooms (HABs) around the Great Lakes in priority watersheds, such as the Lower Fox River, Saginaw River, and Maumee River. GLRI federal agencies estimate that GLRI-funded projects implemented since the program's inception have prevented over 2 million pounds of phosphorus (including over 500,000 pounds of phosphorus in FY 2020–FY 2021) from leaving farms and entering the Great Lakes. In addition, GLRI federal agencies and their partners worked collaboratively in urban areas to prevent about 140 million gallons of polluted stormwater from entering the Great Lakes in FY 2020–FY 2021.

4) Habitat and Species

During FY 2020–FY 2021, GLRI federal agencies and their partners protected, restored, and enhanced habitats and native species throughout the Great Lakes basin. Since GLRI began, these efforts have protected and restored over 479,000 acres (including over 37,000 acres in FY 2020–FY 2021) of coastal wetland, nearshore, and other habitats. These efforts benefit native fish, bird, and amphibian species, including actions that significantly protected and promoted recovery of the lakeside daisy and piping plover. Since the start of the GLRI, these actions have increased connectivity for aquatic organisms in more than 6,725 miles (including over 1,200 miles in FY 2020–FY 2021) of streams and rivers.

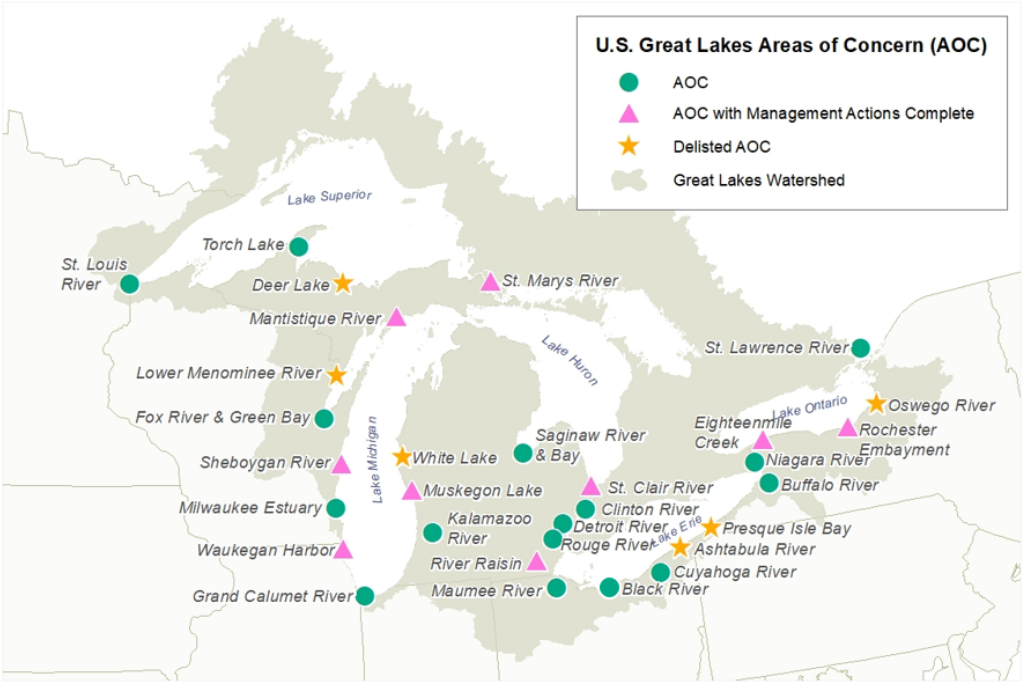
5) Foundations for Future Restoration Actions

During FY 2020–FY 2021, GLRI federal agencies and their partners engaged over 165,000 youth through hands-on education and stewardship projects. GLRI federal agencies and their partners also conducted comprehensive monitoring to assess and collect data on Great Lakes ecosystem status and trends. These data guided plans for projects addressing coastal resiliency and both nuisance and harmful algae.

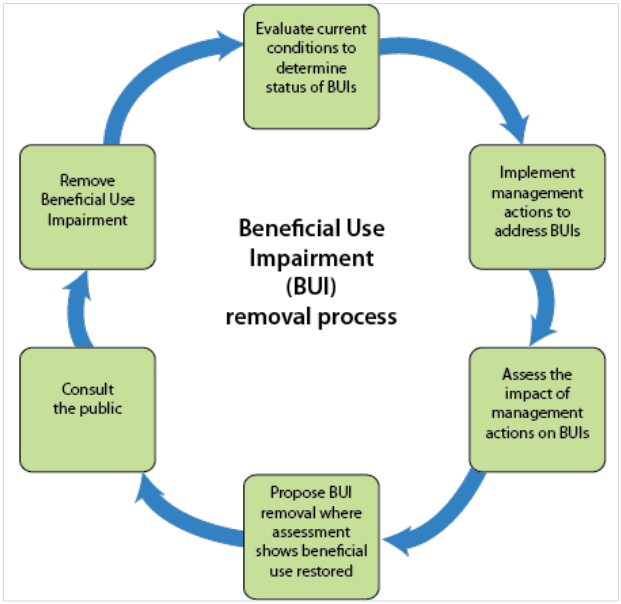
[1] Includes U.S. Department of Agriculture (Animal and Plant Health Inspection Service, Natural Resources Conservation Service, and U.S. Forest Service); U.S. Department of Commerce (National Oceanic and Atmospheric Administration); U.S. Department of Army (U.S. Army Corps of Engineers); U.S. Department of Health and Human Services (Agency for Toxic Substances and Disease Registry and Centers for Disease Control and Prevention); U.S. Department of State; U.S. Department of Homeland Security (U.S. Coast Guard); U.S. Department of the Interior (Bureau of Indian Affairs, U.S. Fish and Wildlife Service, National Park Service, and U.S. Geological Survey); U.S. Department of Transportation (Federal Highway Administration and Maritime Administration; and EPA (Great Lakes National Program Office).

Section 2 – Program Accomplishments

FOCUS AREA 1: Toxic Substances and Areas of Concern



Defined in the 1987 Great Lakes Water Quality Agreement, AOCs are specific areas of the Great Lakes basin that are heavily contaminated with legacy pollutants and show signs of significant environmental degradation, such as habitat loss and fish consumption advisories. In FY 2020, EPA and the states of Michigan and Wisconsin announced the delisting of the Lower Menominee River AOC, and in FY 2021, EPA and the state of Ohio announced the delisting of the Ashtabula River AOC; these are the fifth and sixth AOCs ever delisted. Through the end of FY 2021, GLRI federal agencies and their partners have also completed all management actions required to delist an additional 10 AOCs.



In FY 2020–FY 2021, GLRI federal agencies and their partners removed 17 BUIs, indicators of environmental harm, at 13 AOCs in six states, bringing the cumulative total of BUIs removed to 106. Between FY 2010 and FY 2021, 96 BUIs have been removed, more than nine times the total of BUIs removed before the inception of the GLRI. Once all BUIs in an AOC are removed, the AOC can move forward with delisting. The graphic above describes the BUI removal process.

During FY 2020–FY 2021, GLRI federal agencies supported projects to help 16 Tribal and state organizations collect and share information with vulnerable populations regarding Great Lakes fish consumption. GLRI federal agencies and their partners conducted outreach activities, targeting populations that consume high amounts of Great Lakes fish, including urban, ethnic, Tribal, and subsistence anglers, and provided the public with information on the benefits and risks of Great Lakes fish consumption. Additionally, GLRI federal agencies and their partners conducted monitoring activities to assess contaminant levels in fish collected from the Great Lakes and inland waters of the basin that will be used to establish updated safe fish consumption guidelines by Tribal organizations and the states. Partners expanded implementation efforts in environmental justice communities and with ethnic populations, including multiple Tribal and Asian (Hmong, Burmese, and Bhutanese) communities. Other projects enabled Tribes and states to collect and share fish tissue contaminant information that was used to update fish consumption guidelines for mercury, perfluorooctanesulfonic acid (PFOS), and other contaminants.

GLRI federal agencies and their partners continued their integrated efforts to identify the extent to which chemicals of emerging concern (CECs), such as pharmaceuticals, pesticides, and flame retardants, threaten Great Lakes fish and wildlife populations. Through these efforts, GLRI partners identified some CECs (e.g., pesticides like atrazine and several polycyclic aromatic hydrocarbons (PAHs)), that are found throughout many Great Lakes tributaries. GLRI partners are developing and refining biological surveillance tools that will allow resource managers to make better decisions about possible adverse effects from these chemicals.

Lower Menominee River Delisted as a Great Lakes Area of Concern

On August 14, 2020, EPA and the states of Michigan and Wisconsin removed the Lower Menominee River from the international list of Great Lakes AOCs. This delisting, only the 5th since the AOCs were first identified in the 1980s, was the culmination of 30 years of collaborative efforts and 10 years of on-the-ground work totaling about $170 million. Collectively, project partners restored 140 acres of degraded habitat and 2 miles of shoreline, remediated 330,000 cubic yards of contaminated sediment, and restored lake sturgeon access to 21 miles of river.

Menekaunee Harbor habitat restoration site after invasive species control and native plantings. (Credit: Cheryl Bougie, Wisconsin Department of Natural Resources)

Ashtabula River Delisted as a Great Lakes Area of Concern

In August 2021, EPA and the state of Ohio removed the Ashtabula River from the international list of Great Lakes AOCs. This 6th AOC delisting, the first in Ohio, results from a ground-breaking public-private partnership that invested nearly $70 million in sediment remediation and habitat restoration projects. Collectively, project partners removed more than 620,000 cubic yards of contaminated sediment containing 14,000 pounds of polychlorinated biphenyls (PCBs) and created over 2,500 linear feet of fish habitat.

Ashtabula school children assist with habitat restoration planting at the AOC. (Credit: Amy Pelka, EPA)

Focus Area 1 Success Stories

Brecksville Dam Removed at Cuyahoga River AOC

GLRI federal agencies and their partners completed the removal of the Brecksville (Canal Diversion) Dam, which is within Cuyahoga Valley National Park in the Cuyahoga River AOC. This dam removal restored a free-flowing section of the Cuyahoga River, bringing the AOC a step closer to delisting. Deconstruction started in late May 2020 and began by "notching" the dam, which allowed for water levels to be lowered in a controlled manner. The restored free-flowing conditions allow for increased fish passage, decreased sedimentation, and safer paddling and recreational opportunities. Extensive collaboration by the National Park Service (NPS), U.S. Army Corps of Engineers (USACE), EPA, Ohio Environmental Protection Agency, Ohio Department of Natural Resources, and Friends of the Crooked River made this project possible.

"Notching" the dam on the first day of deconstruction. (Credit: NPS)

Habitat Restoration at the St. Louis River AOC

GLRI federal agencies and their partners completed habitat restoration projects in Superior, Wisconsin, that support the St. Louis River AOC goal of removing the *Degradation of Fish and Wildlife Populations* BUI. The Wisconsin Point Bird Sanctuary project included dredging over 87,000 cubic yards of sand from the Duluth/Superior Harbor and placing it along 1,700 feet of shoreline to increase the available beach habitat for piping plovers' stopover and nesting to 14 acres. The Interstate Island Avian Habitat Restoration Project enhanced the island's nesting area for the common tern, which has been classified as a threatened species in Minnesota since 1996. Restoration work included creating nesting space on the island at a higher elevation to protect it from flooding and doubling the size of the island by repurposing clean dredge materials from annual maintenance dredging in Duluth Harbor. The project was made possible by successful collaboration among the Wisconsin Department of Natural Resources, USACE, U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), EPA, the Minnesota Land Trust, Minnesota Department of Natural Resources, and Minnesota's Outdoor Heritage Fund.

