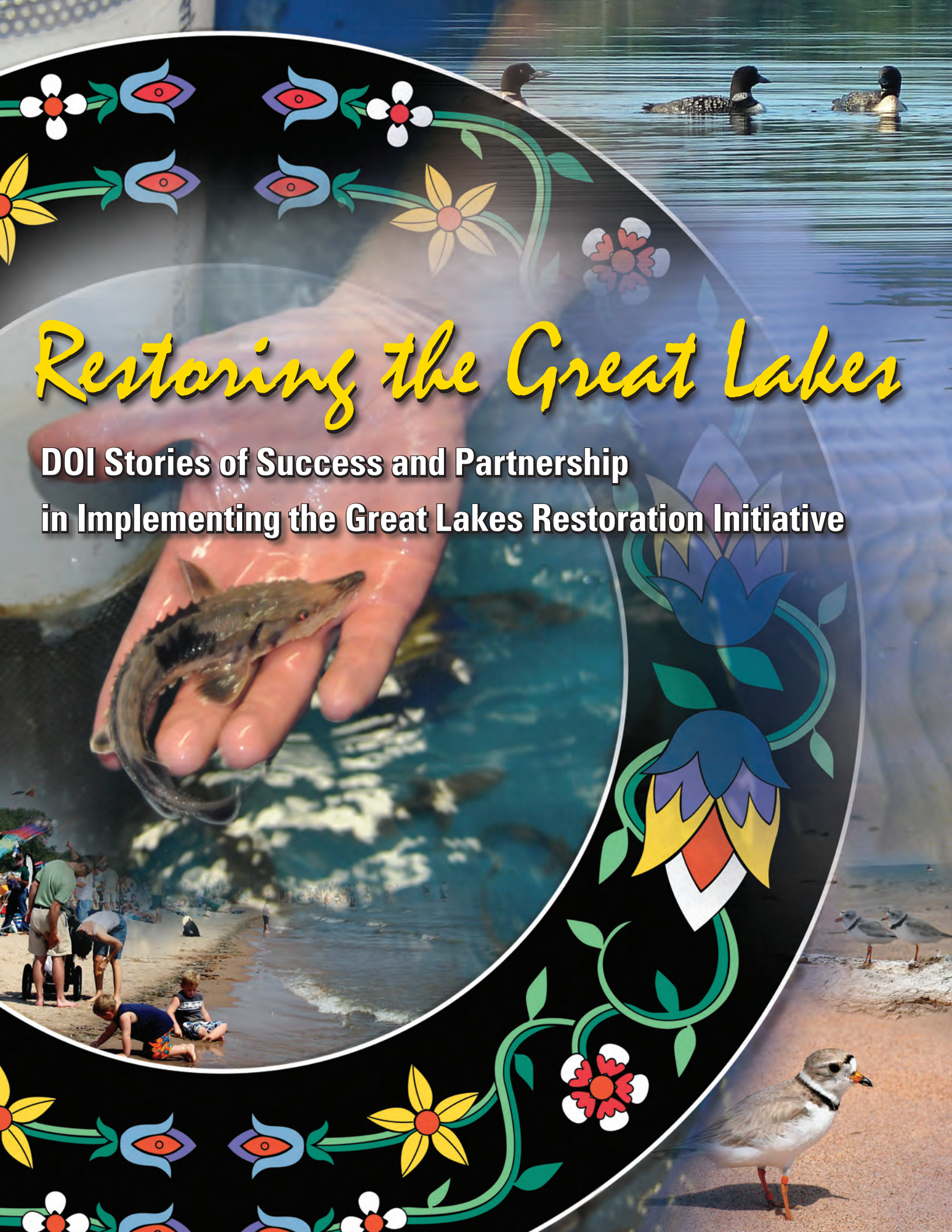


Restoring the Great Lakes

DOI Stories of Success and Partnership in Implementing the Great Lakes Restoration Initiative

Restoring the Great Lakes

DOI Stories of Success and Partnership in Implementing the Great Lakes Restoration Initiative

U.S. Department of the Interior

Credit: DarnellI, NOAA GLERL

Dear Reader,

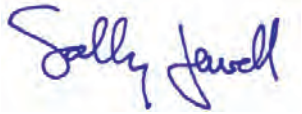
The Great Lakes are a monumentally unique national treasure containing nearly ninety-five percent of the United States' fresh surface water. Formed by receding glaciers, the Great Lakes support a thriving, resilient ecosystem rich with fish, wildlife, and abundant natural resources. The Great Lakes also support an array of commercial uses, including shipping, and provide a source of recreation, drinking water, and other critical services that drive the economy of the region and the Nation. Regrettably, activities such as clear cutting of mature forests, over-harvesting of fish populations, industrial pollution, invasive species, and agricultural runoff have degraded these treasured lakes over the decades creating long-term impacts to the surrounding watershed. Fortunately, the people who live, work, and recreate in the region recognize the critical importance of a healthy Great Lakes ecosystem, and have come together to support comprehensive restoration.

To stimulate and promote the goal of a healthy Great Lakes region, President Obama and Congress created the Great Lakes Restoration Initiative (GLRI) in 2009. This program provides the seed money to clean up legacy pollution, restore habitats, protect wildlife, combat invasive species, and address agricultural runoff in the Great Lakes watershed. At the same time GLRI promotes public outreach, education, accountability, and partnerships

As the steward of many of the spectacular and ecologically significant places that comprise the Great Lakes basin, the Department of the Interior (Interior) is committed to achieving a healthy Great Lakes ecosystem. It is therefore with great pleasure that I present these GLRI success stories, which highlight some of the ways Interior works in concert with our partners for effective, lasting restoration of the Great Lakes region. We use cutting edge science to help resource managers better understand the stressors on the ecosystem and select the right tools to manage those stressors. Our work with peers in academia advances the understanding of sensitive, rare, threatened, and endangered species; improves fisheries management practices; and helps mitigate the effects of pollution, invasive species and climate change. We collaborate with the Great Lakes Tribes to restore fisheries, wetlands, wild rice, waterfowl, and other resources important to the culture and life of tribal communities. And finally, our work with State agencies, non-profit organizations, and other Federal agencies, is making large strides to improve water quality and restore wetlands and dunes.

GLRI investments have helped the Interior family develop these essential partnerships and implement key restoration efforts. Although we have a long way to go, we are starting to see results of those investments in the form of a healthier Great Lakes ecosystem. In the pages that follow, I invite you to share in just a few of the many success stories that have been made possible by the GLRI and the partnerships which benefit the Great Lakes region.

Sincerely,



Sally Jewell

Four years of restoration actions have resulted in the removal of most invasive cattail and common reed, and the establishment of many native plant species. Credit: Dan Mason

