### Great akes SMALL STREAMS

HOW WATER SHAPES WISCONSIN

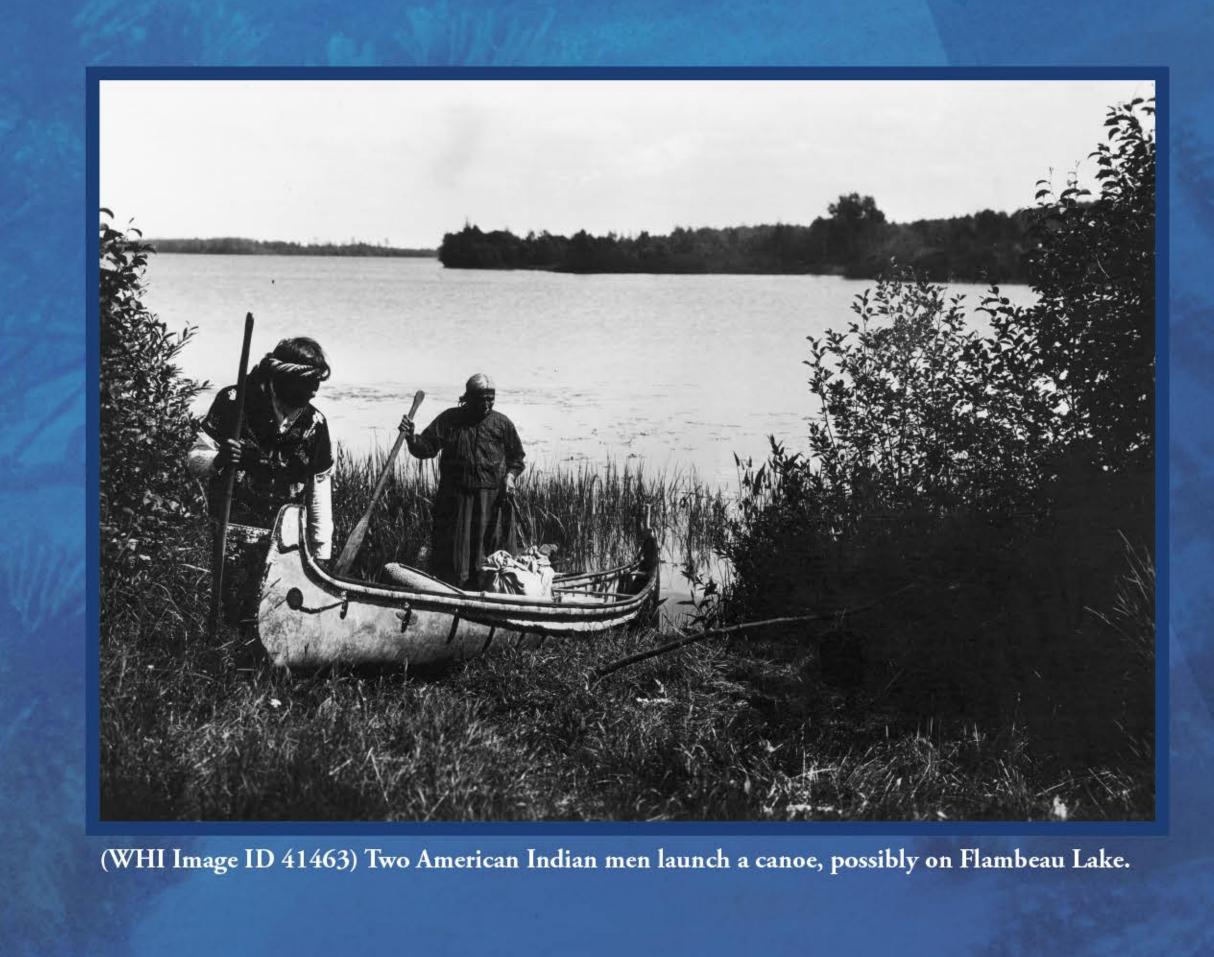


(WHI Image ID 33334) Children pose around a bubbler at the Wisconsin State Fair in



(WHI Image ID 109228) Jennie and Edgar Krueger hold two carp strung up on a pole in Emmet, Wisconsin, in a photograph taken around 1902.





Water is the most important resource we have.

We drink it, fish in it, clean with it, swim in it, and travel across it. Water makes up sixty percent of the human body. It powers our homes and factories. Every living thing on Earth needs water.

Water has always been critical for our survival. As people have tried to manage water resources, they have made many changes to waterways. Many of these changes have benefitted people; other changes, though, have not.

The Great Lakes region is home to one of the largest freshwater resources on the planet. All of that water helped to shape the landscape, history, and communities of our state.



The Great Lakes contain twenty percent of Earth's surface fresh water. Wisconsin alone has more than 860 miles of Great Lakes shoreline, 44,000 miles of rivers and streams, and 13,949 lakes larger than fifty



How has water shaped Wisconsin, and how have we shaped our water?

acres!

## Long ago, oceans and glaciers created many of the waterways and geological features in and around our state.

Millions of years ago,
Wisconsin was covered with a
shallow sea of saltwater. This
huge ocean was filled with life!
Over time, some of these
creatures, like corals and
clams, died and sank to the
bottom. There, they cemented
together to form limestone.
Today, geologists study
limestone to find fossils and
learn more about this ancient
ocean.

About one million years ago, the climate grew colder. More snow fell in the winters than could melt in the summers. The ice and snow eventually formed glaciers across what is now Canada and the Upper Midwest. As the glaciers moved across Wisconsin, they changed the land beneath them. Glaciers created the Great Lakes and many other lakes and rivers in our state.



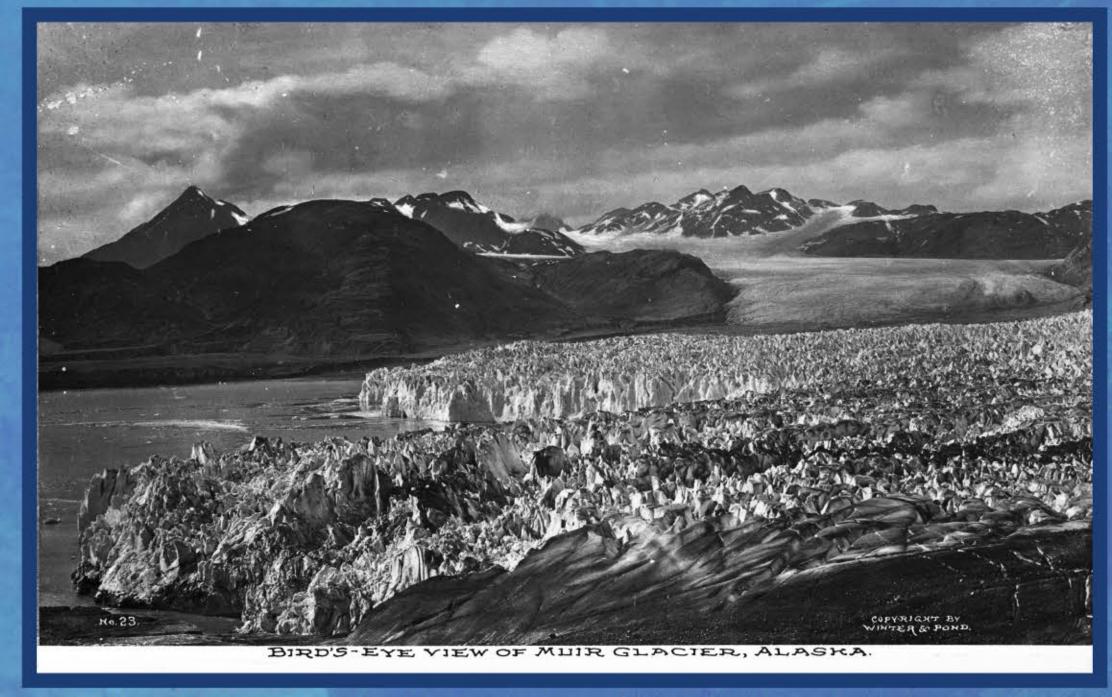
The Wisconsin Dells were formed by rushing water from melting glaciers.