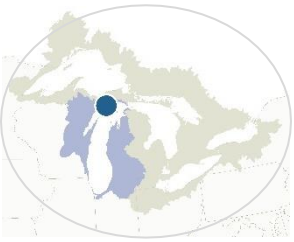
Adult piping plover. (Credit: USFWS)

Detroit Riverwalk Sediment Remediation at Detroit River AOC

In November of 2020, GLRI federal agencies and their partners completed sediment remediation at the Detroit Riverwalk site that will help remove the *Degradation of Benthos, Fish Tumors and other Deformities, and Restrictions on Dredging Activities* BUIs at the Detroit River AOC. The project included isolation and stabilization of contaminated sediment with a "cap" made of clean material that prevents future recontamination of the river. The project also stabilized an aging seawall to provide geophysical support for a future Detroit Riverwalk extension connecting Mt. Elliott and Gabriel Richards parks. EPA's collaborators in the project included the Detroit River Conservancy; USACE; the Michigan Department of Environment, Great Lakes, and Energy; and the City of Detroit.

Mobilization of marine equipment prior to sediment remediation. (Credit: Sevenson Environmental Services)

Restoring the Manistique River AOC Through the Removal of Contaminated Sediments and Mill Debris



In FY 2020, GLRI federal agencies and their partners completed the last management actions necessary to begin the AOC delisting process at the Manistique River AOC in the city of Manistique, Michigan. Pollution from local industry, particularly PCBs from a paper mill, resulted in contamination of sediments in the river. This project included removing mill debris and remediating over 50,000 cubic yards of PCB-contaminated sediment. Remediation of the contaminated sediments is expected to lower concentrations of PCBs in the fish that live in and near the harbor—including those eaten by people and wildlife. GLRI federal agencies and their partners will monitor PCB levels in fish tissue and sediment remaining in the navigation channel to determine when all BUIs have been removed and the AOC can be delisted.

Mechanical dredging of PCB-contaminated sediment from a barge on the river. (Credit: Julie Simmons, NOAA)

Muskegon Lake AOC Restoration and Cleanup

The final two management actions were completed at the Muskegon Lake AOC. A regional partnership between NOAA and the Great Lakes Commission helped to remove 2,700 metric tons of fill and debris at the 23-acre former Amoco shoreline site. The partnership also installed fish habitat structures (to help buffer Muskegon Lake wave energy and protect the restored shoreline), enhanced wetlands, and restored Muskegon Lake connectivity with the Muskegon River.

Post-restoration view of former Amoco site. (Credit: Ramboll)

Removing mill debris at the Ryerson Creek Outfall.

At the Ryerson Creek Outfall, EPA collaborated with the Michigan Department of Environment, Great Lakes, and Energy; Muskegon County; and an industry partner to complete the final sediment remediation project in the AOC. This work will help restore benthic populations and decrease contamination in the lake. Partners in this project dredged 10,600 cubic yards of contaminated sediment, removed over 2,000 tons of mill debris, covered the area with clean sand, softened shorelines, and restored surrounding wetlands.

The clean-up and restoration efforts should bring additional economic benefits to Muskegon. A prior study demonstrated that habitat restoration has generated roughly a six-to-one return on investment in the local economy.

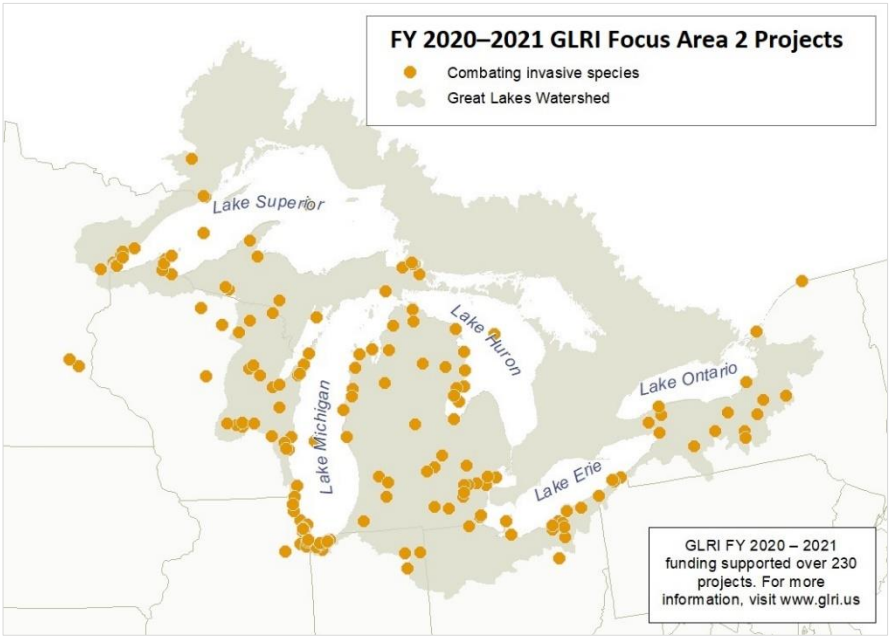
Spicer Creek Wildlife Management Area Habitat Restoration (Niagara River AOC)

EPA and its partners restored 16 acres of habitat along the Grand Island shoreline in the Niagara River AOC. Project components included: (1) low-profile berms to deflect wave energy; (2) protected backwater area to aid in vegetation propagation; and (3) the use of native vegetation and seed mixes to promote long-term naturalized growth.

Placing log structures along the shore to deflect wave energy. (Credit: New York State Department of Environmental Conservation)

FOCUS AREA 2: Preventing and Controlling Invasive Species

During FY 2020–FY 2021, GLRI federal agencies and their partners continued efforts to prevent the introduction of new invasive species and control existing invasive species populations in the Great Lakes ecosystem. GLRI investments in Focus Area 2 in FY 2020–FY 2021 continued a history of prioritizing the prevention of new introductions of non-native and invasive species into the Great Lakes. This approach is more cost-efficient and proactive than strategies that largely invest in the control and management of invasive species after the establishment of populations.



Key investments during this time period included ongoing and critical prevention activities, such as maintaining a comprehensive invasive species tracking and reporting system (the Great Lakes Aquatic Nuisance Species Information System, or GLANSIS); targeted monitoring of high-risk sites for introductions of new invasive species; risk assessments for invasive species not currently present, but which could become established if introduced; and development and application of genomic tools to aid in the early detection of aquatic nuisance species.

In FY 2020, NOAA launched its GLANSIS Twitter feed to educate and update the public about invasive species in the Great Lakes.

GLRI federal agencies and their partners conducted early detection monitoring exercises and trained for rapid responses. During this period, GLRI funded 46 early detection monitoring activities that enhance the ability to detect and respond to new invasive species introductions. GLRI federal agencies and their partners also completed a total of 77 tabletop exercises, field responses, and drills—exceeding the GLRI Action Plan III target of eight rapid responses and exercises in both FY 2020 and FY 2021.

GLRI federal agencies and their partners have further reduced the risk of invasive species entering the Great Lakes watershed by funding 66 projects in FY 2020–FY 2021 that help block the pathways of introduction. These pathways include canals and waterways, recreational boating, commercial shipping, illegal trade of banned species, the release of aquarium species, and release of live bait.

Biologist conducts post-treatment monitoring of the invasive European frog-bit in Green Lake, Michigan. (Credit: Michigan Department of Environment, Great Lakes, and Energy)

GLRI federal agencies and their partners also restored sites degraded by aquatic, wetland, and terrestrial invasive species. Federal agencies supported community efforts to control and reduce the spread of invasive species. These projects were implemented with local partners who are expected to continue maintenance and stewardship beyond the duration of the federally funded project's lifespan. In addition, GLRI federal agencies directly implemented control projects in national forests, parks, and wildlife refuges. In FY 2020–FY 2021, GLRI funded projects that controlled aquatic/terrestrial invasive species on over 38,000 acres for a cumulative total of more than 216,000 acres since the inception of GLRI.

In FY 2020–FY 2021, GLRI federal agencies and their partners maintained or enhanced support to seven species-specific "collaboratives," which help communicate the latest control technologies and management techniques amongst the collaborative's members. Collaboratives that received continued funding included invasive carp, phragmites, invasive mussels, invasive crayfish, monoecious hydrilla, European frog-bit, and forest insects and pests. These collaboratives are actively involved in the protection and control efforts that achieve invasive species results under the Action Plan.

The Great Lakes Phragmites Collaborative provides online resources to entities wishing to understand previous and ongoing efforts to implement a science-based approach to attacking and controlling phragmites, an invasive species of grass.

During FY 2020–FY 2021, GLRI federal agencies and their partners developed and refined invasive species control technologies and management techniques while minimizing harm to other noninvasive fish species. To evaluate their effectiveness in controlling invasive species, GLRI federal agencies and their partners field tested 21 different technologies and methods, including new ballast water management systems.

Monitoring for invasive carp in the Great Lakes.

Starting in FY 2020, the GLRI has supported the implementation of a Great Lakes Ballast Water Research and Development Plan. This comprehensive plan includes extensive collaboration with states, private entities, and other stakeholders. It will accelerate testing of ballast water management systems and assess ship-mediated transfers of organisms within the Great Lakes. The research and technology development effort is led by the University of Wisconsin-Superior's Lake Superior Research Institute through an agreement with the U.S. Department of Transportation – Maritime Administration. The Great Waters Research Collaborative in Superior, Wisconsin, provides the land-based testing facility for ballast water treatment systems, replicating environmental conditions that commercial vessels operating in the Great Lakes may experience. In FY 2021, EPA delivered to Congress a requested implementation plan detailing efforts to reduce the risk of introducing invasive species into the Great Lakes and Lake Champlain.

The land-based ballast water treatment system research and development facility in Superior, Wisconsin. (Credit: University of Wisconsin-Superior's Lake Superior Research Institute)

Protecting the Great Lakes from invasive carp

The GLRI provides support to the Invasive Carp Regional Coordinating Committee (IRCC).

More IRCC information is available at https://www.invasivecarp.us.

Focus Area 2 Success Stories

Managing Invasive Quagga Mussels near Sleeping Bear Dunes National Lakeshore in Lake Michigan

The Invasive Mussel Collaborative and its partners evaluated whether a molluscicide treatment (Zequanox®) would reduce quagga mussel density on a reef in Good Harbor Bay in Lake Michigan near Sleeping Bear Dunes National Lakeshore. This experimental treatment resulted in a 95% reduction in mussel density following application of the treatment. The reduction of quagga mussels also led to a significant reduction in nuisance algae at the site. Results suggest this promising treatment may be a method for managers to reduce invasive mussels in targeted areas.

Zequanox® is pumped below a heavy-duty sealed enclosure that remains in place for up to 8 hours. (Credit: University of Wisconsin-Milwaukee)

GLRI Promoting Environmental Stewardship and Job Training

The Forest Preserve District of Cook County and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) have worked together since 2011 on restoring three critical habitats in Illinois' Lake Michigan Watershed: Turnbull Woods, Powderhorn Prairie and Marsh, and Eggers Grove and Marsh. Invasive species such as glossy buckthorn were controlled on 178 acres across the three sites. One of the sites—Turnbull Woods—has become the first Forest Preserve site to be completely free of invasive brush. Activities at these sites included planting native trees, removing invasive plant species, and thinning invasive trees to allow more sunlight to reach the ground and support resprouting native trees. Partnership project funding has been provided by GLRI through NRCS and by Forest Preserve matching funds.

A volunteer crew from Greencorps Chicago worked to remove invasive species on Cook County Forest Preserve sites.