Letter from the Secretary


Department of the Interior
Great Lakes Restoration Initiative
ONTARIO
QUEBEC
MICHIGAN
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WISCONSIN
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
INDIANA
ILLINOIS
Bureau
Bureau of Indian Affairs
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Service Layer Credits: Source: ESRI digitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community.
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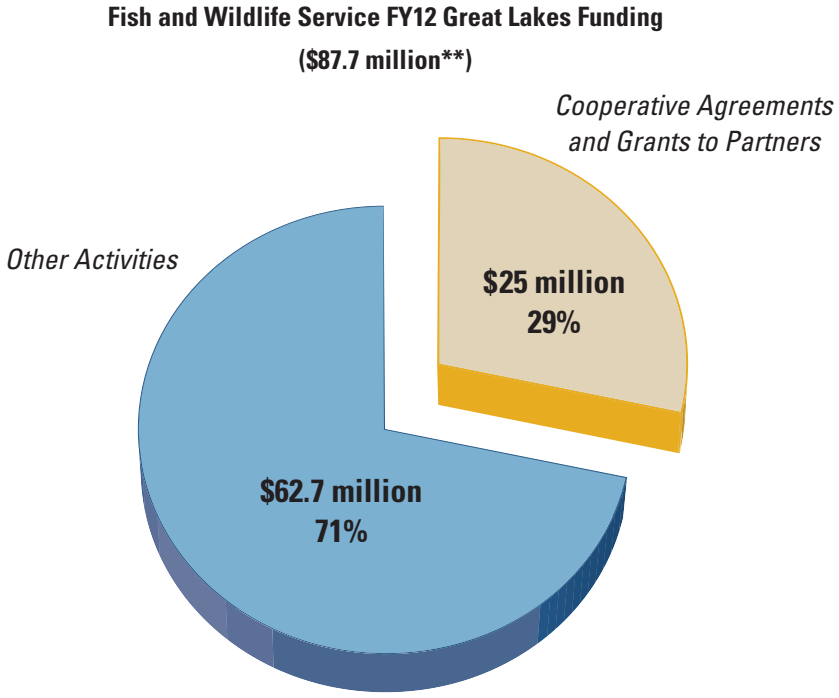
FY2012 GLRI Funding through DOI*

Bureau	Funding
BIA	$4,718,840
FWS	$44,651,309
NPS	$3,369,509
USGS	$12,848,361
Total	$65,588,019

*FY2012 Actual Allocation as reported in the FY12 GLRI Report to Congress prepared by EPA

FWS Support to Partners*



***$43.7 million from GLRI and $44 million of FWS Base Resource Funding*

USGS scientist Kevin Kenow releases a tagged common loon to study effects of botulism in the Great Lakes.

Tackling Avian Botulism

The Great Lakes are undergoing drastic ecosystem changes, including invasions by non-native mussels and fish, warmer water temperatures, and the growth of nuisance algae. Each of these is bad enough by themselves, but together, these changes may be causing more frequent outbreaks of type E botulism among wildlife that depend upon the lakes. In recent years, over one hundred thousand birds and fish in the Great Lakes—including the federally endangered piping plover, common loons, and lake sturgeon—have died from this form of "food poisoning" caused by toxins produced by the naturally occurring bacterium, ***Clostridium botulinum.***

With support from the Great Lakes Restoration Initiative (GLRI), a Department of Interior (DOI) team that includes the U.S. Geological Survey (USGS), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), state wildlife agencies in Michigan and Wisconsin, and other organizations are working to understand more about botulism outbreaks and how to mitigate them.

"Botulinum toxin is considered the most toxic substance on earth," said Stephen Riley, a USGS research biologist. "The anaerobic bacteria that produce the toxin live in aquatic environments, and current environmental conditions within the Great Lakes basin may be contributing to enhanced production of the toxin."

The toxin is thought to accumulate in some species of fish, which are then eaten by birds. Using USGS bird mortality data for Lake Michigan from 1963 to 2008, scientists from the USGS and NPS found that botulism outbreaks occurred primarily during years with lower lake levels and warmer water temperatures. Invasion of the Great Lakes by non-native zebra and quagga mussels and by round gobies occurred at the same time as a resurgence of botulism outbreaks in the Great Lakes in the early 2000s, but the role of these invasive species in causing the outbreaks has not been fully identified. DOI scientists are exploring the role of these invasive species in botulism outbreaks and unraveling the workings of this toxic cycle.

"The first time I dove in Lake Michigan, I was shocked," said Brenda Moraska Lafrancois, a regional aquatic ecologist with the NPS. "Nearly everything I looked at was an invasive species."

Botulism outbreaks have occurred in the Great Lakes region since at least the 1960s, but they have increased in severity and frequency since the early 2000s. Most recently, botulism outbreaks have become especially troublesome in northern Lake Michigan. In 2010 and 2012, respectively, more than 1,300 and 2,400 dead birds were found on Lake Michigan beaches in areas actively monitored. Total estimates for dead birds for 2012 are much higher, as not all beaches are regularly monitored. Of these carcasses, estimates are that over 1,500 were common loons (800 were from areas actively monitored).

The GLRI botulism research team (see sidebar, p. 5) is focusing its efforts on Lake Michigan, primarily near Sleeping Bear Dunes National Lakeshore, where thousands of bird carcasses have been found since the first documented large outbreak in 2006. The challenge is to determine what environmental and biological factors link together to trigger a botulism outbreak. In order to predict what triggers an outbreak, manage environmental conditions to inhibit toxin production, and improve aquatic food chains, the team is working to uncover sites where toxin is likely to be produced, the role of the nuisance algae *Cladophora* in promoting toxin production, and the food-web pathways that promote consumption of the toxin by waterfowl and possibly fish.

Scientists sample fish in Lake Michigan near Sleeping Bear Dunes National Lakeshore. (Credit: Bryan Maitland)

Identifying the culprit

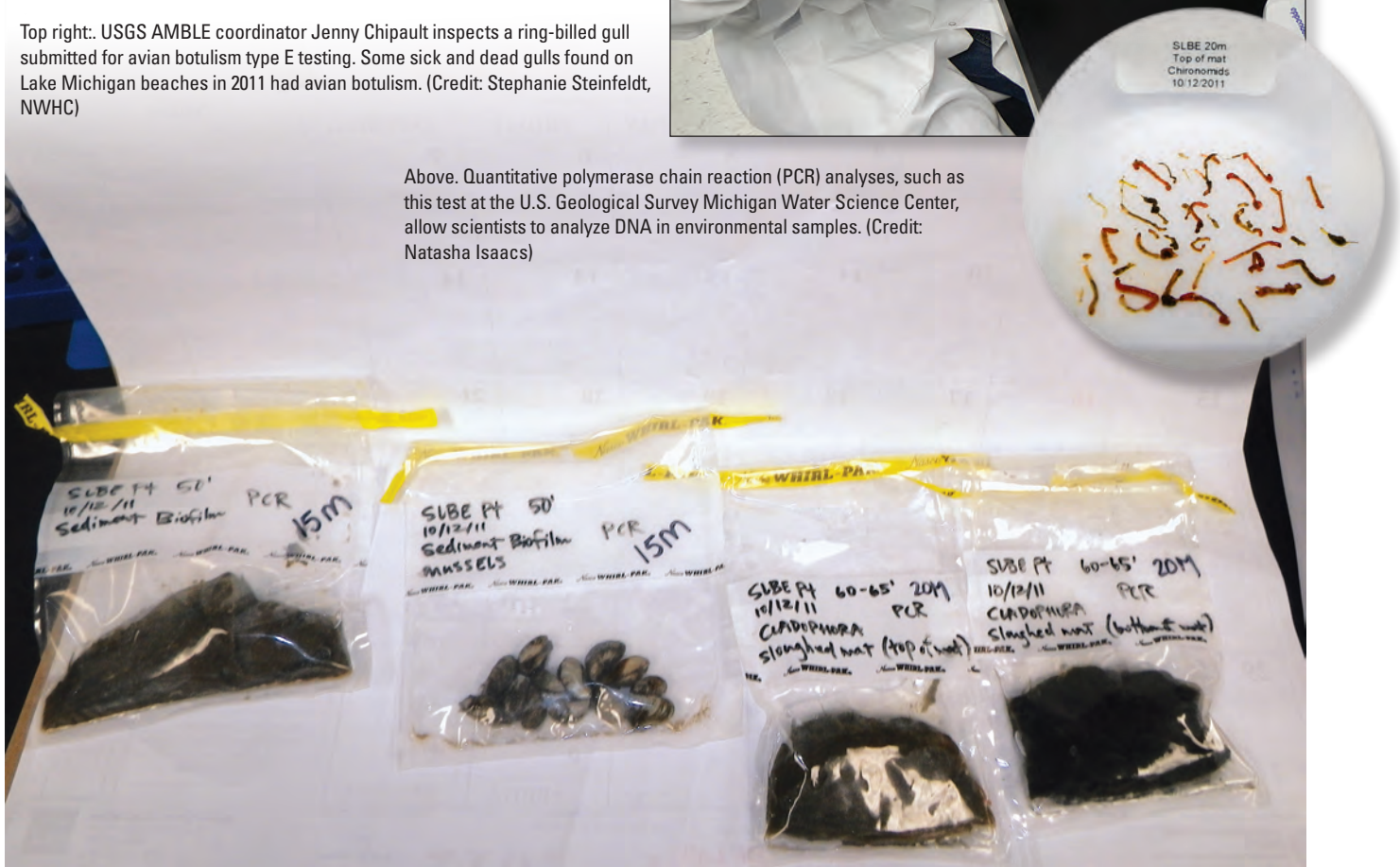
USGS microbiologists use a molecular testing technique to estimate the amount of toxin-producing *Clostridium botulinum* bacteria in a given substrate, such as sand or mud. During the investigation of disease outbreaks, it is also necessary to identify toxin within animal carcasses to confirm botulism intoxication as the cause of death. For years, the benchmark test to detect botulinum toxin involved the use of live mice. USGS scientists, in conjunction with the pharmaceutical company BioSentinel, Inc., have since developed a biochemical (or non-animal based) test to detect botulinum toxin. This new test is as accurate as the traditional mouse test, and is a major step forward in the study of botulism.