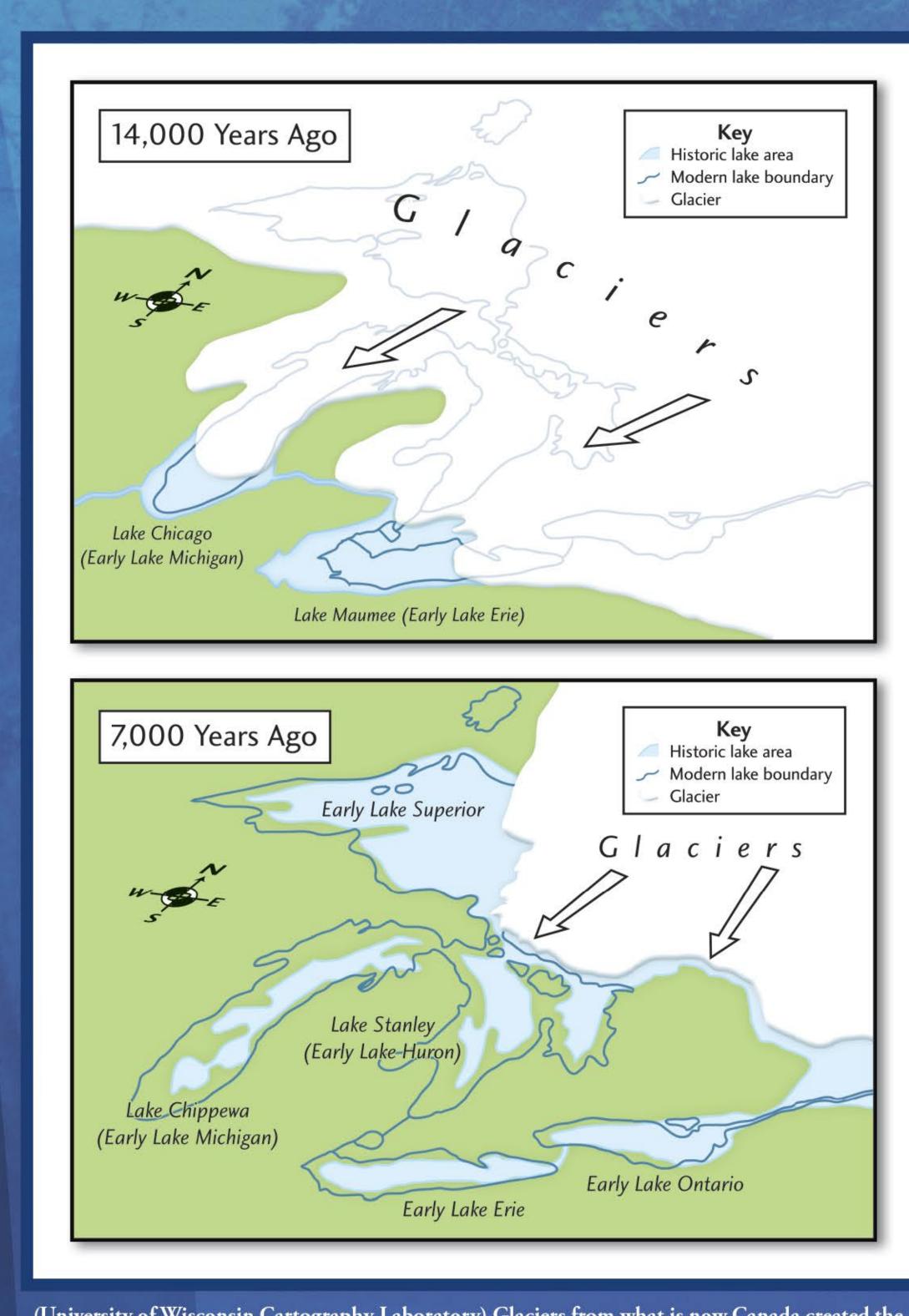
(Courtesy of the Milwaukee Public Mi ocean that may have looked like this.



(Courtesy of the Milwaukee Public Museum) This fossil belonged to an ancient snail that lived in Wisconsin's saltwater sea.



(WHI Image ID 81463) Glaciers, like the one pictured here in Alaska, are large, slow-moving sheets of ice. They once covered much of Wisconsin.

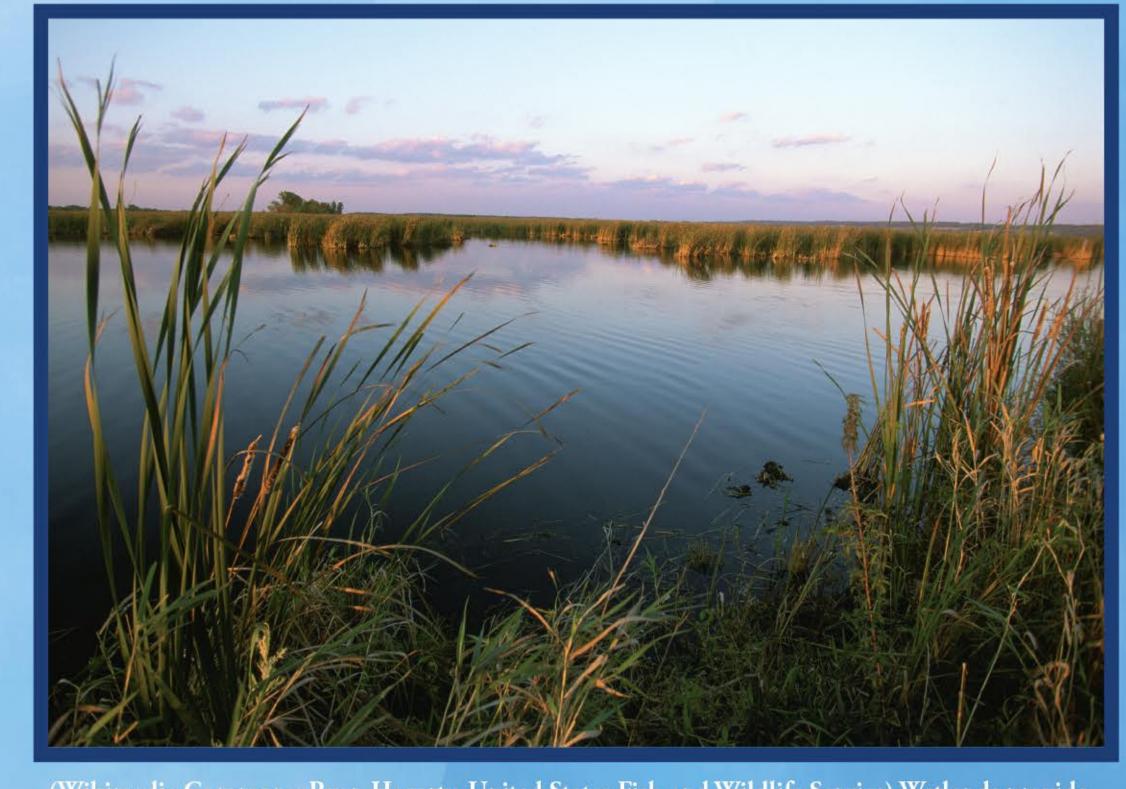


(University of Wisconsin Cartography Laboratory) Glaciers from what is now Canada created the Great Lakes when they deepened the lake basins and filled them with water.



How have Wisconsin's waterways provided a home for plants and animals?

### Wisconsin's waters and wetlands provide habitats for many unique species of plants and animals.



(Wikimedia Commons: Ryan Hagerty, United States Fish and Wildlife Service) Wetlands provide habitat for many plants and animals but are often threatened by land development and pollution.



(Wikimedia Commons) Aquatic habitats, like the Chequamegon Waters Flowage pictured here, support fish, plants, insects, amphibians, mammals, and birds.



(Wikimedia Commons: Leslie Velarde, National Park Service) The great blue heron depends on



habitat destruction and pollution.



Wisconsin is home to more than 2,400 species of native plants and animals. Many of them rely on water as a vital part of their habitat.

Wetlands are areas where the soil is frequently wet or covered in water. Wetlands are home to many plants and animals, such as yellow water lilies, great blue herons, and boreal chorus frogs. Some organisms spend their entire lives in the water, while others only need wetlands for part of their lifecycle. Wetlands once covered one third of Wisconsin. Over time, people have changed and damaged nearly half of this land.

Lakes, rivers, and streams are called aquatic communities. These communities are home to many different species, like lake sturgeon, mudpuppies, and muskellunge. Many species in these communities get all they need to survive directly from the water.



In 2014, there were 233 species of endangered or threatened plants and animals in Wisconsin.

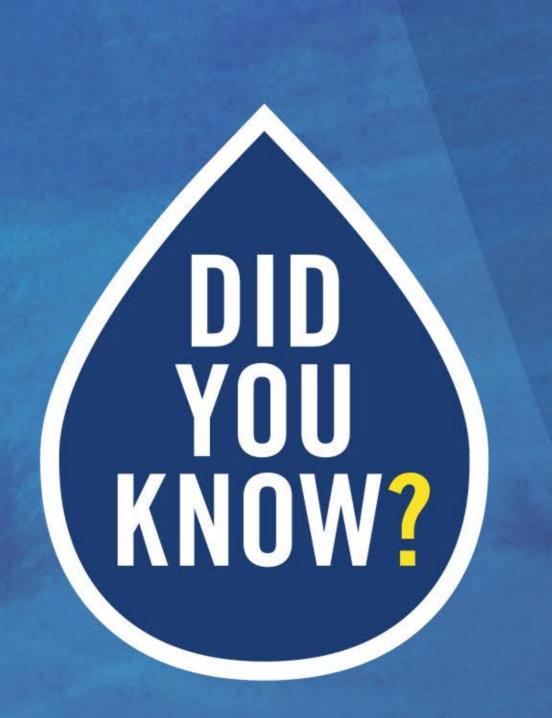


How have people inhabited the land and used its waterways?