Ohio and Erie Canal Aquatic Nuisance Species Barrier Project Complete

In May 2020, USACE and partners finished constructing an aquatic nuisance species barrier at a 5-mile stretch along the Ohio and Erie Canal towpath near Akron, Ohio. The barrier effectively prevents the transfer of invasive carp between the Great Lakes and Mississippi River basins at the second of three non-Chicago area sites at medium risk for such transfer. The project included raising ground surface elevations, installing concrete and fence barriers, driving steel sheet piles, and placing stone-filled gabion baskets. Installing barrier measures at this and other locations substantially reduces the likelihood of movement between the basins by northern snakehead, silver carp, black carp, and bighead carp.

USACE Buffalo District contractors install a check valve at Wolf Creek in Barberton, Ohio, on May 13, 2020, as part of the Ohio-Erie Canal Aquatic Nuisance Species Barrier Project in Akron, Ohio. (Credit: Andrew Kornacki)

Supporting Landowners Who Protect the Headwaters of Lake Superior

Where Wisconsin's far northern border meets Michigan's Upper Peninsula in the Tenderfoot Forest Reserve, the Wisconsin Headwaters Invasives Partnership has worked with Vilas County and private landowners for the past five years to prevent invasive purple loosestrife from spreading through the headwaters of Lake Superior. With support from the U.S. Forest Service (USFS), program partners rear and release biocontrol beetles to feed on purple loosestrife, thus reducing that invasive plant's expansion and reducing the use of herbicides in sensitive wetlands. In 2020, partners began catching beetles locally for use on the site, an indication that the beetles were successfully surviving the winter and consuming purple loosestrife. Beginning in 2020, partners observed lower numbers of purple loosestrife in this site compared to locations without biocontrol. Native plants also appeared to be thriving and increasing, including noticeably larger populations of native calla lily, swamp milkweed, sweet gale, and blue flag iris.

Removing invasive species in the headwaters of Lake Superior using a canoe. (Credit: USFS)

Benefiting Breeding Marsh Birds Through Invasive Species Control

In FY 2021, a partnership among the Michigan Department of Natural Resources, Detroit Audubon, the USFWS Coastal Program, and Audubon Great Lakes restored and enhanced habitat conditions for black terns and other marsh birds and waterfowl. The partnership treated 99 acres of invasive hybrid cattail at Wigwam Bay State Wildlife Area in Arenac County, Michigan, and completed the initial phase of a water level-control feasibility study of the diked wetland, including a detailed bathymetric analysis and assessment of the existing water control infrastructure. Managers use results from feasibility and survey activities to provide the optimal amount of emergent vegetation and open water conditions to sustain and increase populations of bird species. To guide future management of the site, partners developed a Conservation Action Plan for the Wigwam Bay State Game Area.

Assessing marsh bird use, including nesting and fledging success in Wigwam Bay State Wildlife Area. (Credit: USFWS)

Comprehensive Invasive Species Management by the Fond du Lac Band of Lake Superior Chippewa

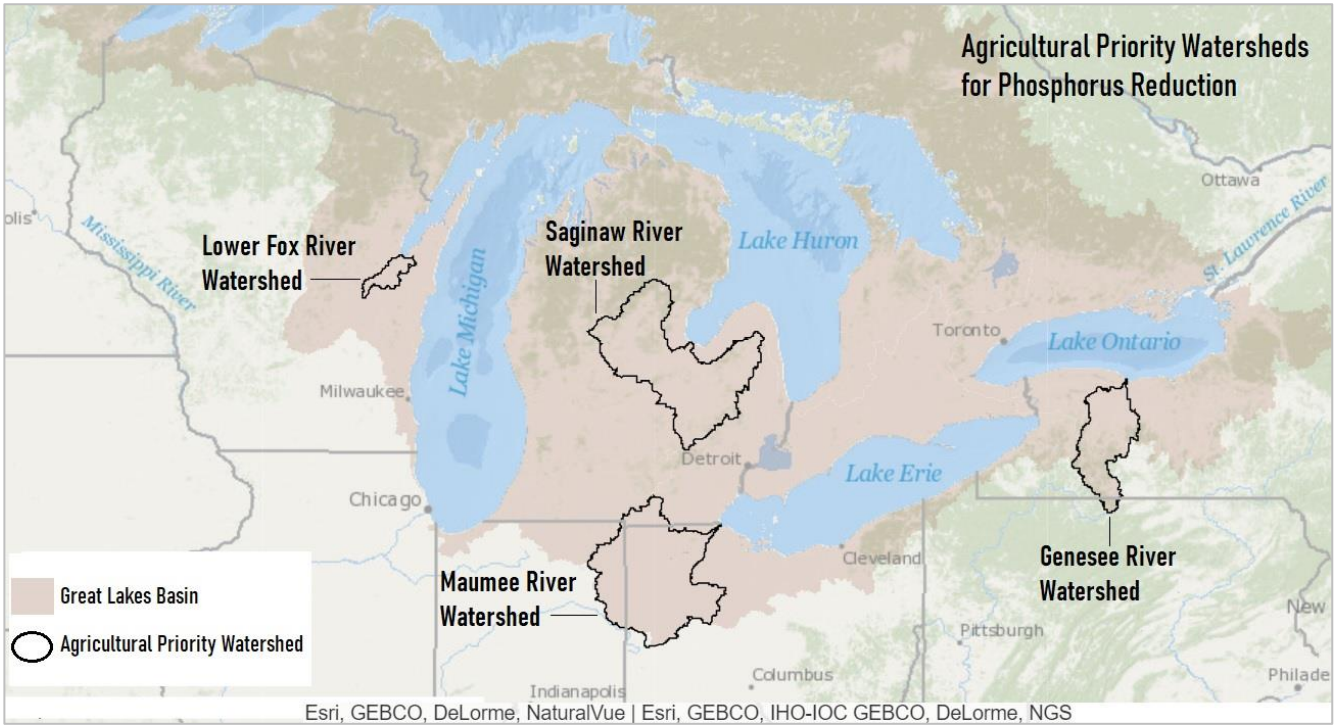
In FY 2021, the Fond du Lac Band of Lake Superior Chippewa implemented multiple invasive species management activities, including early detection and surveillance, rapid response control and management efforts using best management practices (BMPs), prevention, and education and outreach events. Prevention efforts included decontaminating approximately 150 nets and 70 boats during the spring treaty fishing season to prevent the spread of invasive species to other water bodies within the Lake Superior basin. The Fond du Lac Band also inspected and decontaminated 114 watercraft throughout the remainder of the year. Early detection efforts included assessing for the presence of emerald ash borer, curly leaf pondweed, Chinese mystery snail, and zebra mussels on 82 acres and 24 water bodies on the reservation. Ninety-one new infestations were found along 6.5 miles of trails. Informed by early detection efforts, the Fond du Lac Band conducted invasive species control activities on over 62 acres of reservation land. They also educated approximately 430 youth and adults about invasive species through multiple outdoor and community outreach events.

Spotting nuisance and non-native vegetation during invasive species early detection surveys. (Credit: Fond du Lac Band of Lake Superior Chippewa)

FOCUS AREA 3: Nonpoint Source Pollution Impacts on Nearshore Health

Polluted runoff, also known as nonpoint source pollution, threatens the Great Lakes ecosystem by contributing to HABs, nuisance algae, drinking water impairments, ecological dead zones, and beach closures that result in lost recreational opportunities. Runoff carries nutrients from fertilizer, sediment, bacteria, road salts, and other land-applied chemicals, such as herbicides and pesticides. The pollutant carried by runoff that most significantly impacts the Great Lakes nearshore areas is phosphorus because it is the primary nutrient that drives algal growth.

GLRI federal agencies and partners are working to reduce phosphorus loadings from agricultural watersheds in several ways. GLRI funding is used to supplement other prominent agricultural conservation programs, such as the Conservation Technical Assistance Program and Environmental Quality Incentives Program, which provide technical and financial assistance to agricultural producers to plan and install conservation practices. In addition, GLRI federal agencies partner with and provide grants to support nongovernment programs and projects at the state and local levels, such as demonstration farms. Phosphorus reduction efforts to help prevent excess algae growth in the Great Lakes are further prioritized in the four GLRI agricultural priority watersheds (the Lower Fox River, the Saginaw River, the Maumee River, and the Genesee River).



Constructed Wetland Maximizes Phosphorus Retention

The 10-acre USACE-constructed Phosphorus Optimal Demonstration Wetland in Defiance, Ohio, will reduce nonpoint source runoff to western Lake Erie from legacy phosphorus in agricultural runoff and serve as a long-term research and demonstration site.

The project is expected to maximize phosphorus retention through multiple mechanisms (sediment retention, soil adsorption, plant assimilation) and investigate phosphorus reduction under various scenarios. Preliminary studies indicate that, when maintained, the constructed wetland will more effectively capture nutrients than a typical wetland.

Phosphorus Optimal Demonstration Wetland in Defiance, Ohio.

GLRI agencies estimate that over 500,000 pounds of phosphorus will be prevented from entering the Great Lakes as a result of projects funded in FY 2020–FY 2021. This includes a renewed focus on improving on-farm nutrient management through technical and financial assistance to farmers on over 160,000 acres. Many of the conservation practices being adopted also reduce other pollutants like nitrogen and sediment.

GLRI federal agencies and their partners also use GLRI funding to support watershed-based projects to address nonpoint source pollution in urban areas. Projects started in FY 2020–FY 2021 will capture approximately 140 million gallons of untreated urban runoff per year. These projects reduce flooding, increase green space in urban areas, reduce bacterial contamination, and return vacant properties to productive use. The types of BMPs implemented include:

- Tree plantings
- Constructed wetlands
- Bioretention ponds
- Porous pavement
- Bioswales
- Rain gardens

During FY 2020–FY 2021, 23 GLRI green infrastructure projects were initiated. They reflect over $8.5 million in investments to treat, slow, or capture untreated stormwater runoff, helping to improve water quality conditions in the following 17 areas:

- Riverdale, IL
- Robbins, IL
- Hobart, IN
- Cleveland, OH
- Buffalo, NY
- Arenac County, MI
- Clinton Township, MI
- Detroit, MI
- Elk Rapids, MI
- Independence Township, MI
- Muskegon, MI
- Pittsfield Township, MI
- Rochester Hills, MI
- Walled Lake, MI
- Milwaukee, WI
- Superior, WI
- Grant Marais, MN

GLRI federal agencies conduct over 30 nutrient monitoring and assessment activities annually to evaluate the effectiveness of nutrient and stormwater reduction practices. These include an edge-of-field monitoring network in the agricultural priority watersheds and urban stormwater monitoring in Gary, IN; Milwaukee, WI; Buffalo, NY; and Detroit, MI.

Proving Green Infrastructure Performance

The U.S. Geological Survey (USGS) is measuring the performance of green infrastructure in select cities across the Great Lakes basin. The green infrastructure project implemented at the city hall in Gary, Indiana, included removing impervious cover, repairing a failed subsurface drainage system, and redirecting stormwater from drains to a newly constructed rain garden. This rain garden now captures 98% of stormwater runoff that otherwise would have flowed directly into Lake Michigan.

In Buffalo, New York, the USGS and the Buffalo Sewer Authority are monitoring a series of tree boxes and sand filters designed to reduce stormwater runoff along a 1.3-mile corridor of Niagara Street.