"Determining precisely where botulism outbreaks occur will allow us to further determine how birds ingest toxin. To facilitate this research, we are working to improve our capacity to detect the botulinim toxin," said David Blehert, a USGS microbiologist.

Understanding toxin production and how it moves through the food web

To uncover factors that cause botulism in Great Lakes waterbirds, researchers are investigating where and how *Clostridium botulinum* grows in the lake. The USGS and NPS scientists have proposed that invasive mussels may drive this process. The mussels create a hard surface on the lake bottom, filter lake water and make it clearer, while excreting phosphorus-rich waste. This increase in phosphorous combined with the clear lake water allows sunlight to reach further down into the lake and promotes extensive growth of the nuisance algae *Cladophora*. Later in the summer, *Cladophora* dies off and

Top right:. USGS AMBLE coordinator Jenny Chipault inspects a ring-billed gull submitted for avian botulism type E testing. Some sick and dead gulls found on Lake Michigan beaches in 2011 had avian botulism. (Credit: Stephanie Steinfeldt, NWHC)



Above. Quantitative polymerase chain reaction (PCR) analyses, such as this test at the U.S. Geological Survey Michigan Water Science Center, allow scientists to analyze DNA in environmental samples. (Credit: Natasha Isaacs)

Left. Scientists place a geolocator tag and colored leg band on adult common loon to study migration and feeding ecology.

Above. This common loon has been marked with a satellite transmitter and geolocator tag. (Credit: Luke Fara)

decays on the lake bottom, creating a low-oxygen environment favorable to *Clostridium botulinum*. So far, lab results support this hypothesis. Tests have found *C. botulinum* cells to be widespread in lake-bottom sediments near Sleeping Bear Dunes National Lakeshore, and they suggest that *Clostridium botulinum* may occur in high abundance in decomposing *Cladophora* algae. With the 2013 field season underway, scientists are using new, high-resolution lake bottom data acquired by the NPS and partners to focus sampling efforts on areas where rotting *Cladophora* algae is known to accumulate.

For botulism to affect birds, the toxin must find its way into their diet. Consequently, understanding how the toxin moves up the food chain to birds is a key component to understanding how botulism outbreaks occur. The toxin likely moves from bacteria in lakebed sediments into small invertebrates. The invertebrates are then consumed by fish, which, in turn, are eaten by waterbirds. Determining which species of invertebrates and fish act as sources of this food-borne toxin will be an important step in managing botulism outbreaks.

Researchers have collected fish and invertebrates from a variety of sites near Sleeping Bear Dunes National Lakeshore, and testing is underway to determine if *Clostridium botulinum* is commonly present in any particular species or locations. Scientists have already demonstrated that fish communities in the area are now dominated by highly abundant and invasive round gobies. NPS and USGS scientists are also collaborating with researchers at Northern Michigan University, who conduct detailed analyses of what birds ate before succumbing to botulism. Preliminary results indicate that all of the loons that tested positive for botulism had eaten round gobies prior to death, suggesting that gobies may be a source of botulinum toxin. A review of historic data also indicates that the timing of botulism outbreaks in lakes Michigan, Erie, and Ontario coincided with times when invasive round gobies became established in those lakes.

Bird distribution and foraging patterns

Another key component to understanding how birds come in contact with botulinum toxin is to better define migration pathways and feeding grounds where waterbirds are likely to be harmed or killed by botulism. USGS scientists are addressing this knowledge gap by assessing distribution and foraging patterns of fish-eating waterbirds on selected portions of Lake Michigan through aerial surveys, the use of satellite transmitters to track the migration movements of common loons, and by capturing feeding behavior with archival geolocator tags. These geolocators and transmitters are electronic devices that are either attached to a loon's leg or surgically implanted. They record information about where the bird has been including how far down in the water it is hunting for fish. Geolocator tags have recorded dive depths to nearly 150 feet (45 meters) in Lake Michigan. If scientists can determine where fish-eating waterbirds are most likely catching their food, management actions can be specifically targeted to those locations.

Aerial surveys in northern Lake Michigan have revealed concentrations of common loons and other fish-eating waterbirds during migration, allowing future research to focus on these hotspots of potential exposure. Satellite tracking has provided accurate locations of migrating loons, lending insight on migration timing, staging, and distribution in the Great Lakes. These preliminary results suggest that loons are feeding offshore in deeper water. Combined with the fact that loon carcasses are decomposed when they are discovered on beaches, this indicates that loons may be exposed to toxins in deep offshore waters. Movements of radio-marked loons can be found on the USGS Upper Midwest Environmental Sciences Center Web site: *http://www.umesc.usgs.gov/terrestrial/migratory_birds/loons/migrations.html*.

NPS citizen scientist Eleanor Comings counts loon carcasses at Sleeping Bear Dunes National Lakeshore during a large botulism outbreak in October of 2012. (Credit: Dan Ray)

U.S. Geological Survey beach monitor surveys the beach at South Manitou Island for carcasses. (Credit: Amy Fingerle)

NPS staff and volunteers prepare to transport a piping plover suffering from botulism intoxication to a wildlife veterinarian for administration of antitoxin. (Credit: NPS)

Bird carcass monitoring, testing, and tracking

One of the most apparent and devastating consequences of an avian botulism outbreak is a beach littered with dead birds. Such scenes have been a mobilizing force for concerned citizens. The NPS has coordinated a citizen-based carcass monitoring, collection, and burial program at Sleeping Bear Dunes National Lakeshore since 2007. In 2011, the USGS established a similar citizen-science program called Avian Monitoring for Botulism Lakeshore Events, or AMBLE, to collect data on bird carcasses from other locations in northern Lake Michigan. Data from this program have increased knowledge of botulism outbreak timing, severity, and bird species affected. The AMBLE coordinators are working with other groups around Lake Michigan to monitor bird mortality, and the USGS National Wildlife Health Center (NWHC) maintains an online data entry portal for use by citizen-scientists and partner organizations.