## Native people were the first to use the natural resources of the Great Lakes region.

Native nations and tribes began using Wisconsin's waterways as early as 12,000 years ago. These original residents made their homes near streams, lakes, and rivers. They used waterways and wetlands to fish, hunt, and gather plants.

Wisconsin's Native people made much of what they needed from nearby resources, but they also depended on other materials that came from farther away. Native people used the water highways of Wisconsin to travel all over the Great Lakes region. They built canoes to carry large amounts of food, trade goods, and other supplies. Waterways were often the best and fastest way to travel.



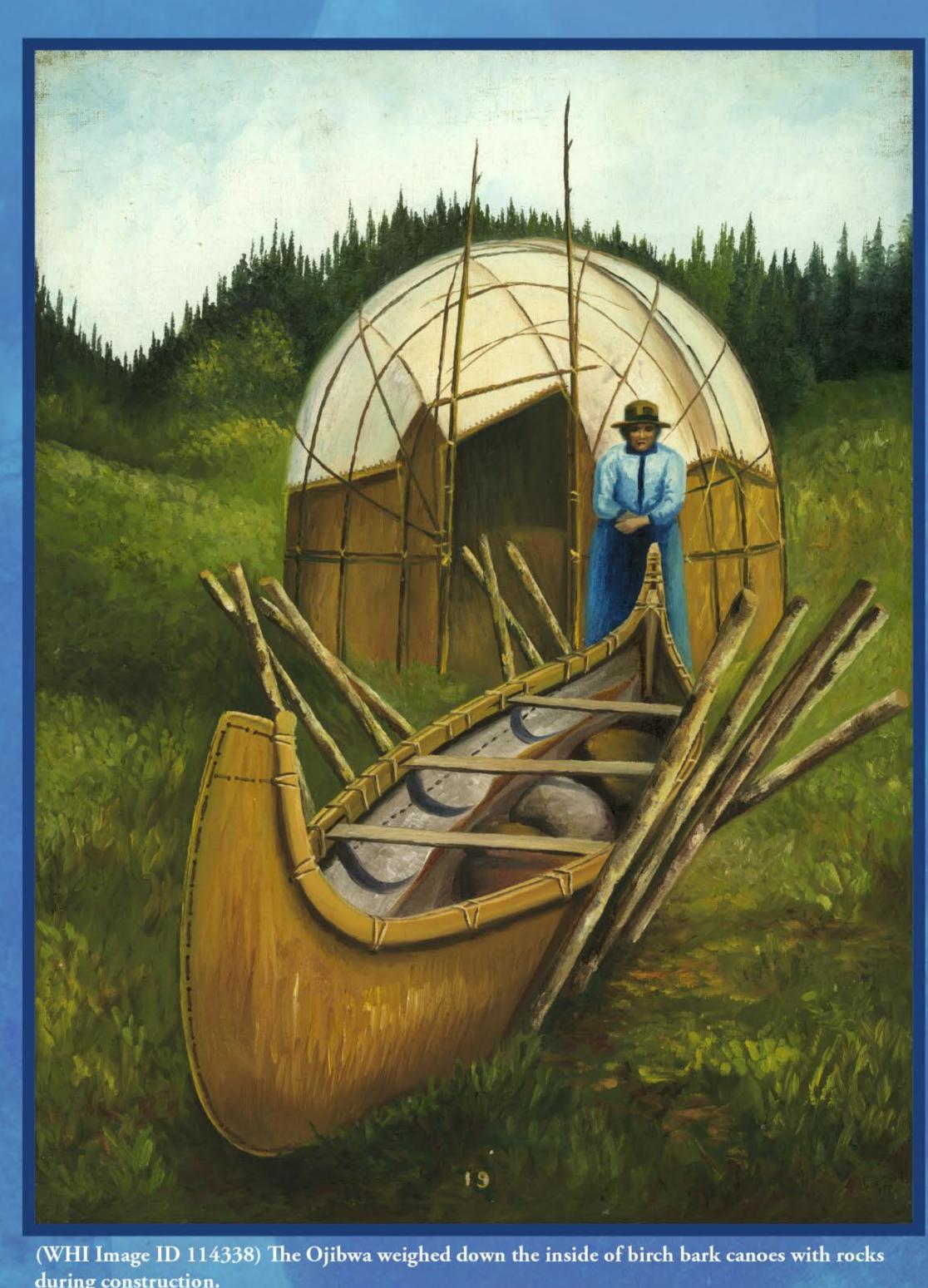
It was often easier to trade with someone three hundred miles away by water than with someone thirty miles away across land!



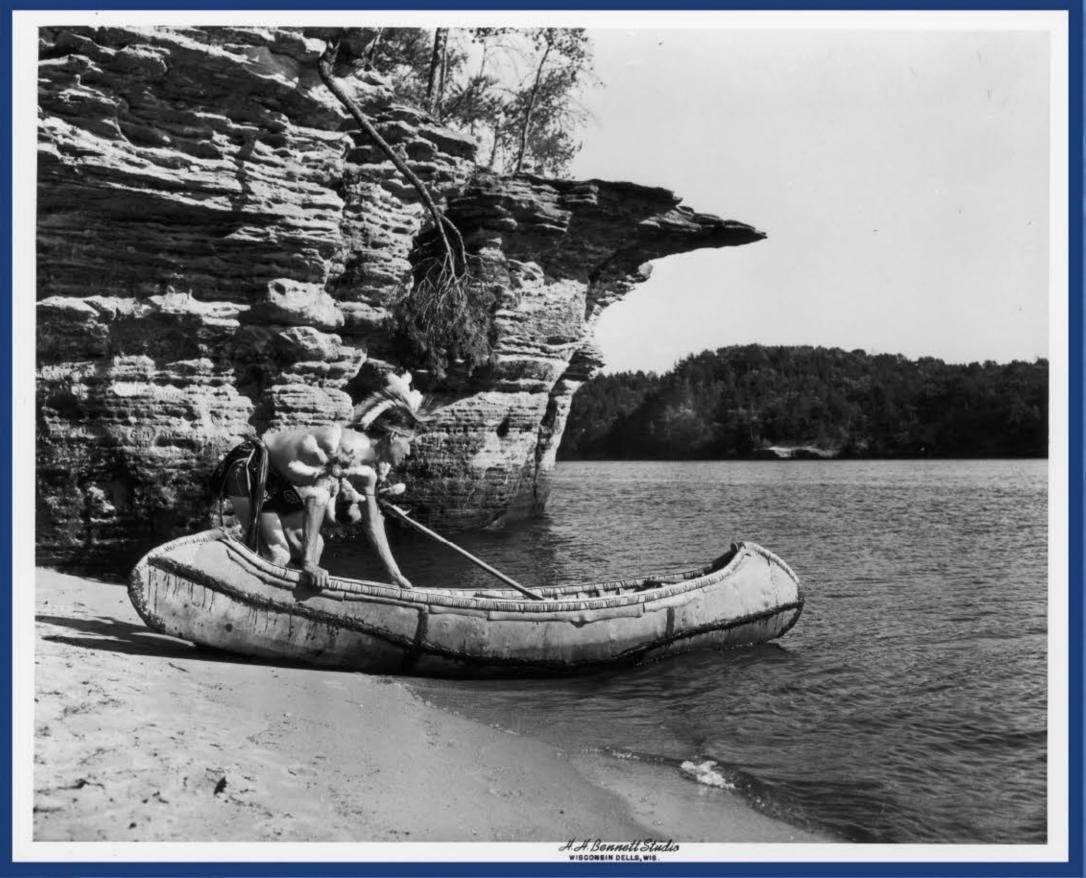
(WHI Image ID 9023) American Indians often used canoes when hunting or gathering food Here, three American Indian women harvest wild rice.



(WHI Image ID 95718) A small group of American Indians spears fish through ice on a river.



(WHI Image ID 114338) The Ojibwa weighed down the inside of birch bark canoes with roc during construction.



(WHI Image ID 32604) An American Indian man launches a canoe into the water in the Wisconsin Dells.