Green infrastructure installed at Gary City Hall. (Credit: USGS)

Focus Area 3 Success Stories

Stopping Stormwater Runoff to Lake Superior

The Superior Watershed Partnership, along with the city of Marquette, Michigan, rerouted an open-channel urban stormwater drain that once discharged water across a beach and directly into Lake Superior. The stormwater now flows through 12 acres of restored wetlands, infiltrating over 7.5 million gallons of untreated urban runoff per year and reducing by nearly 100% the bacteria, nutrients, sediments, and other pollutants (including phosphorus) impacting the nearshore waters of Lake Superior and the public beach. This project also restored native habitat along 1,100 linear feet of lake shoreline—benefitting wildlife and migratory birds and increasing nature-based recreational opportunities for the public, including a kayak launch and the first handicap access to Lake Superior in the city of Marquette.

Pictures depict how the project rerouted storm drain discharge from Lake Superior (left) to wetland plantings (right), where it is filtered. Stars mark a common reference point, and arrows show the general direction of flow.

Wisconsin Dairy Farmers Expand Conservation Efforts

Many farmers in Wisconsin are using GLRI funding through the USDA NRCS to manage their land more effectively while protecting water quality. For example, Plum Pride Holsteins, LLC in Greenleaf, Wisconsin, recently converted 60 acres of previously cropped corn acreage into land managed for rotational grazing. They used a multispecies seed mix to complete a forest and biomass planting, and they installed fencing, a livestock watering pipeline, two watering stations, trails, and two stream crossings. These improvements prevent erosion, reduce pesticide and fertilizer use, and save money and time at this second-generation family farm.

Heifers at Plum Pride Holsteins, LLC.

Engaging Toledo-area Farmers in Innovative Conservation Practices

In FY 2020, the Toledo Metropolitan Area Council of Governments (TMACOG) completed a GLRI-funded project that reduced phosphorus, nitrogen, and sediment loadings to the Portage and Toussaint rivers and Lake Erie's western basin by implementing cover crops, variable rate fertilizer application, and water control structures. This project presented an opportunity to expand BMP adoption and build farmer confidence in practices perceived to be risky. TMACOG worked with county soil and water conservation districts to recruit farmers to participate and promoted the program with signage, newsletter articles, farmer interviews, tours, videos (see documentary), and social media.

Soil and water conservation district staff demonstrate water control structures in Wood County, Ohio, with EPA's Paul Thomas.

Demonstration Farms Reduce Phosphorus Entering the Great Lakes

GLRI supports nine large demonstration farm networks in Great Lakes priority watersheds. The networks, which are multipartner efforts funded in large part by GLRI, are designed to showcase and demonstrate leading-edge BMPs and spur greater adoption among the agricultural community by enabling farmers to share ideas, work with partners, and try out new conservation practices. Dan and Ruth Boerst of Manawa, Wisconsin, are part of the Upper Fox-Wolf Demonstration Farm Network of 10 farms across eight counties in northeast Wisconsin. The Boersts used NRCS assistance to install water and sediment control basins, subsurface drains, and underground outlets to reduce erosion and improve water quality, thereby preventing sediment and nutrients from reaching the nearby Little Wolf River. Dan and Ruth also implemented no-till and cover crops, and the improved soil health has made planting and harvesting on their farm in wet conditions easier.

Above (L to R): Farm owners Ruth and Dan Boerst check Milpa Garden growth with Matt Brugger, Demo Farm Manager, and Derrick Raspor, NRCS Soil Conservationist and Demo Farm Project Coordinator. (Credit: NRCS)

Pilgrim River Restoration Reduces Erosion and Improves Trout Habitat

The Pilgrim River is a 12.9-mile-long Lake Superior tributary and a notable cold-water trout stream that provides spawning habitat for salmon. A major flooding event in 2018 severely eroded the streambanks in this popular destination for nature enthusiasts and residents of nearby Houghton, Michigan. Using GLRI funds, the USFS supported the local community's efforts to repair the damage. Partners, including landowner Joe Hovel, the Sustainable Research Institute, and Partners in Forestry, stabilized nearly 2 miles of Pilgrim River streambanks. A total of 5,170 trees were planted in 2020–2021. The plantings will be monitored over the next three years; initial indications are that the planting survival rate is very good. Without these conservation actions, sections of the streambanks would have continued to degrade. By stabilizing streambanks and repairing the erosion, the project protects water quality and fish habitat in the river and in Lake Superior.

Crews work to stabilize streambanks on the Pilgrim River. (Credit: Sustainable Research Institute)

Reducing Stormwater Runoff with Bioswales and Rain Gardens

In FY 2021, the Watershed Center in Grand Traverse Bay, Michigan, in collaboration with the Village of Elk Rapids, installed green infrastructure to treat stormwater runoff before it enters Grand Traverse Bay. Two rain gardens installed at the marina, combined with four rain gardens near the beach, cover more than 10,000 square feet of surface area and prevent approximately 1.27 million gallons of stormwater from entering Grand Traverse Bay each year. The largest rain garden converted about 5,000 square feet of mowed grassy area and added curb cuts along an existing parking area to allow for more stormwater inflow. This GLRI grant project has been a catalyst for additional green infrastructure in Elk Rapids.

A green infrastructure installation in Elk Rapids, Michigan.

FOCUS AREA 4: Habitat and Species

During FY 2020–FY 2021, GLRI federal agencies and their partners protected, restored, and enhanced habitats and native species throughout the Great Lakes basin, notwithstanding the pandemic-imposed limitations on in-person activities.

By the end of FY 2021, GLRI federal agencies and their partners had implemented projects that protected, restored, and enhanced Great Lakes habitats and species and reopened more than 6,725 miles of Great Lakes tributaries, which has increased aquatic connectivity for numerous fish species. Projects that addressed aquatic connectivity in FY 2020–FY 2021 supported local dam owners, states, and conservation entities seeking to address aging infrastructure while simultaneously restoring rivers.

With particular benefits to two emblematic Great Lakes species, the piping plover in FY 2020 and the lakeside daisy in FY 2021, GLRI continues emphasizing protecting and restoring Great Lakes species through comprehensive approaches not possible through agency base-funded programs. Overcoming diminished coastal beach habitats from historic high-water levels and storm events in FY 2020, staff from federal agencies, universities, and volunteers rescued numerous nests and carried out a successful captive rearing program for the endangered Great Lakes piping plover. A *record* number (53) of piping plover eggs were salvaged from clutches, a high rate (85%) of eggs incubated were hatched, and more captively reared chicks were released in a season (39) than ever before. This captive rearing effort was critical to sustaining population recovery.

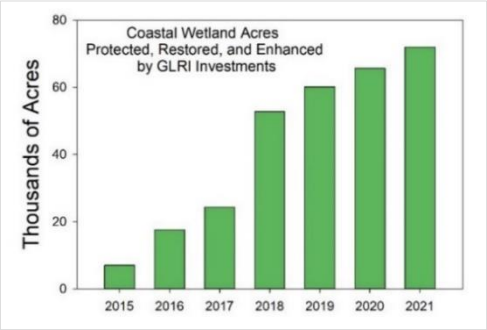
Staff collecting piping plover eggs for a captive rearing and release program.

In 2021, USFWS and the Ohio Department of Natural Resources completed projects at the Huntley-Beatty Preserve on Kelley's Island that significantly increased the number of the federally threatened lakeside daisy plants, which are unique to the Great Lakes. After an original seeding in 2012, the number of lakeside daisies on the site has increased from zero to over 138,000 daisies. Due to this dramatic spread, the population is now self-sustaining and has the resiliency needed for species recovery. This re-establishment is an example of broader, pollinator-friendly restoration efforts that GLRI continues to support across the basin.

Cooperative efforts are helping to expand lakeside daisy populations.

Since GLRI began in 2010, EPA has highlighted the importance of efforts to protect, restore, and enhance Great Lakes coastal wetlands. Coastal wetlands provide residents of the Great Lakes with many environmental and economic benefits, including protecting property from high water levels and wave action, removing nutrients from rivers and the nearshore areas of the Great Lakes before they feed harmful and nuisance algae, and supporting fish nursery habitats necessary to support recreational and commercial fisheries. More than 72,000 acres of coastal wetlands have been protected, restored, and enhanced—aided by a GLRI-supported comprehensive annual binational monitoring effort of these habitats. After the Great Lakes Coastal Wetland Monitoring Program established COVID-19 mitigation

protocols, sampling teams were largely able to sample the necessary number of sites across the five Great Lakes to maintain the statistical design and tracking of this important resource.

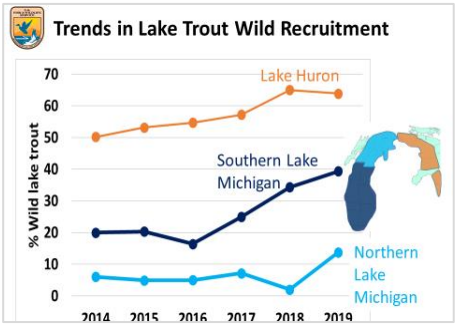


Coastal wetlands have improved through GLRI investments.

A staff member samples a coastal wetland habitat site.

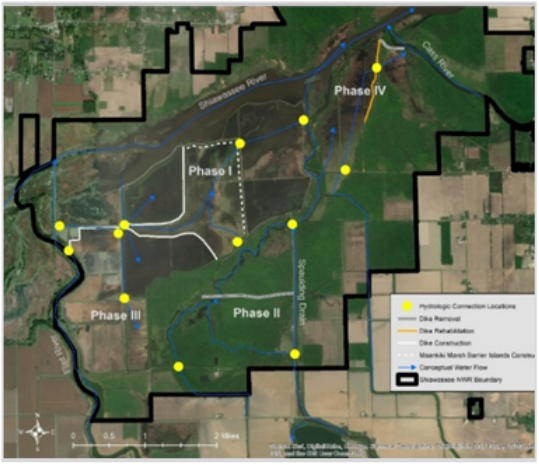
Restoring a self-sustaining, native offshore aquatic food web (with lake trout as a top native predator and cisco and bloater as important native prey fish) continued to be a priority in FY 2020–FY 2021. A healthy native food web is critical to supporting a commercial and recreational fishery for Great Lakes residents, valued at $7 billion annually. This food web restoration approach is comprehensive; it restores critical habitats needed by the native fish—propagating and stocking fish as necessary and monitoring the success of these efforts through tagging and recapturing fish to determine annual trends. USFWS staff developed and implemented new COVID-19 mitigation protocols necessary to continue critical activities in specialized fish processing trailers. This ability to adapt to the COVID-related challenges presented in 2020–2021 will allow USFWS, state fishery managers, and other GLRI partners to maintain critical legacy data sets that will be relied on to judge GLRI success over the long term.

USFWS staff works in a fish processing trailer.



Lake trout populations have improved.

GLRI habitat restoration can provide multiple benefits for fish and wildlife while also supporting climate resilience. A massive ongoing Shiawassee wetland restoration project has reconnected over 1,000 acres of floodplain wetlands (recently converted from agricultural land) to the adjacent Shiawassee River for the first time in more than a century. The reconnection allows fish to use shallow floodplain habitat for spawning and nursery habitat and promotes establishing wetland vegetation that is important to other wildlife species. Plus, when historic rainfall in mid-May 2020 in Michigan caused two dams on the Tittawabassee River to fail, created extreme flooding, and forced more than 10,000 people from their homes, the wetlands performed another important function: protection. As the historic high-water levels traveled down the Saginaw River watershed, managers at the USFWS Shiawassee National Wildlife Refuge monitored flood levels and diverted Saginaw River floodwaters into 10,000 acres of Shiawassee wetlands, which protected downstream communities, properties, and infrastructure.



The USFWS Shiawassee National Wildlife Refuge and 1,000 acres of recently restored and reconnected wetlands (Phases I–III) that were reconnected to the Shiawassee River during historic May 2020 flooding.