GLRI Botulism Research Team

Department of Interior	
U.S. Geological Survey	National Wildlife Health Center
	Upper Midwest Environmental Science Center
	Michigan Water Science Center
	Great Lakes Science Center
National Park Service	Sleeping Bear Dunes National Lakeshore
	Midwest Region Aquatic Ecologist and Fishery Biologist,
	NPS Volunteers
U.S. Fish and Wildlife Service	Region 3 Pilot (Twin Cities)
	East Lansing (Michigan) Field Office
Wisconsin Department of Natural Resources	
Michigan Department of Natural Resources	
University of Wisconsin	
Northern Michigan University	
Northwestern Michigan College	
Michigan Tech Research Institute	
Science Museum of Minnesota	
Citizen Groups/NGOs	Lake Michigan Avian Monitoring for Botulism Lakeshore Events (AMBLE)
	Common Coast Research and Conservation
	The Ridges Sanctuary
	Crossroads at Big Creek

Endangered piping plovers are monitored on the beaches near the Sleeping Bear Dunes National Lakeshore by the USFWS. Bird carcass specimens are submitted to the USGS National Wildlife Health Center to verify botulism-related deaths. Roughly 60 percent of the carcasses tested from 2010–2012 at NWHC were positive for type E botulism, suggesting that avian botulism is the main driver of mortality in assessed bird populations on Lake Michigan.

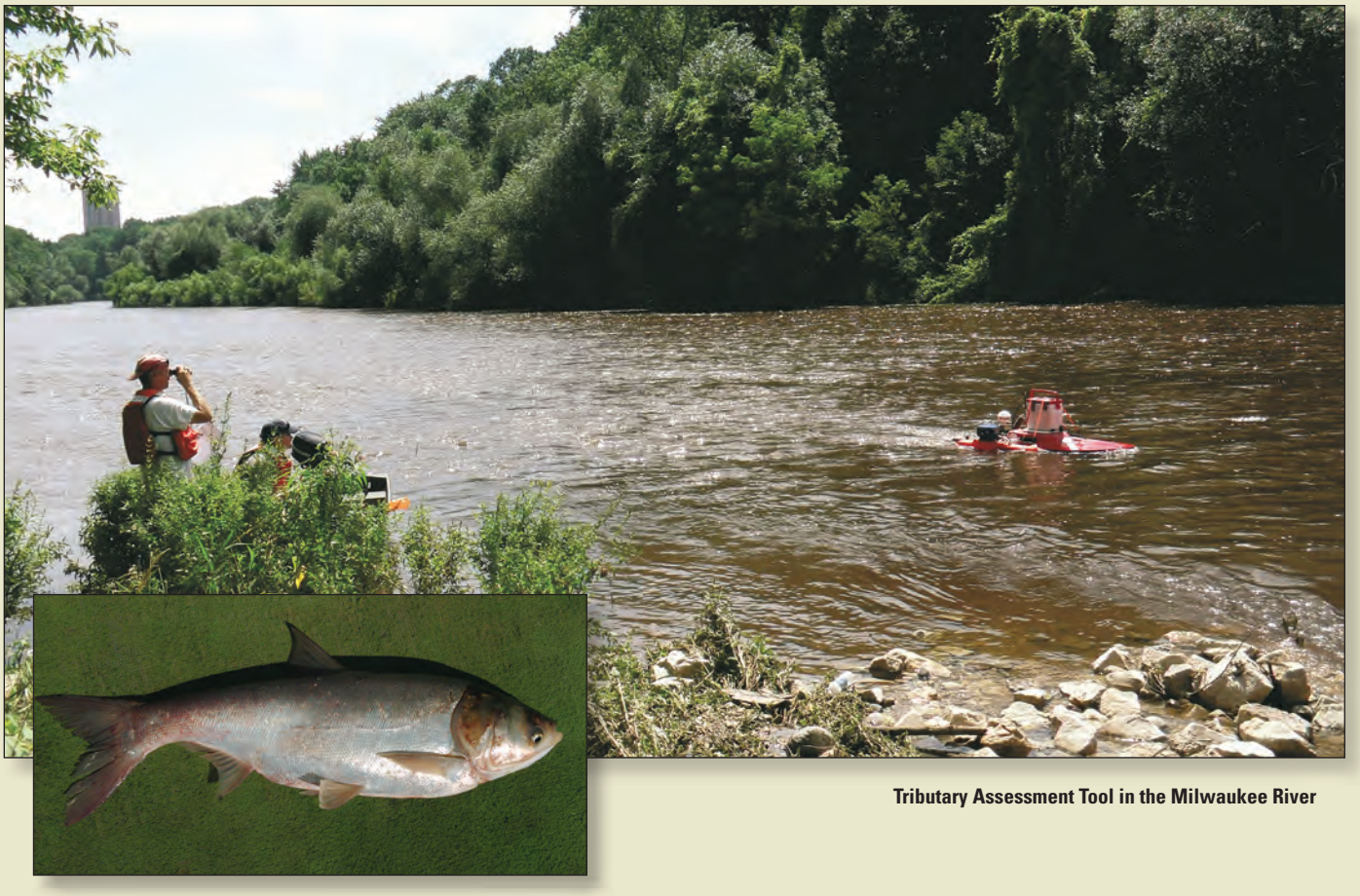
Aerial bird surveys and other data collected by USGS and USFWS are being integrated with carcass location data to create a model that will help to identify sites where birds are likely to be exposed to botulinum toxin. The model will predict where a bird most likely died from toxin ingestion based on where the carcass was deposited by wind and waves. The USFWS, in cooperation with NPS and USGS scientists, is leading the effort for population recovery of endangered piping plovers around the Great Lakes.

Moving forward

Outbreaks of avian botulism in the Great Lakes present a serious challenge to Great Lakes restoration because along with their direct environmental impacts, they also hinder human use of beaches and other recreational activities such as hunting and bird watching. Additionally, increased lake temperatures and lower water levels associated with climate change may further increase the likelihood of future botulism outbreaks. In the face of these problems, the DOI team will work together to protect our natural resources by improving our ability to predict, manage, and mitigate botulism outbreaks.

U.S. Geological Survey

Getting to Know Asian Carp



Tributary Assessment Tool in the Milwaukee River

At the USGS, we are working with our partners to prevent the establishment of sustainable Asian carp populations in the Great Lakes. Our science is geared toward: 1) Understanding the life history of Asian carp (from egg to adult) which will help enhance our abilities to assess where they could survive and reproduce, and to monitor, detect, and control them; and 2) Developing control tools to keep Asian carp out of the Great Lakes and to reduce or push back current populations outside the Great Lakes basin. The GLRI has been instrumental in helping us meet this challenge.

One of the latest USGS science developments is the Tributary Assessment Tool, which is a type of simulation model that provides managers with information to determine which rivers in the Great Lakes basin or beyond could provide the needed habitat for Asian carp to successfully reproduce. The tool can also be used to determine spawning locations in any river where the carp are present or may invade in the future. It combines biological data about Asian carp development and water data such as flow, velocity, and temperature into the model to assess the suitability of a river for spawning.

As part of this effort, the USGS recently investigated two Lake Michigan tributaries (the Milwaukee and St. Joseph Rivers) and two Lake Erie tributaries (the Maumee and Sandusky Rivers) to determine if they possess the water flow and water-quality characteristics to allow successful spawning of Asian carp (silver and bighead).

"Our data indicate that these four tributaries could support successful Asian carp spawning, egg transport and development," said Elizabeth Murphy, USGS lead scientist on this project. "This information can help resource managers implement control measures and potentially prevent Asian carp establishment in the Great Lakes."

USGS is also developing new and innovative management tools and technologies to control or remove Asian carp. Toxic microparticles have been developed that are designed to target Asian carp. Once eaten, the microparticles break down in the fish's digestive system, which limits the impact on non-target species. Seismic waterguns are in the final stages of testing to determine how they affect fish behavior and movement. The watergun creates a pulsed sound energy or pressure wave and may be employed as a barrier to deter movement of or drive Asian carp from an area. These tools would be used by managers to reduce existing silver and bighead Asian carp populations and reduce pressure at the invasion front.