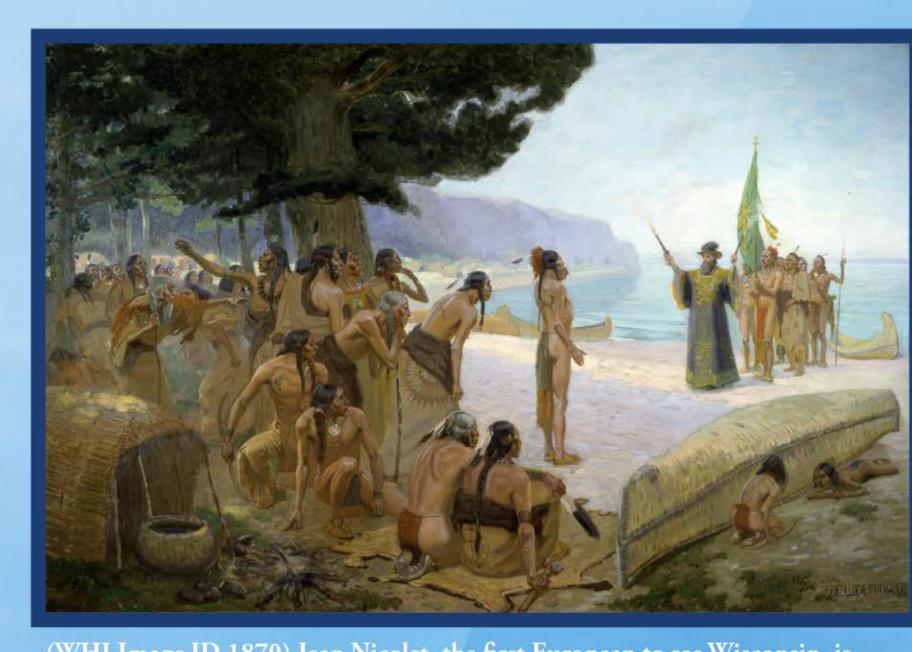


Members of Wisconsin's American Indian nations continue many of their ancestors' traditions today. Here, Travis Thorbahn and Fred Ackley farm wild rice on the Mole Lake Reservation.

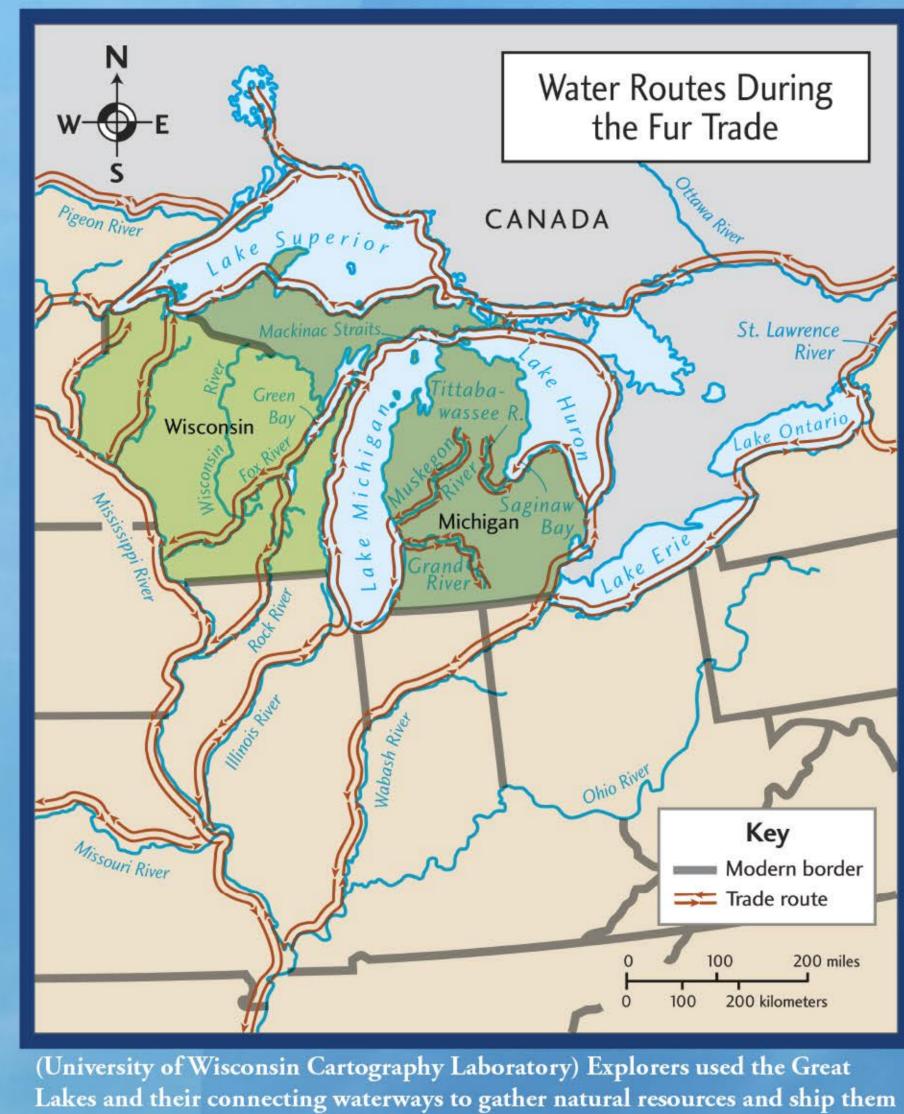


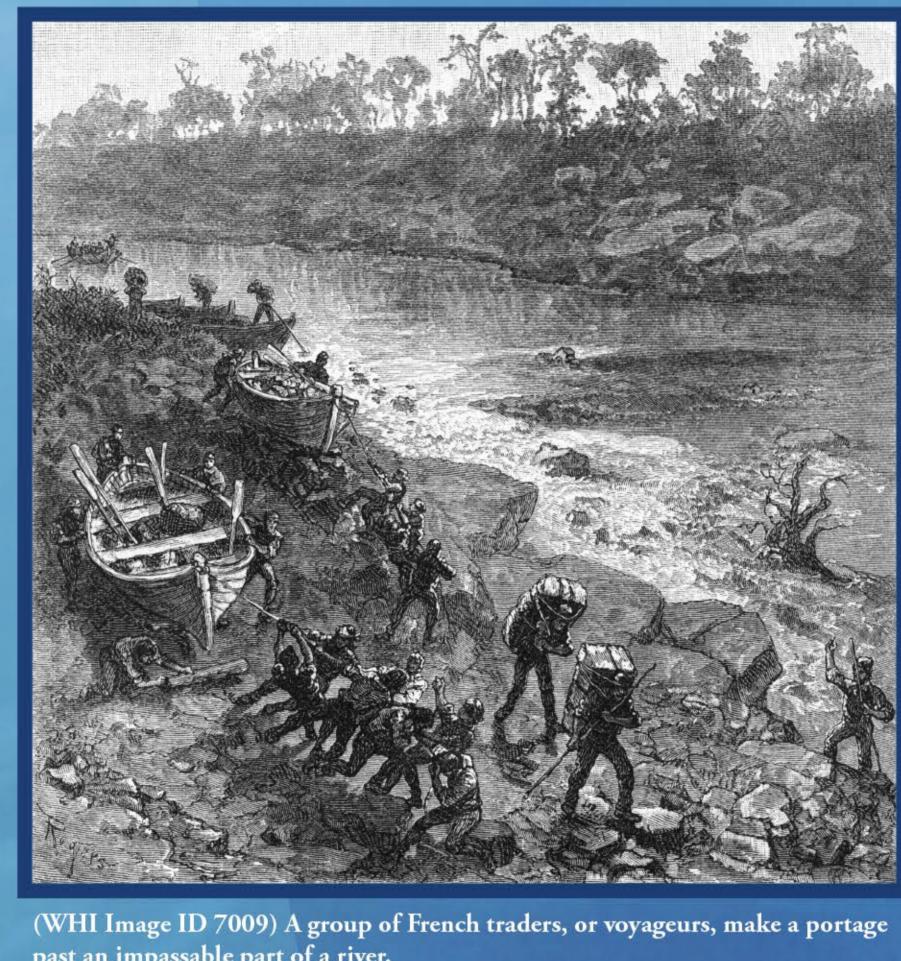
How did water use change when Europeans arrived in Wisconsin?

Explorers and fur traders used the Great Lakes and their connecting waterways to gather resources and ship them back to Europe.



(WHI Image ID 1870) Jean Nicolet, the first European to see Wisconsin, is greeted by a group of Menomonee Indians in this twentieth century painting. Nicolet landed at Red Banks, near modern-day Green Bay, in 1634.





past an impassable part of a river.



conversing with European traders at the Hudson Bay Company's fort.



circa 1755.

European explorers and fur traders began to arrive in North America in the early 1600s. River systems carried people and goods across Wisconsin from Lake Michigan to the Mississippi River. From there, explorers and traders could go anywhere the Mississippi would take them!

The fur trade dominated Wisconsin for the next two hundred years. Traders provided guns, steel knives, and other items to Native people. In return, Native people hunted otter, mink, and beaver for their fur. Traders packed these pelts into canoes and sent them to Montreal and eventually to Europe. Traders often exploited their fur suppliers as Native people became dependent on the fur trade.



Beaver pelts were the most valuable pelt in the fur trade era. They were made into waterproof hats that were fashionable in Europe.



How did waterways shape the settlement of Wisconsin?