Focus Area 4 Success Stories

Restoring River Connectivity Following Removal of Elkhart Dam

Removal of the Elkhart River Dam in Elkhart, Indiana, reconnected over 47 stream miles and improved riverine habitat, thus providing more natural hydrology, temperature, flow pattern, and sediment transport while also providing education and recreation opportunities. The Elkhart Dam had substantially altered the character of the riverine water system that flowed into Lake Michigan—playing a central role in the decline of migratory aquatic species by severing historic migration routes and preventing healthy recruitment. The dam obstructed 20–30 native fish species, including the state-endangered greater redhorse and the highly prized walleye. The project enables the passage of aquatic species to far-reaching areas above the dam, improves riverine habitat for endangered and threatened fish and mussel species, and stabilizes the streambanks.

Newly reopened access to the Elkhart River following removal of the Elkhart Dam.

Rebuilding A Lost Reef Important to the Saginaw Bay Fishery

More than a decade of assessments and planning culminated in the construction of the 2-acre Coreyon Reef in Saginaw Bay, Michigan. Once a critical spawning location for important recreational and commercial fish species, including walleye and lake whitefish, the reef had been buried over the last 200 years by sediment from logging and agriculture. GLRI funding was used to complete reef restoration in fall 2019 by placing limestone rock and glacial cobble in areas of reduced sedimentation and remnant reef locations. Subsequent monitoring, including underwater videography and mapping, is generating critical information necessary for future fishery projects in the Saginaw Bay and other nearshore waters. The Coreyon Reef project is expected to enhance the recreational fishery, recently valued at $33 million.

Recreational fish species such as walleye are important to the economy of Saginaw Bay communities.

Successful Manoomin Management and Restoration by the Fond du Lac Band of Lake Superior Chippewa

In 2020, the Fond du Lac Band of Lake Superior Chippewa used GLRI funding to continue manoomin (wild rice) management, habitat enhancement, and restoration activities. Manoomin is a critically important cultural resource whose habitat also supports numerous wildlife species of great importance to the Fond du Lac Band. To manage manoomin in Perch Lake, the Tribe focused on beaver dam removal, beaver trapping, water level recording, water control structure gate and stop log opening management, and mechanical vegetation removal. The Fond du Lac Resource Management Program also constructed eight 20-foot by 100-foot exclosures in Duck Hunter Bay North to prevent waterfowl damage to newly seeded areas; monitored germination and growth of 86 acres of manoomin in bays reseeded in 2019; purchased 13,816 pounds of seed from Tribal harvesters; reseeded 132 acres; and removed exclosures following seed formation.

Successful manoomin harvest from Mud Lake on Fond du Lac.

Creating Nearshore Habitat and Providing Shoreline Erosion Protection

In FY 2021, a regional partnership between NOAA and the Great Lakes Commission completed a GLRI-funded $1.3 million project that improves habitat for fish and wildlife by replacing 740 feet of failing steel seawall with a combination of native vegetation and rocky habitat. The Brandenburg Township Park (MI) project on the shore of Lake St. Clair at the heart of the St. Clair-Detroit River System included low-profile habitat shoals, deepwater habitat, native submerged aquatic vegetation, and numerous habitat structures for fish spawning, nursery, and feeding. The restoration will benefit numerous native fish species such as smallmouth bass, Great Lakes muskellunge, northern pike, yellow perch, lake sturgeon, and walleye. An initial 84% increase in the abundance of these species has been observed. The project will also provide breeding and spawning areas for amphibians, feeding areas for waterfowl, and additional recreational access for county residents.

Evaluating recently completed shoreline stabilization and habitat improvement features at Brandenburg Township Park. (Credit: NOAA)

Continued Progress on Cisco Stocking and Fishery Rehabilitation in Saginaw Bay

Through FY 2021, a collaboration of USFWS with Tribal, state, federal, and provincial partners had stocked over 4 million cisco in Lake Huron as part of a rehabilitation program begun in 2018 in Saginaw Bay, Michigan. Once abundant throughout the Great Lakes, nearly all populations of cisco in the lower four Great Lakes were decimated by the early 1900s through overfishing, interactions with invasive species, and habitat changes. In 2021, the first official recapture of a hatchery-origin cisco occurred, indicating stocked fish are surviving and growing in Lake Huron. Rehabilitating cisco in Saginaw Bay will re-establish a native plankton-eating prey fish to help connect the offshore and nearshore food webs, provide an alternative source of prey for native predators like lake trout, and potentially restore a once-abundant fishery.

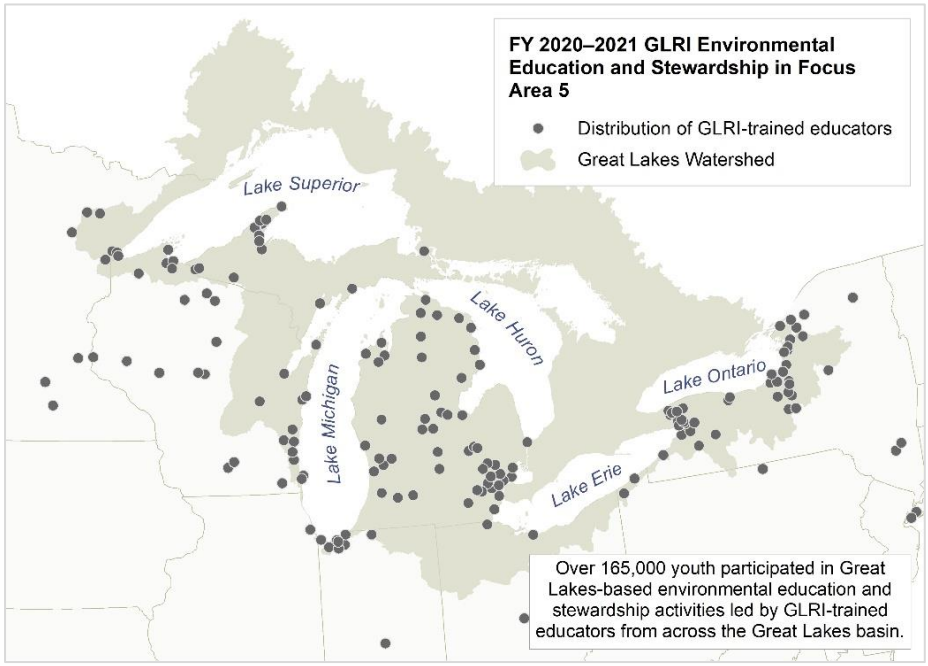
Healthy native prey fish used for stocking and restoration of the fishery in Saginaw Bay, Lake Huron. (Credit: USFWS)

Reducing Stream Erosion, Providing Recreational Opportunities, and Training Future Conservationists

In FY 2021, a partnership between USFS and Superior Watershed Partnership stabilized and improved 19 eroding sites along the Au Train River at the Hiawatha National Forest in Michigan's Upper Peninsula. The partners planted over 2,000 live willow and dogwood stems at previously stabilized sites, installed stabilizing material at two additional sites, and incorporated a variety of techniques using natural and readily available materials to allow for long-term sustainable recreation use on the river. The river provides habitat for important native fish and is a popular canoe trail supporting up to a thousand paddlers per day during peak summer months. Through this project, a Superior Watershed Partnership Climate Corps crew also trained a crew from the Little Traverse Bay Bands of Odawa Indians on techniques to stabilize streambanks to be used on future projects.

Installing and inspecting readily available materials recently used to stabilize eroding streambanks in the Au Train River. (Credit: USFS)

FOCUS AREA 5: Foundations for Future Restoration Actions



As a foundation for future restoration, the GLRI continues to promote Great Lakes-based ecosystem education and stewardship. During FY 2020–FY 2021, GLRI federal agencies and their partners educated over 165,000 youth through NOAA's Great Lakes Bay Watershed Education and Training (B-WET) program, NPS interpretive programs, Great Lakes Sea Grant's Center for Great Lakes Literacy, and state educational programs led by the Ohio Department of Natural Resources, the Michigan Department of Natural Resources, and the Michigan Department of Environment Great Lakes, and Energy. These programs provide hands-on experiences for youth, educational resources, and networking opportunities to promote Great Lakes literacy among an engaged community of educators, students, and citizens. Although many in-person educational programming opportunities were limited due to the pandemic, programs incorporated creative approaches to effectively bring Great Lakes educational programming and live interactions with scientists into virtual classrooms (for example, see the H.O.M.E.S @ Home Virtual Series success story on page 24).

With the support of a Great Lakes B-WET grant from NOAA, Huron Pines (a Michigan-based nonprofit group) worked with schools to engage students in Meaningful Watershed Education Experiences. These project experiences brought students outdoors to help them better understand and appreciate the unique ecosystems of northeast Michigan and to take part in stewardship projects benefitting their local Lake Huron watershed. Projects included creating campus rain gardens for stormwater mitigation, raising and releasing salmon fry, and developing a land use survey as a contribution to a local forest stewardship plan. A highlight of Huron Pines' work included a project with Posen High School, where students learned about the dwarf lake iris, a threatened species, and undertook activities including removing invasive species and conducting a habitat evaluation.

Posen High School students participate in an invasive spotted knapweed removal stewardship activity at Thompson's Harbor State Park (MI), supported by the NOAA Great Lakes B-WET program. (Credit: Great Lakes Outreach Media)

Science is another key piece of the GLRI activities in this Focus Area. During FY 2020–FY 2021, GLRI federal agencies and their partners conducted comprehensive monitoring to assess the status and trends of the Great Lakes ecosystem. GLRI federal agencies and their partners monitored coastal wetlands, contaminants, nutrients, hypoxia, HABs, zooplankton, phytoplankton, benthic communities, and prey fish, among many other components of the Great Lakes ecosystem. Monitoring data are used to prioritize future GLRI-funding decisions by identifying the ecosystem's most significant ongoing and emerging problems.

Scientists survey vegetation in a coastal wetland along Lake Michigan's shore as part of the Great Lakes Coastal Wetland Monitoring Program.

The GLRI Action Plan III incorporates science-based adaptive management to guide restoration and protection actions by using the best available science and lessons learned from GLRI investments. In FY 2020–FY 2021, GLRI federal agencies identified three cross-focus area science priorities to address current and emerging challenges to Great Lakes water quality and ecosystem health: HABs, nuisance algae, and the need for coastal resilience. These priorities were identified in coordination with Tribal, state, and Lakewide Action and Management Plan partners. These priorities, along with results of annual science and monitoring, are used to guide GLRI project planning. They have resulted in new projects, including the USGS *Cladophora* study, which helps researchers better understand the nuisance algae resurgence.

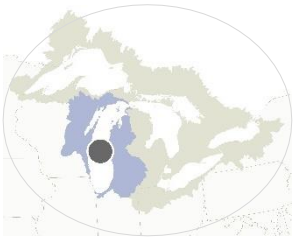
Using sentinel sites along the U.S. coastline, the USGS-led Great Lakes Integrated *Cladophora* Monitoring Project investigates whether nuisance *Cladophora* algae can be managed throughout the lower four Great Lakes by limiting tributary phosphorus inputs. The project team completed its fourth field season in FY 2021. USGS incorporated underwater light measurements and assessed fine-scale variability in bottom water nutrients to investigate pathways through which dreissenid mussels can influence *Cladophora* growth. The project team's use of autonomous underwater vehicles (AUVs) expanded the coverage area of the *Cladophora* assessment. The team drove AUVs along the diver-sampled transects and out into deeper depths. Combining diver and AUV datasets will allow the scientists to better determine the depths to which *Cladophora* can grow in each lake.