Learn more about this project and other Asian carp efforts at: *http://asiancarp.us/*

Innovation-at-Work: U.S. Fish and Wildlife Service's Mobile eDNA Lab

One of the USFWS newest tools in the detection of Asian carp comes from a scientific method developed and implemented by the University of Notre Dame that analyzes water samples for traces of DNA left behind by Asian carp in the environment, known as environmental DNA, or "eDNA."

To determine the presence or absence of Asian carp genetic material in a river or lake, fish biologists take a water sample from the surface of the water. The water sample may contain traces of Asian carp DNA in the form of scales, cells, feces, or mucus. To find out, the water is filtered through sterilized paper, and that filter paper is sent to an eDNA processing lab.

During the eDNA sampling and filtering process, much care is taken to prevent the water samples from becoming contaminated or compromised. When performing eDNA water sampling at remote locations, USFWS staff were confronted with the challenge of filtering numerous water samples in a sterilized environment with limited access to adequate lab facilities.

USFWS staff began exploring options for field-based filtration of water samples. USFWS Biologist Chris Olds in the Alpena Fish and Wildlife Conservation Office suggested a mobile filtering unit similar to one used for raising lake sturgeon in Wisconsin. The idea was to design a mobile laboratory that could be used at remote sampling locations along Lake Huron and could use a plug-in power source where facilities are available.

Brainstorming and design considerations started and the final trailer concept was shared with the Regional Safety Department and the La Crosse Fish Health Center Staff to ensure that it would meet all safety requirements and quality assurance standards for the water filtering procedures. Upon approval, the trailer contract was awarded to Featherlite, Inc., who worked with USFWS staff to ensure that the internal trailer components would meet all of the filtering needs both at remote sampling locations and when hooked up to shore power.

The final product is an example of innovation-at-work. The mobile eDNA lab is fully stocked and capable of filtering numerous water samples even at the most remote field sites. Highlights include six filter stations, a freshwater tank that links to a de-ionized water system, and enough storage space to accommodate the necessary equipment for the collection of 300 water samples. The new unit can even be used as a mobile classroom.

Research has shown that eDNA is more commonly found on or near the surface of the water, so water samples are collected from the top two inches of the water column.

Water samples are temporarily stored in an ice-filled cooler to prevent them from becoming too warm. Heat can compromise the quality of the water samples.

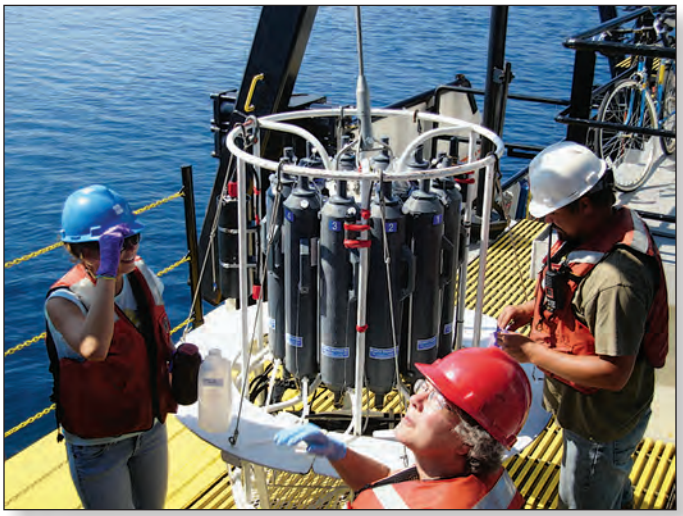
Service Biologists Chris Olds (left) and Steve Gambicki next to the mobile eDNA lab. The USFWS capitalized on the innovation allowed by the GLRI to dramatically increase its ability to monitor for the presence of Asian carp.

USGS Science Reveals New Information about Mercury Cycling and Methylation

USGS science for a changing world

Mercury is a highly toxic element that is found both naturally and as an introduced contaminant in the environment. Mercury exists in many different chemical forms depending on environmental conditions. One of these forms—methylmercury—can be absorbed by and stored in the tissues of living organisms such as fish and humans, affecting their neurological and immune systems.

Methylmercury is created from elemental, or inorganic, mercury through a process called methylation that involves certain bacteria. Elevated levels of methylmercury have been observed in sport and commercial fish across the Great Lakes, but where and how methylation occurs is not well known. Understanding the sources and processes that control movement of methylmercury is critical to reducing toxic substances and improving the health of the Great Lakes and its ecosystems, one of the many goals for the GLRI.



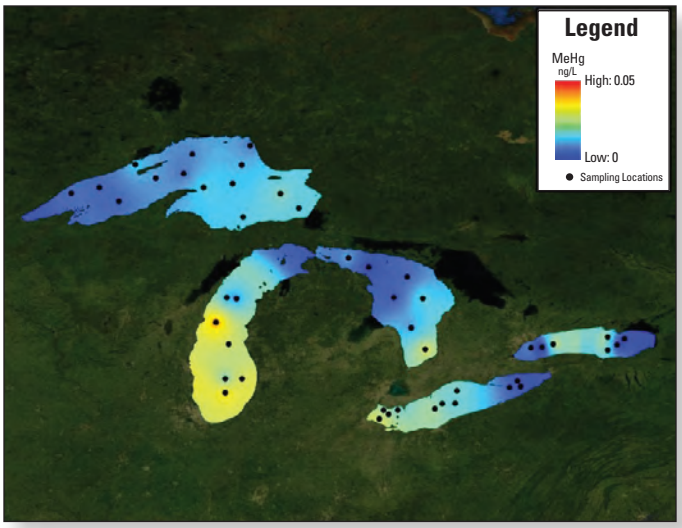
Researchers aboard the USEPA Lake Guardian prepare to lower the mercury sampling rosette into the water. The device allows 12 samples to be collected at different depths for a single cast. (Credit: USGS)

Discovering mercury methylation in the Great Lakes water column

Until recently, most scientists thought that the methylation process was primarily taking place upstream from the Great Lakes and that methylmercury was then moving into the lakes via tributaries that flow into them. To test this theory, the USGS and U.S. Environmental Protection Agency (USEPA) initiated a multi-year project in August 2010 to evaluate mercury and methylmercury concentrations and distribution among the Great Lakes in water, sediment, fish, and other aquatic organisms.

Scientists collected the first complete set of observations for mercury and methylmercury during six sampling cruises aboard the USEPA's research vessel Lake Guardian, traversing all five Great Lakes. They sampled the water, bottom sediments, and suspended algae at multiple depths throughout the water column. This new data revealed that, in addition to tributary contributions, methylmercury was being produced within the lakes themselves. In fact, methylation was occurring deep in the lakes' water column near the thermocline (the point where warm and cold water meet) — a location of significant importance for biological production and fish foraging.

This discovery significantly changes the conceptual model of Great Lakes mercury cycling, as the presence of water-column methylation has considerable implications for the health and management of the Great Lakes. In particular, scientists are anticipating a decrease in future atmospheric mercury deposition due to recent national mercury emission reduction laws for coal- and oil-burning utilities. A reduction in depositional mercury should reduce the amount of mercury available for methylation. This study will document the ecological response to that change in mercury loading. A follow-up research cruise in the fall of 2013 will further investigate the mercury cycling process and its potential impacts on mercury levels throughout the Great Lakes ecosystem. This new understanding of methylmercury sources for the Great Lakes will help inform decision makers and resource managers on effective steps toward reducing mercury contamination in fish.