# As people began to shape the land and waterways to make travel easier, settlement in Wisconsin expanded rapidly.

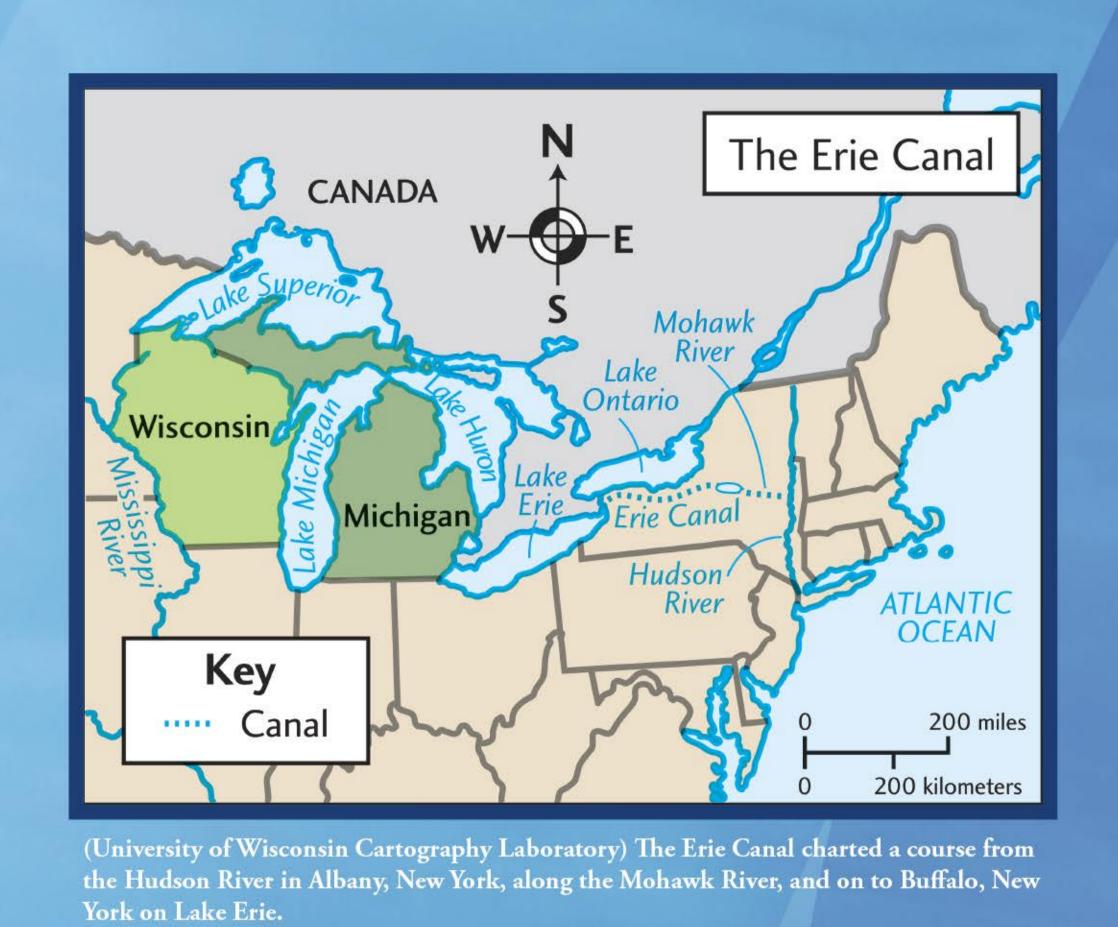
Even though Wisconsin was a crossroads for Native people, explorers, and fur traders, it was still far from larger settlements out east. Traveling over land was difficult and slow.

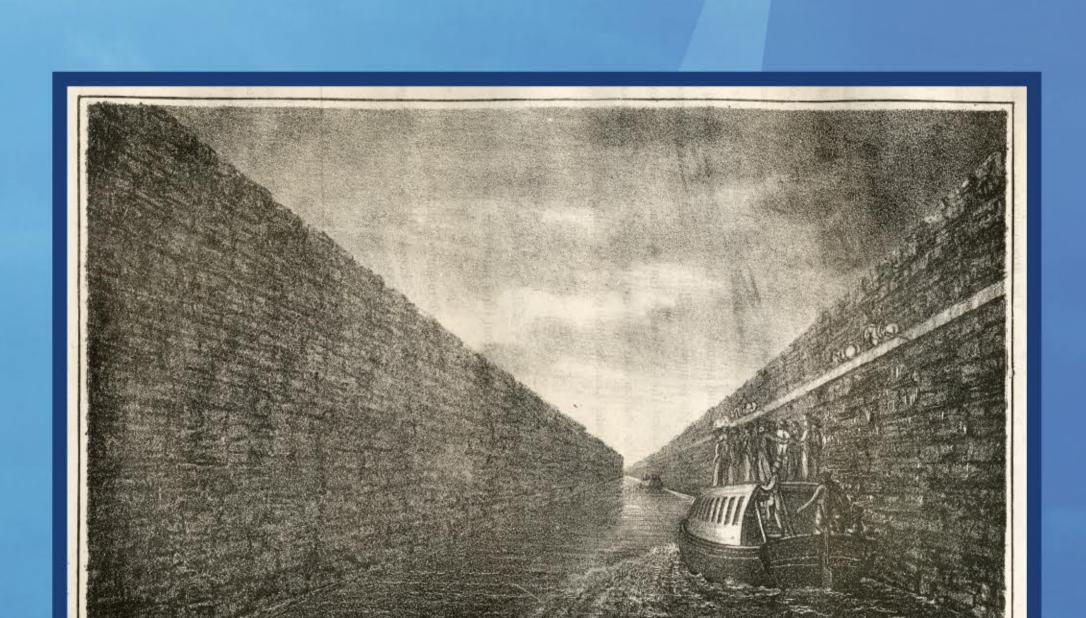
The Erie Canal was completed in 1825. For the first time, people could travel by water from the northeastern United States to the Great Lakes region. Over the next twenty years, more than 40,000 boats traveled through the canal.

The first white settlements in the Great Lakes region began along waterways. These communities were often in the same places where Indian villages and trading posts once stood. The American government forced many tribes to sign treaties giving up their lands in the area to further settlement.

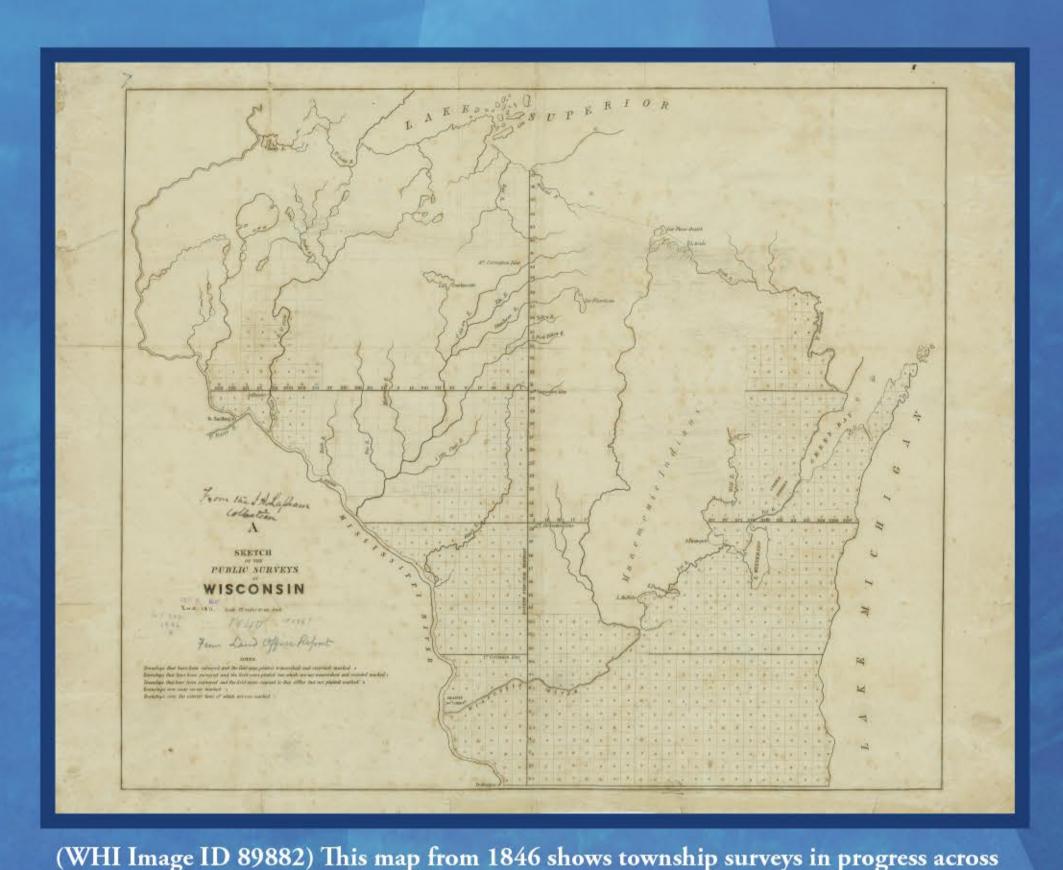


Wisconsin's population grew from 11,000 in 1836 to one million by 1870!