Left: USGS diver Kasia Przybyla-Kelly displays a sample she collected from the bottom of Lake Ontario in August 2021. Right: USGS divers Glen Black and Greg Kennedy conduct sampling in Lake Michigan in October 2021. (Credit: Ashley Spoljaric, USGS)

In FY 2020–FY 2021, GLRI federal agencies and their partners continued tracking the progress of GLRI-funded projects. GLRI federal agencies developed and used an improved relational database, Environmental Accomplishments in the Great Lakes 2 (EAGL2), to track results from GLRI-funded projects against the GLRI Action Plan III Measures of Progress. To evaluate and improve the quality of reporting, EPA conducted annual systemwide audits of the accountability system in accordance with the EAGL2 implementation manual.

Focus Area 5 Success Stories

Biophysical Nowcast-Forecast Models for Lake Michigan



NOAA Great Lakes Environmental Research Laboratory (GLERL) and the Cooperative Institute for Great Lake Research developed Lake Michigan nowcast-forecast models to predict: (1) the influence of tributary nutrient inputs on nearshore water quality and ecological productivity and (2) the dispersion of larval fish from nearshore spawning areas. The information is essential to Lake Michigan ecosystem managers dealing with low nutrients and ecosystem productivity in offshore areas, nuisance production of benthic algae in nearshore areas, and fish stocking and restoration. An experimental biophysical model and satellite remote sensing algorithms provide forecast and near real-time information on surface chlorophyll *a* and dissolved organic carbon (a tracer for river water) in Lake Michigan, which helps field researchers monitor the impacts of episodic events.

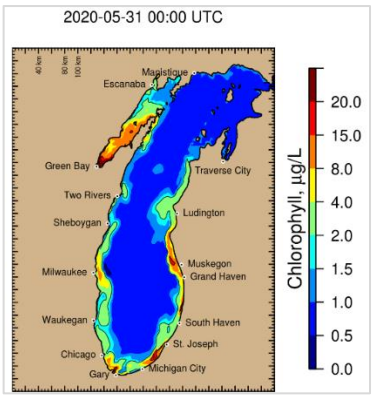
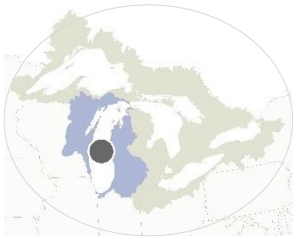


Image depicts real-time biophysical model output for surface chlorophyll a in May 2020, shortly after record flooding and the discharge of a large amount of river water and associated nutrients into Lake Michigan.

Robot-Assisted Computer Vision System Assesses Round Goby and Their Habitat



Since the early 2000s, uncertainties in estimating round goby abundance have challenged fisheries managers' abilities to make informed decisions regarding predator stocking and harvest limits and species restoration. In 2020, USGS conducted the first full-scale survey in Lake Michigan of invasive round goby, now among the most abundant Lake Michigan prey fish, using an autonomous underwater vehicle called "Goby-Bot." Goby-Bot "flies" just above the lakebed taking thousands of pictures each day that are processed after retrieval using sophisticated computer algorithms. The Goby-Bot survey measured round goby densities 12 times higher than previously recorded in USGS's annual trawl surveys. Goby-Bot appears to provide a more accurate measure of lakewide round goby density than trawl surveys that are unable to collect fishes in the rocky habitats that round goby prefer. Fisheries managers can use this improved information to aid with their decisions about predator management. Invasive round goby are now a primary food item for lake trout, lake whitefish, walleye, and other important species in the $7 billion dollar Great Lakes fishery. Goby-Bot also maps invasive mussel species, nuisance algae, and critical spawning habitats for native fishes.

USGS's customized AUV prepares to dive for a round goby and habitat survey over the Lake Michigan lakebed. The vehicle can collect data as deep as 200 meters for hours without human intervention. (Credit: Anthony Arnold, USGS)

Developing and Using eDNA Testing to Reintroduce Native Mussels

In FY 2020, USGS and NPS scientists piloted a new environmental DNA (eDNA) monitoring test used to aid efforts to reintroduce native mussels to an area where they haven't been found in many years. Native mussels are among the most threatened aquatic biota in the Great Lakes. NPS conducted mussel habitat suitability assessments at locations in Indiana Dunes National Park on the south shore of Lake Michigan to identify sites suitable to sustain populations of the native Fatmucket mussel. USGS used the new test to determine that the mussel was not present in potentially suitable streams. NPS then reared and reintroduced a small population of extirpated Fatmucket mussels to these streams. Within four months after reintroduction, Fatmucket eDNA was successfully detected using the USGS test in samples from the restoration site and further downstream, indicating that the mussels likely survived.

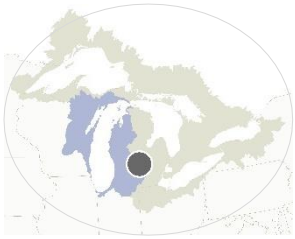
A native Fatmucket mussel.

Aerial Mapping of Harmful Algal Blooms in Lake Muskegon

In FY 2021, NOAA continued to assess water quality status and trends by deploying buoys and remote sensing platforms that generate multiyear observations used to forecast HABs in Lake Michigan, Lake Huron, and western Lake Erie. NOAA GLERL leads this work through its Synthesis, Observations, and Response (SOAR) project. In fall 2021, NOAA's SOAR project team rapidly responded to a HAB in Muskegon Lake, Michigan. The team flew a hyperspectral camera over Muskegon Lake and over the channel that feeds into Lake Michigan, where the main drinking water intake for the city of Muskegon is located. The hyperspectral camera images the lake at a finer resolution and scale than is available by satellite, allowing resource managers to track the bloom's potential impact more closely. Although drinking water safety was not impacted during this HAB event, the event prompted local stakeholders to initiate the development of a local HAB response plan for Muskegon Lake.

Image from the Muskegon Lake flyovers, autumn 2021. HABs appear as bright green scums at the lake surface.

H.O.M.E.S @ Home Virtual Series



In March 2020, when families began e-learning and working from their homes, Michigan Sea Grant's members of the Center for Great Lakes Literacy focused on developing the H.O.M.E.S. @ Home series. Named after the Great Lakes (Huron, Ontario, Michigan, Erie, and Superior), the H.O.M.E.S. series provided half-hour learning sessions for families with elementary-aged children. The series included engaging videos and visuals about Great Lakes topics and a daily stewardship challenge. Over 1,200 learners engaged in the live content of the series, and recorded series videos uploaded to YouTube and Facebook garnered over 12,000 additional views. Over 50 families completed at least five challenges, earning a Great Lakes Junior Scientist certificate. A post-project evaluation showed the program increased participants' appreciation for the Great Lakes and empowered them to be better environmental stewards.

Screenshot from a session that featured a virtual cruise through all five Great Lakes, visiting many ports of call, such as Detroit.

Lake Sturgeon Conservation by Educators, Students, and Scientists

The Center for Great Lakes Literacy partnered with Michigan State University Department of Fisheries and Wildlife in FY 2021 to pilot a lake sturgeon community science program with over 480 students and 14 teacher participants. Researchers helped students better understand the biodiversity of Michigan's Black River, and teachers shared lessons on lake sturgeon and Great Lakes ecology with students. Students were then able to review underwater video footage and identify fish from the Black River. Said one participating teacher: "I loved the opportunity to connect my [New York students] with scientists working in Michigan. The students benefit from seeing that collaboratively, scientists can accomplish so much more than when they work in isolation."

Researchers sampled adult lake sturgeon in the Black River system and collaborated with K-12 students.

Section 3 – Regional Partner Engagement

The federal agencies that make up the GLRI collaborate and coordinate extensively with numerous entities each fiscal year to address the challenging ecosystem problems that affect the Great Lakes. Below are a few examples of this engagement with Great Lakes Tribes and states.

Great Lakes Tribes

GLRI support for Tribal nations within the Great Lakes basin has created and enhanced valuable partnerships and resulted in the implementation of important restoration and protective actions, including controlling invasive species, reducing nutrient and phosphorous loadings into waterways, reopening tributaries to restore fish passage, protecting Lake Superior coastal wetlands, and restoring several culturally significant species such as lake sturgeon, moose, and wild rice.

Accompanying the GLRI's FY 2019 enacted appropriation (Public Law [PL] 116-6) was explanatory language (House Report [HR] 116-9) calling for EPA to follow directions in Senate Report 115–276 that encourage EPA to "work with Tribal governments and the Bureau of Indian Affairs to develop a proposal for the creation of a distinct GLRI Tribal program through which GLRI funds would be provided to allow Tribes the flexibility to develop the programs that are of the highest priorities to their communities, and which fulfill the spirit of self-determination, meet treaty obligations, and carry out Federal trust responsibilities." EPA has continued to work with Tribal governments and the Bureau of Indian Affairs (BIA) to create such a program. Explanatory language (HR 116-448) associated with EPA's FY 2021 enacted appropriation (PL 116-260) directed EPA to maintain funding for tribal-related activities at not less than $15 million. In FY 2021, EPA and BIA, working with Great Lakes Tribes, produced the penultimate draft of a GLRI Distinct Tribal Program Framework outlining principals, projects, and a funding commitment of $15 million to be allocated specifically for the operation of a GLRI Distinct Tribal Program. Since GLRI's inception in FY 2010, Tribes have received a total of over $116 million in GLRI funding, including over $16 million directed to Tribes in each of FY 2020 and FY 2021. This funding has been key in building Tribal resource management capacity and contributing to the protection and restoration of treaty-reserved resources and culturally significant habitats and species that support Tribal lifeways.

Great Lakes States

GLRI federal partners are committed to working with all eight states within the Great Lakes Basin. These states—Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York—play a critical role in restoring and protecting the health of the Great Lakes to ensure the quality of their economies and the health of their citizens. The partnership between Great Lakes states and the GLRI continues to result in important work activities: controlling invasive species; protecting fisheries; reducing nutrient and phosphorous loadings into waterways; capturing and treating urban runoff; delisting AOCs; and addressing environmental justice concerns. Since GLRI's inception in FY 2010, over $499 million of GLRI funds have been awarded to Great Lakes states through the end of FY 2021, including over $42 million from the FY 2020 appropriation and over $16 million from the FY 2021 appropriation.

Section 4 – Financial Reporting

From FY 2010 to FY 2021, EPA has been appropriated approximately $3.8 billion in GLRI funds. The agencies that receive GLRI funds use multiple funding mechanisms, including interagency agreements, fund transfers, competitive grants, and capacity-building grants to Tribes and states.

Table 1 and Figure 1 provide information on FY 2017–FY 2021 GLRI funding by focus area. Table 2 provides summary information for FY 2017–FY 2021 GLRI funding by individual agency.