Spatial distribution of methylmercury levels in surface waters across the Great Lakes. Results reveal differences among the lakes and regions within each lake where more or less methylmercury is present

National Park Service
Wetlands are a-Changing…

National Park Service staff take actions to remove the "pathetic desert of cattail" and common reed at Cowles Bog NNL. (Credit: Dan Mason)

In 1913 Professor Henry Cowles, a renowned early 20th Century ecologist, led a group of international scientists on an exploratory excursion of the Great Marsh in what is now Indiana Dunes National Lakeshore on the southeastern shores of Lake Michigan. The group wanted to see the exceptional diversity of flowers, grasses, and other plants present in the marsh, and they were not disappointed. In *Sand Dunes of Indiana* (1917), Stillman Bailey writes, "here the flora are in a perfect riot, according to the season." In 1965, the area's exceptionable presentation of nature qualified it for National Natural Landmark (NNL) status with the designated title of Cowles Bog NNL.

Intense industrial development initiated in the late 1960s resulted in degradation of the NNL and adjacent wetland. Gerould Wilhelm in *Special Vegetation of Indiana Dunes National Lakeshore* (1990) writes, "now the Great Marsh is, for the most part, little more than a pathetic desert of cattail."

The GLRI has made it possible for the NPS and its partners to restore the NNL and adjacent wetland from a state of degradation to one of plant and animal species richness. Thanks to funding from the GLRI, the time and effort of numerous volunteer citizens, and contributions by partners such as The Nature Conservancy, the Student Conservation Association, the Shirley Heinze Land Trust, the USGS and several private contractors, this group of partners has been able achieve visible, and beautiful, results.

Restoration work has taken place on approximately 600 acres, including the Cowles Bog NNL. NPS has removed invasive non-native cattail, common reed, reed canary grass and shrubs, propagated 26 native wetland plant species, planted hundreds of thousands of individual plants, and has re-established the functioning hydrology of the wetland in the national park. Through a cooperative agreement with NPS, the Shirley Heinze Land Trust has done complementary restoration on 28 acres of the Great Marsh adjacent to NPS lands, including dispersal of 10 pounds of native seed. Working with USGS scientists, design work allowing for future wetland enhancement and restoration will target approximately an additional 400 acres, including the reconnection of the Derby Ditch watershed to the Dunes Creek Watershed within the Great Marsh. This work will map ditch systems, measure flow rates through the ditches, monitor ground water, evaluate vegetation and soils and model the potential impacts to adjacent areas. A restored Great Marsh will purify the water, control flooding, and provide habitat for native plants and animals in the Dunes.

These citizen volunteers will plant native species at Cowles Bog NNL. Citizen volunteers have contributed hundreds of hours in the restoration effort. (Credit: Dan Mason)

On July 20, 2013, park visitor Marcia Penny Starin wrote to local ornithologist Ken Brock that she and her husband had spotted two adult sandhill cranes with a well-grown colt feeding with them. Ken Brock responded, "Thanks for the record. This is the first breeding evidence for Cowles Bog and is therefore quite noteworthy!"

The Cowles Bog NNL today may not yet equal the splendor Professor Henry Cowles experienced 100 years ago, but thanks to the GLRI it is far from its recent state as a "pathetic desert of cattail." This beautiful sea of wildflowers attracts both wildlife and people, and is on its way back to providing useful ecosystem services to the southern shore of Lake Michigan.

See photo opposite Table of Contents. Four years of restoration actions have resulted in the removal of most invasive cattail and common reed, and the establishment of many native plant species. (Credit: Dan Mason)

Pokagon Band of Potawatomi

Design Restoration for Dowagiac River

For a river of its size and hydrology, the Dowagiac River is unique in southern Michigan as one of the most heavily groundwater-fed rivers of its size in the State. It exhibits temperature and flow characteristics similar to northern Michigan trout streams, such as the Au Sable River. The high groundwater inflow along much of the Dowagiac River's length maintains cool temperatures and steady base flow throughout the summer season. Most of its tributaries support natural reproducing populations of brown trout. However, the majority of the mainstream, including the segment targeted for restoration, has little-to-no natural brown trout reproduction and supports a smaller population, most likely due to the lack of suitable habitat in the main channel.

Straightening of the Dowagiac River in the early 1900s resulted in the river exhibiting regular, high flow velocities without the characteristic pool and riffle sequence found in more natural river channels. This has led to an unstable channel bottom with a homogeneous streambed, and it has prevented the river from meandering naturally in its floodplain. As a result, the lack of substrate means the river cannot maintain healthy habitats in or along its banks, thus impacting its ability to support naturally reproducing populations of brown trout.

In 2011 and 2012, the Bureau of Indian Affairs (BIA) directed $218,000 of GLRI funding to the Pokagon Band of Potawatomi to prepare a restoration design for the Dowagiac River. The Pokagon Band and Michigan Department of Natural Resources contracted with Inter Fluve, Inc., and Oneida Total Integrated Enterprises (OTIE) to engineer and design plans aimed at restoring natural hydrology to a 4.78-mile-section of the Dowagiac River corridor. The engineering and design project, currently underway, includes conducting channel surveys, collecting stream bed cores, making geomorphic assessments, and analyzing the data to inform restoration design. Once restoration design is complete, the Pokagon Band will turn to implementation of the river corridor restoration.

Restoring this river segment will reduce non-point pollutants, such as sediment and nutrients, and will help to lower the water temperature. This reduction will benefit water quality and increase habitat and species diversity in the Dowagiac River, with the ultimate goal of restoring a thriving brown trout population. Restoring the hydrology of this river will ensure that Pokagon citizens have sustainable opportunities to hunt, fish, and gather the natural resources of this watershed.


Depth of Refusal - Site 2
Depth of Refusal - Site 1
Depth of Refusal - Site 3
Depth of Refusal - Site 5
Depth of Refusal - Site 6
Stationing
Field Photographs
Depth of Refusal Measurement
Roads
Tributary Channels
Relict Meanders
Well Defined
Moderately Defined
Poorly Defined
Dowagiac River Alignment
Relict Alignment
Adjusted Alignment
Existing Alignment
LiDAR Color Intervals = 1 ft
Max Elev - 732 ft Min Elev - 699 ft
0 150 300 600 Feet
1 inch = 300 feet
Upstream Project Limit
6000
7000
8000
9000
10000
11000
DOR-1
DOR-2
DOR-3
DOR-4
DOR-5
DOR-6
Peavine St
Sink Rd
Unnamed Tributary
Unnamed Tributary
Unnamed Tributary

Sokaogon Chippewa Restore Subsistence

Walleye Fishery in Lake Lucerne

Lake Lucerne is a 1,026-acre lake located in northeastern Wisconsin near the Sokaogon Chippewa Reservation. There, tribal members have harvested walleye, a game fish with great importance to the Tribe, for subsistence purposes for generations. During the 2000s, the walleye population declined significantly on the Lake, coinciding with low water levels due to drought and the collapse of the exotic rainbow smelt.

Rainbow smelt provide an excellent source of food for adult walleye and other gamefish. However, through direct competition with and predation of younger life-stages, rainbow smelt are also known to reduce populations of walleye and yellow perch. Though the diminished walleye population in Lake Lucerne was undesirable, the reduction of the rainbow smelt population was considered an opportunity for restoration of a walleye-yellow perch fish community.

With the lake levels down as far as six feet due to drought, many of the historic walleye shallow and nearshore spawning areas were lost, left literally high and dry. Bays and shorelines with the vegetation and woody debris that serve as habitat for rearing many young fish species were also shallow or dry. Further evaluation was needed to determine the condition of these habitat areas and whether they were suitable for restoration efforts.