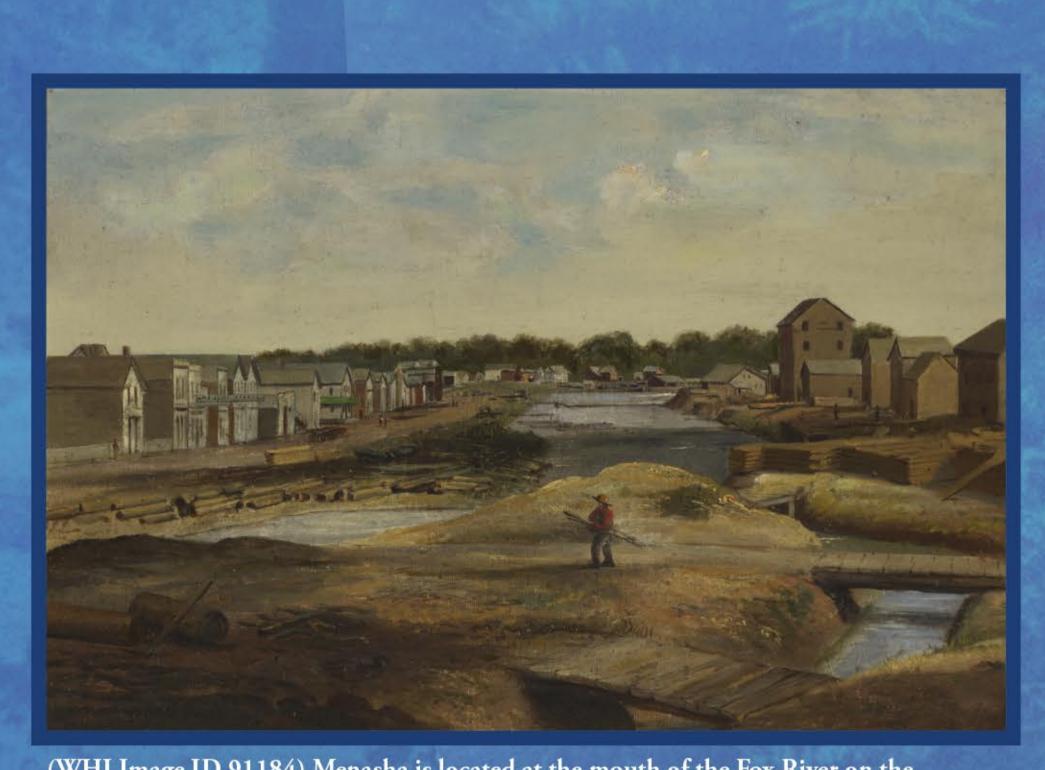




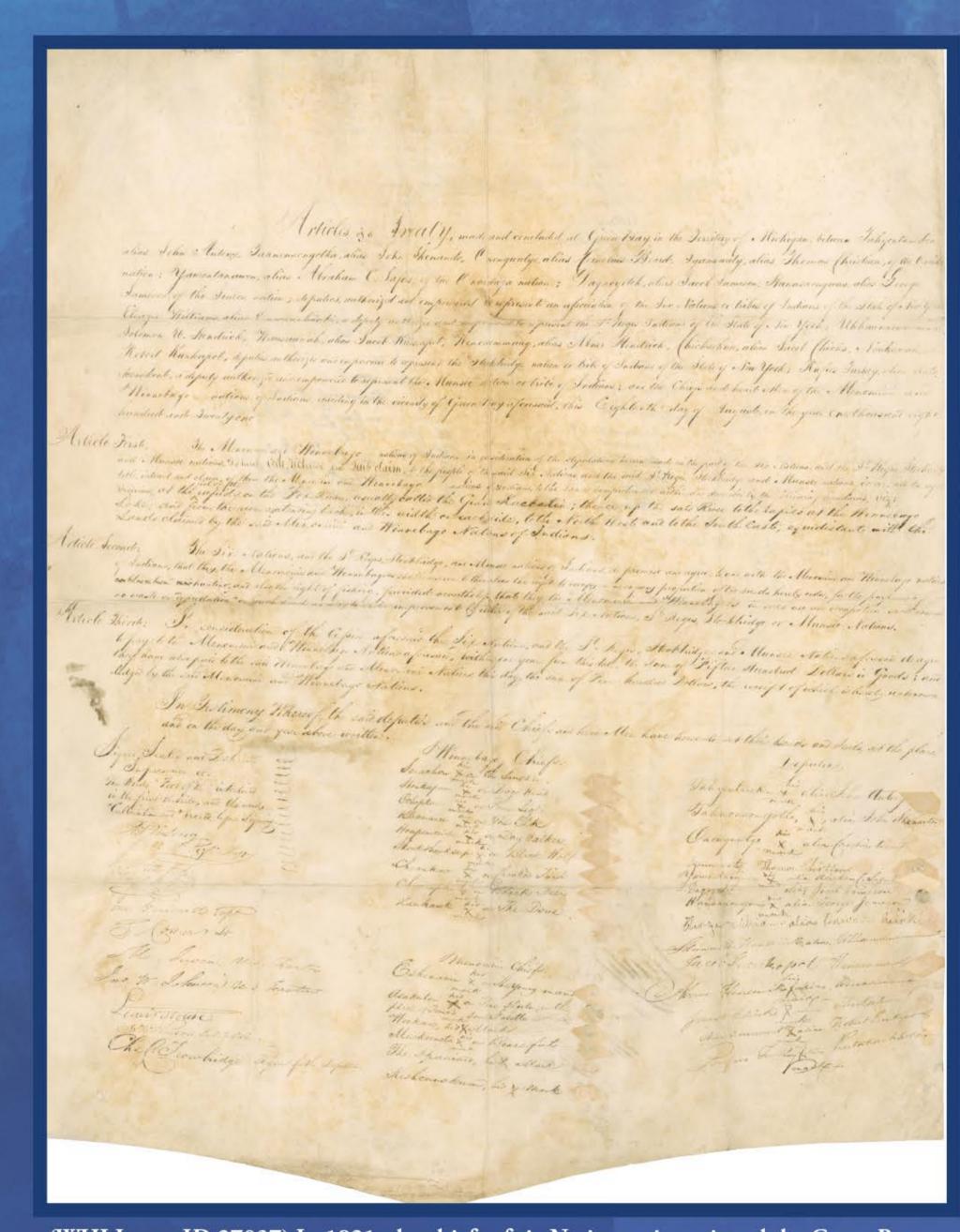
(WHI Image ID 101359) Boats were towed by horses through the Erie Canal at Lockport around 1825.



Wisconsin. After the federal government opened land offices in Mineral Point and Green Bay in 1834, settlement increased rapidly.



(WHI Image ID 91184) Menasha is located at the mouth of the Fox River on the northern tip of Lake Winnebago. In the 1600s, the Fox Indians established a village and collected tolls from passing canoes. White settlers came to Menasha in 1835.

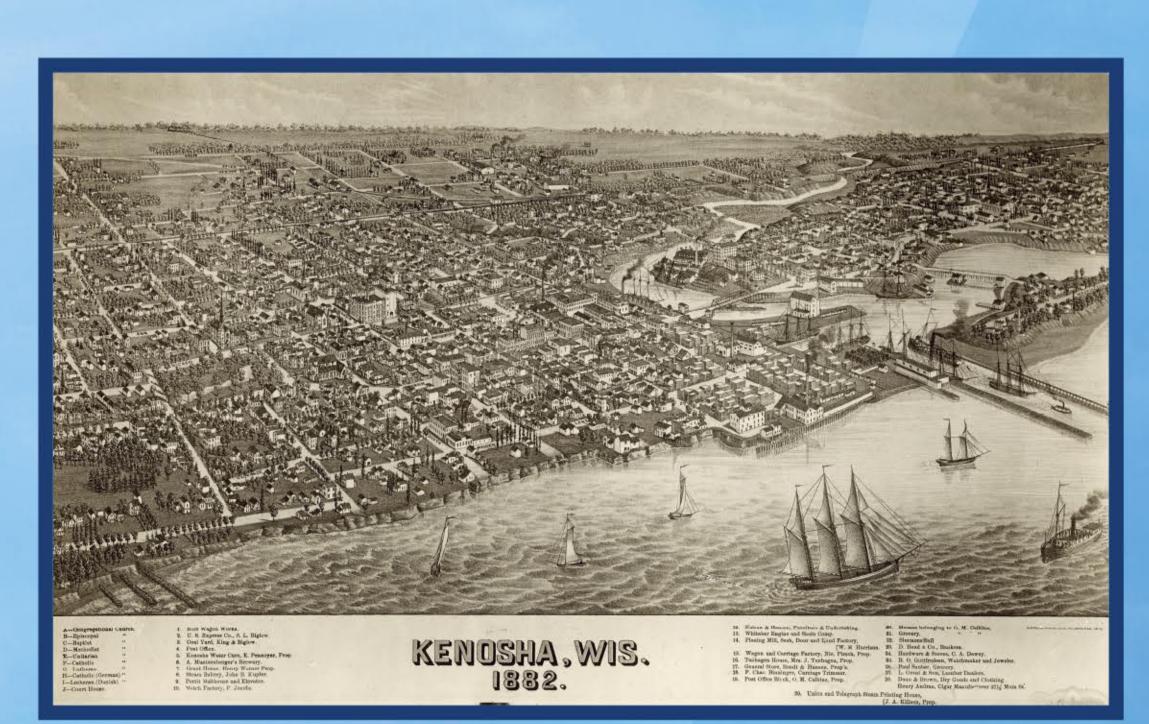


(WHI Image ID 27037) In 1821, the chiefs of six Native nations signed the Green Bay Treaty, giving up possession of lands near the Fox River.