Table 1. GLRI FY 2017–FY 2021 Focus Area Allocations as of October 11, 2021 (Dollars in Thousands)

Focus Area	FY 2017	FY 2018	FY2019	FY 2020	FY 2021
Toxic Substances and Areas of Concern	$107,500	$105,600	$107,400	$115,800	$121,400
Invasive Species	$62,200	$56,700	$57,000	$62,900	$65,700
Nonpoint Source Pollution Impacts on Nearshore Health	$47,900	$50,600	$51,200	$51,000	$53,000
Habitat and Species	$49,500	$52,400	$51,400	$54,500	$56,500
Foundations for Future Restoration Actions	$32,900	$34,700	$33,000	$35,800	$33,400
TOTAL	$300,000	$300,000	$300,000	$320,000	$330,000

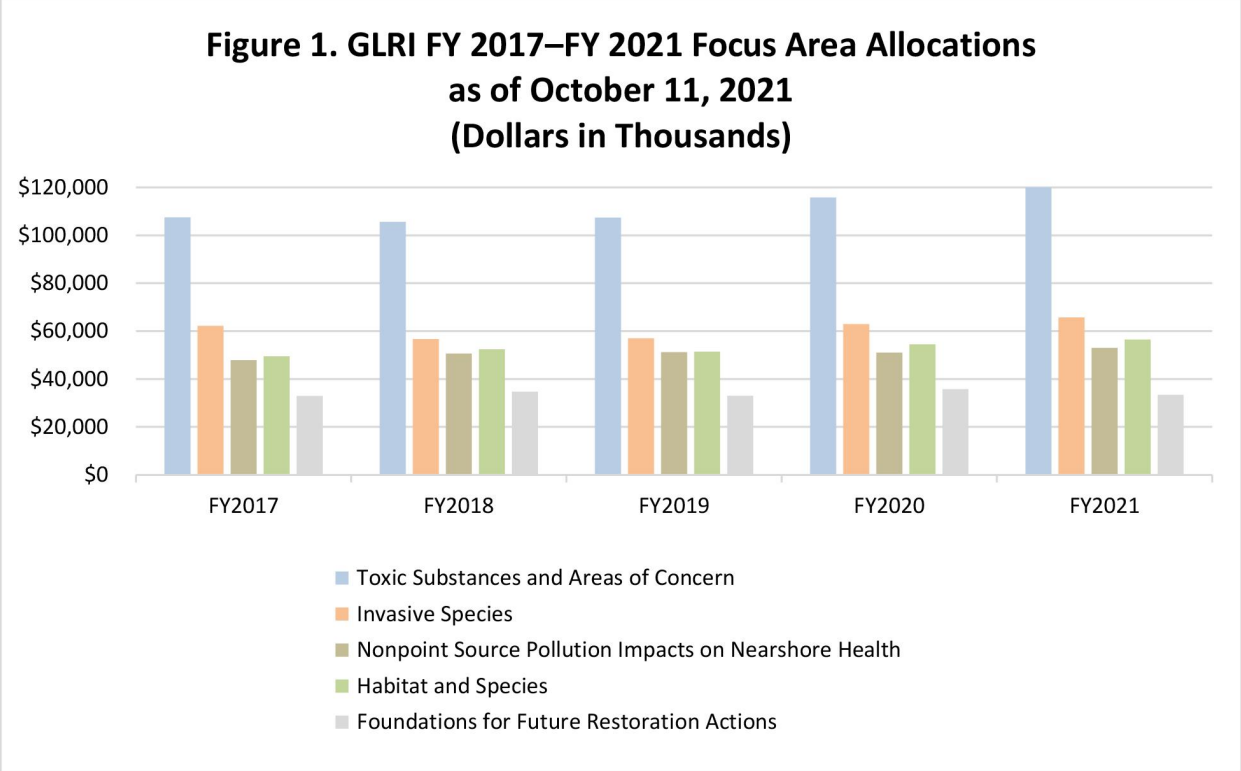


Table 2. GLRI FY 2017–FY 2021 Funding by Agency as of October 11, 2021 (Dollars in Thousands)

Agency[1]	Obligations[2]				
	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
DHS-USCG	$263	$500	$1,661	$1,250	$1,300
DOC-NOAA	$12,027	$24,629	$29,405	$28,163	$16,621
DOD-USACE	$55,313	$43,187	$36,996	$30,599	$56,603
DOI-BIA	$10,904	$11,617	$9,842	$15,840	$15,765
DOI-NPS	$4,379	$3,940	$3,822	$3,794	$4,968
DOI-USFWS	$41,794	$52,902	$47,272	$53,523	$59,288
DOI-USGS	$26,817	$25,724	$21,603	$19,780	$19,790
DOT-MARAD	$800	$675	$803	$5,500	$8,000
HHS-ATSDR	$593	$590	$0	$0	$0
USDA-APHIS	$1,260	$1,166	$1,308	$1,378	$1,459
USDA-NRCS	$22,072	$25,096	$20,697	$22,239	$22,374
USDA-USFS	$11,355	$10,153	$11,646	$9,921	$12,464
IA totals:	**$187,577**	**$200,178**	**$185,054**	**$191,988**	**$218,631**
EPA, GLFC, and miscellaneous IAs[3]	**$106,909**	**$97,993**	**$113,965**	**$127,333**	**$87,579**
Total obligated	**$294,486**	**$298,170**	**$299,019**	**$319,322**	**$306,210**
Returned[4] or remaining[5]	**$5,514**	**$1,830**	**$981**	**$678**	**$23,790**
GLRI grand totals:	**$300,000**	**$300,000**	**$300,000**	**$320,000**	**$330,000**

Notes:

DHS = U.S. Department of Homeland Security; USCG = U.S. Coast Guard; DOC = U.S. Department of Commerce; NOAA = National Oceanic and Atmospheric Administration; DOD = U.S. Department of Defense; USACE = U.S. Army Corps of Engineers; DOI = U.S. Department of the Interior; BIA = Bureau of Indian Affairs; NPS = National Park Service; USFWS = U.S. Fish and Wildlife Service; USGS = U.S. Geological Service; DOT = Department of Transportation; MARAD = Maritime Administration; HHS = U.S. Department of Health and Human Services; ATSDR = Agency for Toxic Substances and Disease Registry; USDA = U.S. Department of Agriculture; APHIS = Animal and Plant Health Inspection Service; NRCS = Natural Resources Conservation Service; USFS = U.S. Forest Service; IA = interagency agreement

[1] Individual agency-planned allocations from appropriations for FY 2017–FY 2020 can be found in previous Reports to Congress and the President.

[2] Obligations are the amount of orders placed; interagency agreements, contracts or grants awarded; and similar transactions by EPA. The amount also reflects deobligations, which generally result from events such as completing a project under budget, contract termination, changes in project scope or focus, or other unforeseeable circumstances.

[3] Components include: (i) grants totaling approximately $30.1 million (including funding for the Great Lakes Fishery Commission, an organization identified in the President's budget); (ii) Great Lakes National Program Office support costs (payroll, travel, general expenses, and working capital) totaling approximately $14.4 million; and (iii) contracts and miscellaneous interagency agreements (other than those above) totaling approximately $43.1 million.

[4] Returned funds (FY 2017–FY 2020) are determined by subtracting obligations as of October 11, 2021, from appropriated funds. Returned funds generally result from deobligating funds as a result of completing a project under budget, contract termination, changes in project scope or focus, or other unforeseeable circumstances. The amount in this line can also include reserves that have been established to provide for contingencies or to effect savings under the Antideficiency Act.

[5] Remaining funds (FY 2021) have been carried over by EPA to fund priority projects, including competitively selected projects and state projects.

Appendix A – GLRI Action Plan III: Measures of Progress

Table A-1 provides an overview of the results achieved for each of the 23 Measures of Progress in the GLRI Action Plan III. Targets for Measures of Progress were established under assumptions contained in Action Plan III. Fourteen measures have annual targets; the rest track progress towards long-term goals that will take more than five years to reach. Detailed information is provided in the following pages (Table A-2).

Table A-1. Overview of the Results Achieved for the 23 Measures of Progress in the GLRI Action Plan III

Focus Area	Measure[1]	Baseline/ Universe[2]	FY 2019 Result/Target[3]	FY 2020 Result/Target[4]	FY 2021 Result/Target[5]
Toxic Substances	1.1.1. AOC management actions*	B: 12/ U: 31	*12/17*	***14/16***	***15/18***
	1.1.2. BUIs*	B: 80/ U: 225	89/85	**97/93**	**106/101**
	1.1.3. AOC management action lists*	B: 18/ U: 31	19	**22/22**	**24/24**
	1.2.1. Organizations sharing consumption information with vulnerable populations	NA	NA	**9**	**7**
	1.3.1. Chemical monitoring and assessment activities	NA	NA	**15**	**12**
Preventing and Controlling Invasive Species	2.1.1. Rapid responses or exercises	B: 8	37/8	**20/8**	**57/8**
	2.1.2. Projects managing pathways	B: 16.25 avg.	80	**38**	**28**
	2.1.3. Early detection activities	B: 12.25 avg.	53	**14**	**32**
	2.2.1. Aquatic/terrestrial acreage controlled*	B: 153,569	178,258/ 140,000	**201,991/ 165,000**	**216,839/ 171,000**
	2.3.1. Technologies and methods field tested	B: 10 avg.	13	**14**	**7**
	2.3.2. Collaboratives developed/enhanced*	B: 10	16	**17**	**19**
Nonpoint Source Pollution Impacts on Nearshore Health	3.1.1. Phosphorus reduction throughout Great Lakes watersheds* (pounds)	B: 1,113,603	1,551,605/ 1,070,000	**1,784,790/ 1,600,000**	**2,066,521/ 1,900,000**
	3.1.2. Nutrient management assistance in priority Great Lakes watersheds* (acres)	B: 1,614,511 U: 10,711,434	1,668,500	***1,762,484/ 2,200,000***	***1,831,158/ 2,370,000***
	3.2.1. Stormwater captured or treated* (millions of gallons)	B: 252	274/250	**372.4/350**	**413.6/400**
	3.2.2. Shoreline restored or protected* (miles)	B: 26	26	**34.3/33**	**43.6/40**
	3.3.1. Nutrient monitoring and assessment activities	B: 30	NA	**31/30**	**31/30**
	3.3.2. Nutrient/stormwater practices or tools	B: 10	NA	**14/10**	**12/10**
Habitats and Species	4.1.1. Habitat restored, protected, or enhanced* (acres)	B: 370,488 U: 1,550,000	441,736/ 287,000	**463,058/ 394,000**	**479,293/ 406,000**
	4.1.2. Aquatic connectivity* (miles)	B: 5,289	*5,497/ 5,500*	**6,052/ 5,700**	**6,727/ 5,900**
	4.2.1. Species benefited*	B: 0	NA	**1/1**	**2/2**
Foundations for Future Restoration	5.1.1. Youth impacted through education/stewardship*	B: 377,000	461,654	**578,559**	**627,106**
	5.2.1. Annual monitoring	NA	NA	**Yes**	**Yes**
	5.2.2. Identify and address science priorities	NA	NA	**Yes**	**Yes**

Notes:

Shaded cells display results achieved/targets. Unmet targets are italicized in red-shaded cells. Green-shaded cells indicate targets are met. Cells without denominators show results for measures that do not have targets.

Avg. = average; B = Baseline; U = Universe; NA = not applicable

[1] Cumulative measures are indicated with an *.

[2] Baselines for cumulative measures identify results through FY 2018 except for measures 1.1.1 and 1.1.2 (through FY 2009). Baselines for noncumulative measures identify regularly expected annual results. The baseline and universe for measure 3.1.2 have been updated from Action Plan III to use an FY 2018 baseline and correctly account for eligible acreage. The "universe" is not available if not provided.

[3] In the FY 2019 column, results and, if applicable, targets from Action Plan II measures are included with results for other cumulative Action Plan III measures.

[4] The FY 2020 column identifies targets and results through September 30, 2020, for the GLRI Action Plan III measures.

[5] The FY 2021 column includes targets and results through September 30, 2021, for the GLRI Action Plan III measures.