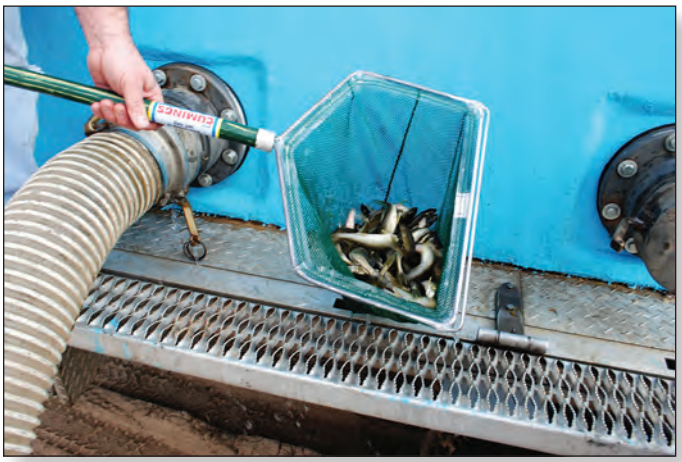
In 2011, the BIA directed $40,000 of GLRI funding to the Sokaogon Chippewa to assess and design restoration plans for the walleye fishery in Lake Lucerne. The Sokaogon Chippewa initiated a comprehensive assessment to better understand the lake ecosystem and walleye population. The project involved a number of components, including: rainbow smelt assessment and removal, surveys of various fish species in numerous life-stages, habitat surveys, and actual stocking of walleye.

The survey results suggested that, after the impact of drought and low lake levels, rainbow smelt were no longer found in the lake, while walleye and yellow perch were still present, albeit in low numbers. While walleye recruitment was low, juvenile yellow perch were still commonly found. Although water levels dropped as far as six feet, quality walleye spawning habitat remained plentiful. Abundant woody debris was present at various depths and the aquatic plant community was diverse and healthy, providing suitable spawning and rearing habitat for key fish species.

This comprehensive assessment confirmed that conditions were suitable for walleye restoration efforts to continue, and the Sokaogon Chippewa partnered with the Lake Lucerne Advancement Association to stock fingerling walleye. Future restoration efforts on Lake Lucerne by the Sokaogon Chippewa will be directed toward achieving the long-term goal of a high density walleye population with yellow perch forage, thus providing increased harvest opportunity for Tribal members. The absence of rainbow smelt is excellent news; walleye and yellow perch populations are expected to expand naturally along with continued annual stocking.

Adult fish survey using fyke net, water level down six feet.

Performing aquatic plant survey



Stocking of fingerling walleye

Juvenile fish survey using seine

Building a Nursery for Lake Sturgeon

In the spring of 2011, an important new field-based sturgeon hatchery, built by the USFWS with funds from the GLRI, was delivered to the banks of the Kalamazoo River in southwestern Michigan. The new facility is a key step in the long-term effort to rehabilitate precariously small lake sturgeon populations in Lake Michigan and would not have been possible without GLRI funds.

Great Lakes sturgeon declined dramatically in the late 1800s from overfishing, pollution, and habitat loss. Though many populations were extirpated long ago, sturgeons still persist in at least eight rivers around Lake Michigan—a small fraction of their historic abundance. Once depleted, it is often difficult for sturgeon to recover because survival of young fish is poor and it takes them many years to mature.

As part of a multi-agency effort to rehabilitate this ancient species in Lake Michigan, the USFWS committed to constructing and operating this new streamside hatchery on the Kalamazoo River. This effort involved collaborations between the USFWS and the Michigan Department of Natural Resources along with other local partners who have been working to rehabilitate the Kalamazoo River sturgeon population for many years. The new streamside hatchery began operating in April 2011. During weeks of day and night field sampling, a dedicated crew of biologists from the USFWS, Michigan DNR, and Match-e-be-nash-she-wish Band of Pottawatomi Indians, along with individuals from the Kalamazoo River Chapter of Sturgeon For Tomorrow, were successful in collecting several hundred wild-fertilized sturgeon eggs from the Kalamazoo River. Once placed in the new hatchery, these wild eggs soon hatched and started their life within the streamside facility where they had a much better chance of survival than eggs and fish in the wild that face predation, disease, and starvation. Over the next six months, the team nurtured the surviving 150 young sturgeon, feeding them brine shrimp, blood worms, and finally krill, getting them up to a size of six-to-10 inches so they could be tagged and released back into the river to continue their life as Kalamazoo River sturgeon.

An important aspect of "streamside" rearing is the fish are reared in water pumped directly from the river. This increases the likelihood that the young sturgeon will "imprint" in the same way wild fish do, ensuring their return to this river as mature adults and reducing the chance that they might stray to other rivers, causing genetic concerns for other populations. The big test will be in 20-to-25 years when these streamside-reared fish begin returning to the Kalamazoo River to spawn and sustain the next generation.

This is the first of what is expected to be 20 years of operation of this facility on the Kalamazoo River, and it followed more than a decade of population assessment, evaluation and planning that set the stage for this and other streamside rearing operations around Lake Michigan. In 2002, a partnership of agency and university biologists and researchers initiated a lake-wide assessment of the status of lake sturgeon in Lake Michigan. Rehabilitation needs were identified and prioritized and rehabilitation guidelines for conserving the genetic characteristics of remaining populations were developed. One particularly important consensus was that stocking traditionally reared hatchery fish might lead to the loss of some remnant but genetically distinct populations. This was the impetus for developing the streamside rearing technique, first initiated on the Manistee River by the Little River Band of Ottawa Indians. This technique was then used to begin reintroducing sturgeon to four rivers in Michigan and Wisconsin where they had been extirpated.

USFWS technician Lindsey Lesmeister (left) and MIDNR Biologist Kregg Smith (right) deploy mats near lake sturgeon spawning grounds to collect eggs. (Credit: Kevin Mann, USFWS)

Above. Service biologists Kevin Mann (left) and Sam Stafslien (right) examine egg mats for lake sturgeon eggs. These wild-collected eggs are then transported to the Kalamazoo River streamside rearing facility where they are reared to fingerling size and released in the fall. (Credit: Rob Elliott, USFWS)

Above right. Tribal employees Jesse Comben (left) and Andrea Koster (right) search for radio-tagged adult lake sturgeon near their spawning grounds. (Credit: Rob Elliott, USFWS)

Staff running the streamside rearing facility (right) welcome visitors (bottom right) inside the unit and talk to them about the work they are doing and the importance of lake sturgeon and other native fishes in the Great Lakes.

National Park Service Combats Invasive Species through Education

Invasive plant species are no respecters of boundaries, and the six national parks located on the Great Lakes suffer from the same threats present in the larger ecosystem: terrestrial invasives are responsible for large-scale changes in the protected areas of the national parks. The GLRI has enabled NPS to ramp up efforts to combat these invasives in a significant way, by bringing on teams of 10 - 20 seasonal staff each year 2010 to 2013 to remove invasive plants and monitor the presence of invasive insects, animals and aquatic species in the parks. Hundreds of acres of park lands have been treated to remove invasives, with thousands more being monitored. In addition to active, on-the-ground management of invasive species, educators funded by the GLRI are helping the public understand the crucial role prevention has in limiting the spread of these threats to our land and water.

Protecting areas from future invasion is the most cost-effective method of controlling invasive species, and GLRI has enabled NPS to put a team of 10 park rangers out in the field, making sure visitors know how to do just that. With education, visitors to national parks along the Great Lakes learn how a carelessly transported piece of firewood or soil in a hiking boot can accidentally introduce a plant or animal to a place where they have never existed before.

"I compare invasive species to bullies," says Amie Lipscomb at Sleeping Bear Dunes National Lakeshore, "They just don't have any boundaries or rules here without their native predators. People understand that, especially kids. Everyone knows a bully and can imagine one in the plant and animal world."