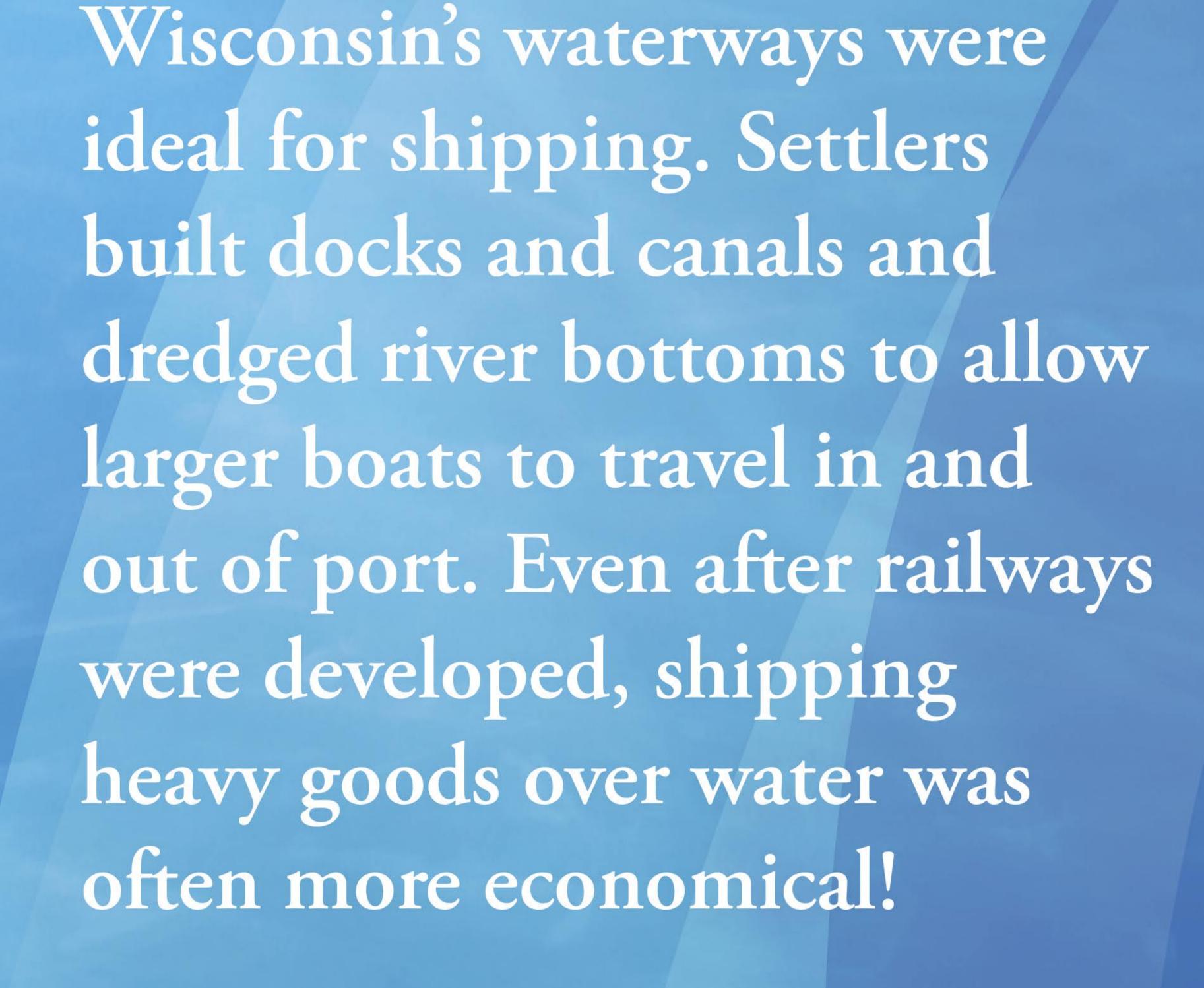


How did Wisconsinites use water to make a living?

# Wisconsin's natural waterways and dams provided resources and power for industrial development.



(WHI Image ID 12378) Kenosha, seen here in an 1882 map, had an advantageous position on Lake Michigan and connections to plank roads and rail lines connecting Green Bay, Milwaukee, and Chicago.

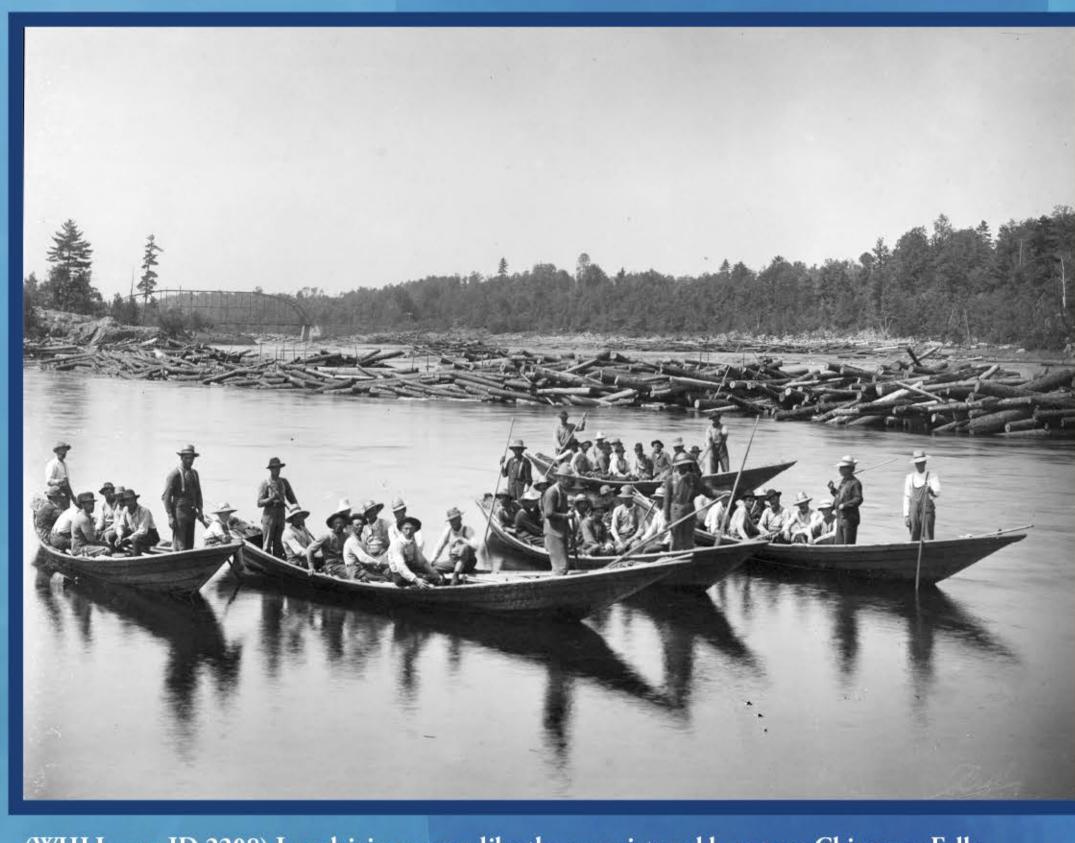


Settlers also built dams and water wheels along rivers to harness the power of water. Water power served many of the state's growing industries, such as milling, lumbering, and paper making.

By 1860, the port city of Milwaukee had become a center of modern manufacturing. Today, agriculture and the production of heavy machinery, tools, and engines dominate Wisconsin's economy. All of these industries, then and now, rely on water!