Table A-2. GLRI Action Plan III Measures of Progress – Detailed Information

Measure	Target/Baseline/ Universe[2]	Result[3]	Explanation/Additional Information
1.1.1. Areas of Concern where all management actions necessary for delisting have been implemented (cumulative)[1]	FY 2021: 18 FY 2020: 16 Baseline: 12 Universe: 31	FY 2021: 15 FY 2020: 14 FY 2019: 12	Manistique River, MI – 02/2020 Eighteenmile Creek, NY – 09/2020 Muskegon Lake, MI – 09/2021
1.1.2. Beneficial Use Impairments removed in Areas of Concern. (cumulative)[1]	FY 2021: 101 FY 2020: 93 Baseline: 80 Universe: 225	FY 2021: 106 FY 2020: 97 FY 2019: 89	*Degradation of Aesthetics:* Clinton River, MI – 09/2020; Black River, OH – 01/2021; Milwaukee Estuary, WI – 09/2021 *Degradation of Benthos:* Sheboygan River, WI – 12/2020 *Degradation of Fish and Wildlife Populations:* Rochester Embayment, NY – 06/2021 *Degradation of Phytoplankton and Zooplankton Populations:* Waukegan Harbor, IL – 08/2020; Sheboygan River, WI – 09/2021 *Eutrophication or Undesirable Algae:* St. Louis River, MN/WI – 04/2020; Cuyahoga River, OH – 04/2021 *Fish Tumors and other Deformities:* Ashtabula River, OH – 10/2019 *Restrictions on Dredging Activities:* Eighteenmile Creek, NY – 09/2020; Ashtabula River, OH – 09/2020; Lower Green Bay/Fox River, WI – 09/2021; Manistique River, MI – 09/2021 *Restrictions on Fish and Wildlife Consumption*: Rochester Embayment, NY – 11/2020 *Tainting of Fish and Wildlife Flavor:* Buffalo River, NY – 06/2020; Lower Green Bay/Fox River, WI – 04/2020
1.1.3. Areas of Concern with a complete and approved list of all management actions necessary for delisting. (Cumulative)	FY 2021: 24 FY 2020: 22 Baseline: 18 Universe: 31	FY 2021: 24 FY 2020: 22 FY 2019: 19	Rouge River, MI – 08/2020 Cuyahoga River, OH – 09/2020 Kalamazoo River, MI – 09/2020 Maumee, OH – 01/2021 Detroit River, MI – 09/2021
1.2.1. State and Tribal organizations that collect and share information with vulnerable populations regarding the consumption of Great Lakes fish, wildlife, and harvested plant resources.	No targets Baseline: NA Universe: NA	FY 2021: 7 FY 2020: 9	GLRI funded several Great Lake states to help develop and enhance fish consumption advisory outreach material, including enhancements by Wisconsin and Michigan for targeted populations such as pregnant women and subsistence fishing groups. GLRI also funded contaminant monitoring, including monitoring of per- and polyfluoroalkyl substances (PFAS) in fish by Illinois to determine if fish consumption advisories are warranted.
1.3.1. Discrete chemical monitoring and assessment activities conducted.	No targets Baseline: NA Universe: NA	FY 2021: 12 FY 2020: 15	GLRI funded projects to complete a 10-year chemicals of emerging concern surveillance and bio-effects assessment effort. GLRI placed a new emphasis on chemicals of mutual concern (CMC) monitoring and assessment that included assessment of: PFAS and other priority contaminants in Lake Superior tributaries; PFAS impacts on native mussels; and CMCs in Lake Erie Fish.

Measure	Target/Baseline/ Universe[2]	Result[3]	Explanation/Additional Information
2.1.1. Rapid responses or exercises conducted.	FY 2021: 8 FY 2020: 8 Baseline: 8 Universe: NA	FY 2021: 57 FY 2020: 20 FY 2019: 37	The eight Great Lakes states have committed to conducting annual training exercises but prioritize activities to respond to detections of new invasive species. The results to the left are the actual number completed each year by multiple state agencies and others.
2.1.2. Projects that manage pathways through which invasive species can be introduced to the Great Lakes ecosystem.	No targets Baseline 16.25 avg. Universe: NA	FY 2021: 28 FY 2020: 38 FY 2019: 80	Projects included work to reduce the spread of invasive species by hunters, anglers, and recreational boat pathways.
2.1.3. Early detection and surveillance activities conducted.	No targets Baseline: 12.25 avg. Universe: NA	FY 2021: 32 FY 2020: 14 FY 2021: 53	Early detection activities were conducted in FY 2020 and FY 2021. Activities included both conventional monitoring techniques (nets, traps, electroshocking) as well as eDNA sampling.
2.2.1. Aquatic/terrestrial acreage controlled. (Cumulative)	FY 2021: 171,000 FY 2020: 165,000 Baseline: 153,569	FY 2021: 216,839 FY 2020: 201,991 FY 2019: 178,258	Collaborations among federal agencies, Tribes, state agencies, and the general public continue to protect high-value ecological and recreational sites from establishment of invasive species while promoting re-establishment of native species.
2.3.1. Technologies and methods field tested.	No targets Baseline: 10 avg. Universe: NA	FY 2021: 7 FY 2020: 14 FY 2019: 13	Technologies included ultraviolet and pasteurization ballast water treatment systems, automated web-surfing algorithms that identify potential sale and transfer of prohibited invasive species, and forest planting BMPs to offset forest pests.
2.3.2. Collaboratives developed/ enhanced. (Cumulative)	No targets Baseline: 10 Universe: NA	FY 2021: 19 FY 2020: 17 FY 2019: 16	FY 2021: (1) Invasive Crayfish Collaborative and (2) Aquatic Invasive Plant Collaborative focused on starry stonewort. FY2020: Woody Ornamental Invasive Plant Collaborative.
3.1.1. Estimated pounds of phosphorus reductions from conservation practice implementation throughout Great Lakes watersheds. (Cumulative)	FY 2021: 1,900,000 FY 2020: 1,600,000 Baseline: 1,113,603 Universe: NA	FY 2021: 2,066,521 FY 2020: 1,784,790 FY 2019: 1,551,605	Contributing agencies: NRCS, BIA, EPA. Results can vary each year due to the nature of voluntary conservation assistance programs. The targets for 3.1.1 were developed based on assumptions about the types of conservation practices that would be adopted by private landowners and their effectiveness. In some years, the practices adopted resulted in an exceedance of performance goals for phosphorus reduction.
3.1.2. Acres receiving technical or financial assistance on nutrient management in priority watersheds. (Cumulative)	FY 2021: 2,370,000 FY 2020: 2,200,000 Baseline: 1,614,511 Universe: 10,711,434	FY 2021: 1,831,158 FY 2020: 1,762,484 FY 2019: 1,668,500	Contributing agencies: BIA, NRCS and EPA. This new Action Plan III measure focuses on improving long-term adoption of nutrient management. Ambitious targets were initially set in GLRI Action Plan III, based on phosphorus reduction needs in the priority watersheds. However, the method used to calculate the baseline and annual targets was incorrect because it contained duplicative reporting. The error resulted in a higher baseline and higher annual targets. The method has been corrected and a new baseline has been calculated. But, new annual targets will not be set. Therefore, the target was not met in FY 2020 and FY 2021, and it is not expected to be met in future years either.
3.2.1. Estimated gallons (in millions) of untreated stormwater runoff captured or treated. (Cumulative)	FY 2021: 400 FY 2020: 350 Baseline: 252 Universe: NA	FY 2021: 413.6 FY 2020: 372.4 FY 2019: 274	Contributing agencies: BIA, EPA, USFS, USFWS, and USACE. Results for on-the-ground construction projects are reported at time of award.

Measure	Target/Baseline/ Universe[2]	Result[3]	Explanation/Additional Information
3.2.2. Miles of Great Lakes shoreline and riparian corridors restored or protected. (Cumulative)	FY 2021: 40 FY 2020: 33 Baseline: 26 Universe: NA	FY 2021: 43.6 FY 2020: 34.3 FY 2019: 26	Contributing agencies: BIA, EPA, USFS, USFWS, and USACE. Results for on-the-ground construction projects are reported at time of award.
3.3.1. Nutrient monitoring and assessment activities conducted.	FY 2021: 30 FY 2020: 30 Baseline: 30 Universe: NA	FY 2021: 31 FY 2020: 31	This measure tracks ongoing monitoring and assessment activities. Actual results may vary each year as new projects are added.
3.3.2. Nutrient or stormwater runoff reduction practices or tools developed or evaluated.	FY 2021: 10 FY 2020: 10 Baseline: 10 Universe: NA	FY 2021: 12 FY 2020: 14	This measure tracks multiyear projects that evaluate or develop new tools or management practices. Actual results may vary each year as new projects are added.
4.1.1. Acres of coastal wetland, nearshore, and other habitats restored, protected, or enhanced. (Cumulative)	FY 2021: 406,000 FY 2020: 394,000 Baseline: 370,488 Universe: 1,550,000	FY 2021: 479,293 FY 2020: 463,058 FY 2019: 441,736	Significant on-the-ground restoration was accomplished each year, largely as a result of previous planning and design activities.
4.1.2. Miles of connectivity established for aquatic species. (Cumulative)	FY 2021: 5,900 FY 2020: 5,700 Baseline: 5,289 Universe: NA	FY 2021: 6,727 FY 2020: 6,052 FY 2019: 5,497	Completion of both large dam removal and small barrier, bridge, and culvert replacements benefited important native species including brook trout and native mussels.
4.2.1. Species benefited where actions have been completed to significantly protect or promote recovery of populations. (Cumulative)	FY 2021: 2 FY 2020: 1 Baseline: 0 Universe: NA	FY 2021: 2 FY 2020: 1	Lakeside daisy in FY 2021. Piping plover in FY 2020.
5.1.1. Youth impacted through education and stewardship projects. (Cumulative)	No targets Baseline: 377,000 Universe: NA	FY 2021: 627,106 FY 2020: 578,559 FY 2019: 461,654	This measure is supported by Great Lakes Sea Grant Center for Great Lakes Literacy, NOAA's Great Lakes Bay Watershed Education and Training program, NPS interpretive programs, Ohio Department of Natural Resources and Michigan Department of Environment, Great Lakes, and Energy.
5.2.1. Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions.	No targets Baseline: NA Universe: NA	FY 2021: Yes FY 2020: Yes	GLRI federal agencies and partners conducted comprehensive monitoring to assess the status and trends of the Great Lakes ecosystem. Monitoring of coastal wetlands, contaminants, nutrients, hypoxia, HABs, zooplankton, phytoplankton, benthic communities, and prey fish, among many other components, was conducted throughout the Great Lakes basin. The monitoring data and information from previous years were used to identify the most significant Great Lakes problems and prioritize funding decisions to address those problems.
5.2.2. Identify and address science priorities to support implementation of GLRI and the Great Lakes Water Quality Agreement.	No targets Baseline: NA Universe: NA	FY 2021: Yes FY 2020: Yes	GLRI federal agencies and partners conducted several projects addressing the established science priorities under this Focus Area. Such projects included studies on *Cladophora* nuisance algae, monitoring HABs in Lake Erie, identifying the need for coastal resilience; and modeling future lake level conditions.

Notes:

NA = not applicable

[1] Results from this Action Plan measure are achieved through GLRI funding as well as other non-GLRI federal and/or state funding.

[2] Baselines for cumulative measures identify results through FY 2018 except for Measures 1.1.1 and 1.1.2 (through FY 2009, the year prior to the GLRI) and Measure 3.1.1 (through FY 2017). Baselines for non-cumulative measures identify regularly expected annual results. The baseline and universe for measure 3.1.2 have been corrected from Action Plan III to exclude acreage outside Great Lakes priority watersheds. The "universe" is not available if not

provided.

[3] Results are included for FY 2020–FY 2021 and, if available, for FY 2019 (the year prior to Action Plan III).