By demonstrating how invasive species are spread, Lipscomb and other park rangers that specialize in invasive species education are ensuring that the next wave of park visitors will not re-infest the areas we are working so hard to restore

Park rangers and volunteers remove the "bully" plant Dame's Rocket from Sleeping Bear Dunes National Lakeshore. (NPS photo)

In addition to the direct contact with park visitors that has now reached over 100,000 visitors, NPS has used GLRI funds to develop, in cooperation with the University of Wisconsin at Madison, a web-based invasive plant database and email-based early detection warning system that the public can use. This Great Lakes Early Detection Network went into operation last year, providing a central data hub for information on invasive species sightings. Cooperative agreements with non-profit organizations located near the parks, like Cleveland Metroparks and The Nature Conservancy, are making possible expanded efforts in Cooperative Weed Management Areas. Finally, a multifaceted media campaign in cooperation with the non-profit group Wildlife Forever is spreading the word on preventing the introduction and spread of invasives. Products developed through this project include a poster series, billboards, boot brush stations, a series of award-winning short films, rack cards, displays, interpretive kiosks, and Junior Ranger activities, to help ensure parks are invasive-free for future generations (see sidebar).

For more information:

Little Things Big Problems Videos
http://www.youtube.com/user/Gr8LakesRestoration/videos

Great Lakes Junior Ranger Activities ***http://www.nps.gov/pevi/forkids/upload/GL-Jr-Ranger-Web-Friendly-8-5x11.pdf***

National Parks in the Great Lakes Watershed:

- Apostle Islands National Lakeshore ***http://www.nps.gov/apis***
- Cuyahoga Valley National Park ***http://www.nps.gov/cuva***
- Grand Portage National Monument ***http://www.nps.gov/grpo***
- Indiana Dunes National Lakeshore ***http://www.nps.gov/indu***
- Isle Royale National Park ***http://www.nps.gov/isro***
- Pictured Rocks National Lakeshore ***http://www.nps.gov/piro***
- Sleeping Bear Dunes National Lakeshore ***http://www.nps.gov/slbe***
- Perry's Victory & International Peace Memorial ***http://www.nps.gov/pevi***

Park rangers share the invasive species prevention message by speaking to groups, guiding hikes, leading work days, and by encouraging the use of educational tools like a boot cleaning station. (Photo credit:Ted Winterfeld)

Park ranger Amie Lipscomb shares with school children about one of the animals threated by invasive plant bullies, the endangered Great Lakes piping plover. (NPS photo)


FIRE

Cave Point, Door County, Wisconsin
Credit: Taylor Trimble

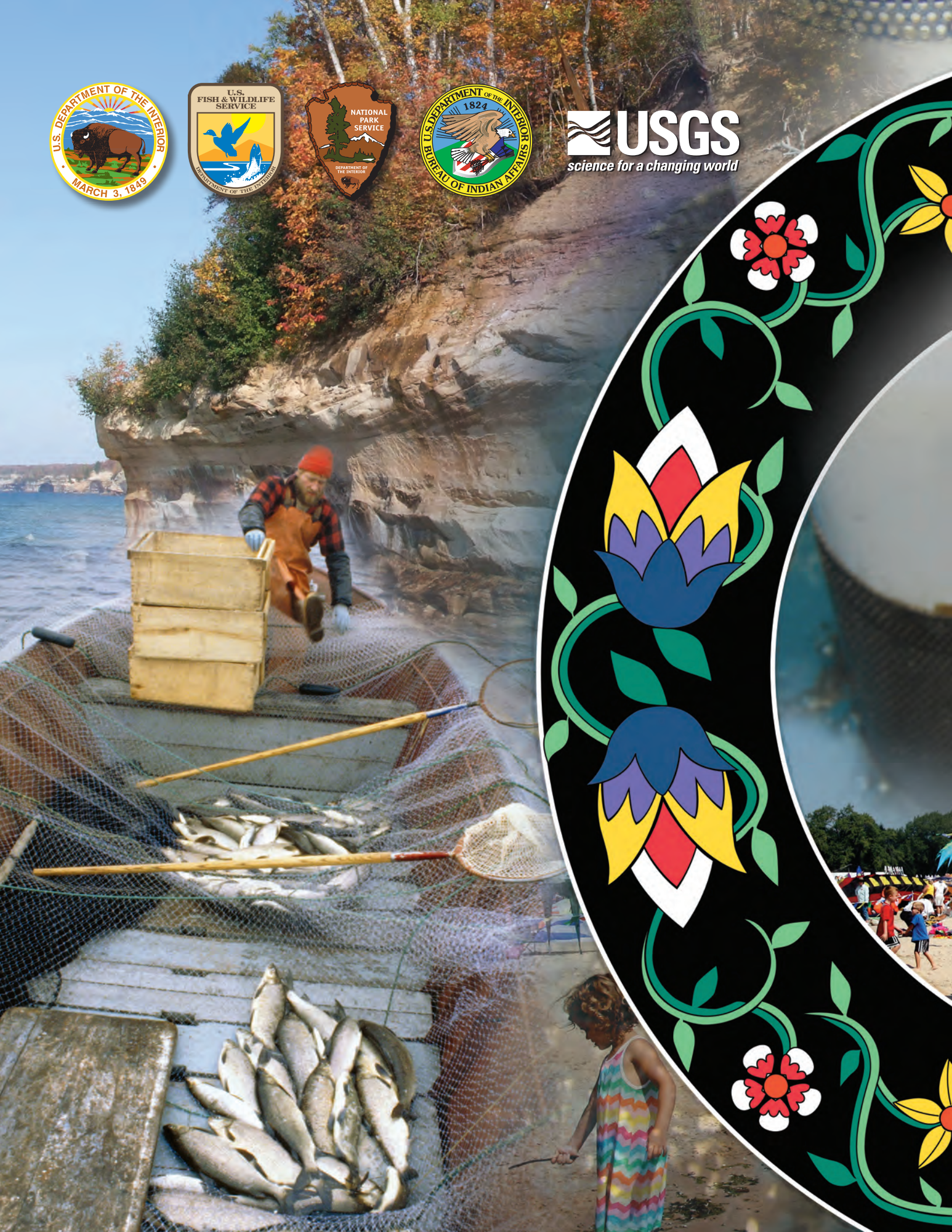
DOI GLRI Interagency Task Force and Regional Workgroup Points of Contact

Interagency Task Force Members

- **DOI Acting Assistant Secretary** – Fish, Wildlife and Parks
    - Rachel Jacobson
- **DOI Deputy Assistant Secretary** – Policy and International Affairs
    - Lori Faeth
- **DOI Deputy Assistant Secretary** – Water and Science
    - Lori Caramanian

Regional Workgroup Points of Contact

- **Bureau of Indian Affairs**
    - Tammie Poitra, Deputy Regional Director, Trust Services
    - Mary Manydeeds, Hydrologist
- **Fish and Wildlife Service**
    - Charles Wooley, Deputy Regional Director, Midwest Region
    - Charles Traxler, Assistant Regional Director – External Affairs, Midwest Region
- **National Park Service**
    - Mike Reynolds, Midwest Regional Director
    - Phyllis Ellin, Midwest Region Partnerships Liaison
    - Jerrilyn Thompson, NPS Research Coordinator
- **DOI Office of Environmental Policy and Compliance**
    - Andrew Raddant, Regional Environmental Officer – Boston
    - Lindy Nelson, Regional Environmental Officer – Philadelphia
- **US Geological Survey**
    - Leon Carl, Regional Director, USGS Midwest Region
    - Norman Grannemann, USGS Great Lakes Program Coordinator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