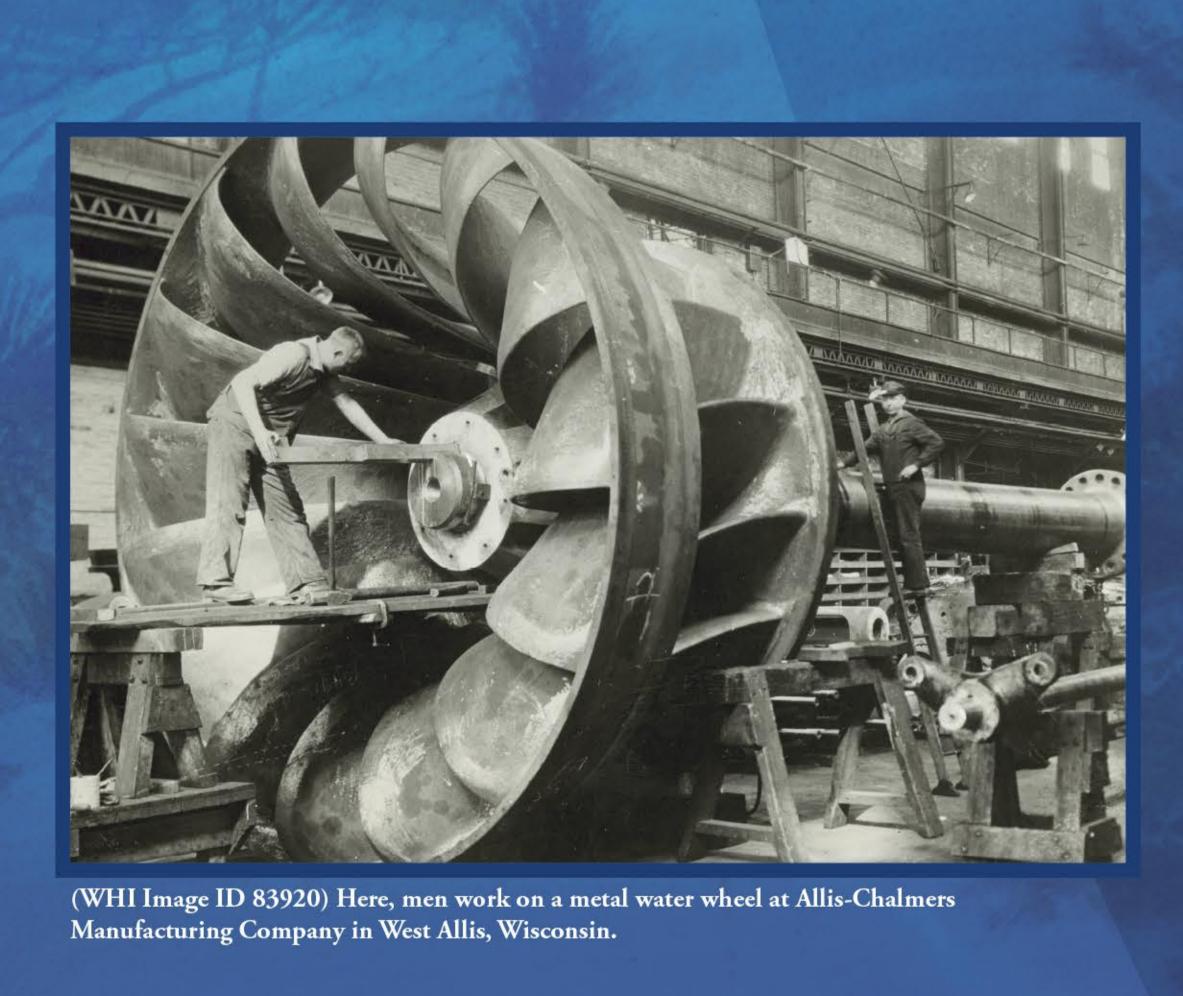
like sawmills or gristmills. Munger's mill and dam, pictured here in 1895, were located in the Wisconsin Dells.



(WHI Image ID 2208) Log driving crews, like the one pictured here near Chippewa Falls, Wisconsin around 1900, floated cut logs downstream to sawmills for processing. In the second half of the 1800s, lumbering created most of Wisconsin's jobs and wealth.



(WHI Image ID 41733)The Neenah Paper Mill, built in 1865-66, was the first paper mill in Neenah, Wisconsin. Paper companies were the state's fourth largest industry by 1925.





Early Wisconsin industries also included cranberry harvesting, collecting pearls, shipbuilding, ice harvesting, brewing, tanning, and meat packing.



How did settlement and industry affect waterways?

### The ways people use natural resources can harm the environment.

Many of the changes we make to the environment have immediate benefits. Increasing fuel and food production, improving transportation, and removing waste are all good things. Sometimes, though, these same changes have long-term negative effects as well.

In the 1800s, people started burning large amounts of fossil fuels to power everyday life. This released carbon dioxide, a heat-trapping gas, into the atmosphere and started a period of climate change that continues today. Glacial melt, rising sea levels, and random and severe weather like floods and droughts are only some of the results of climate change.

When people overuse natural resources without thinking about the risks, they harm the environment. People affect water resources in lasting and damaging ways when they don't consider the full impact of their actions.



heavy industries have polluted land and waterways.



Orleans in 1965. Floods after Hurricane Katrina in 2005 caused drinking water to become contaminated when it mixed with flood water and sewage.



(WHI Image ID 6393) Men with shovels try to manage flood waters at Villa Louis. Weather is expected to become more unpredictable as our climate changes.



(WHI Image ID 75162) A boy stands near a large area of soil erosion in a rural area around 1915. Soil erosion occurs when wind or water removes soil from land, particularly after the land has



Even though carbon dioxide occurs naturally in the atmosphere, it has gone up about thirty-five percent since the beginning of the Industrial Age!



How have people negatively affected Wisconsin's waterways?

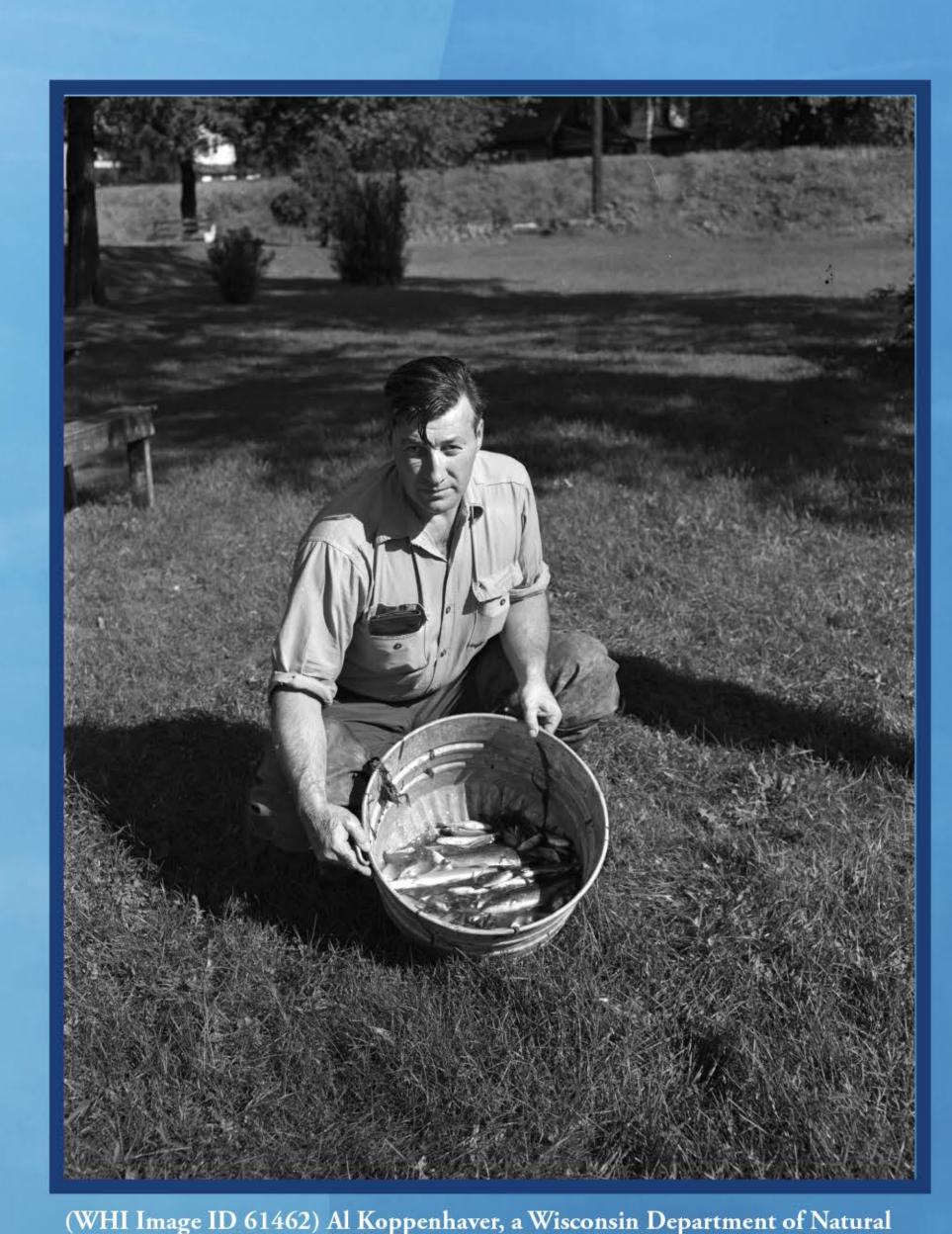
been cleared for farming.

## DAWN

(WHI Image ID 40826) A dock and boats in the Wisconsin Dells are covered with pollution from paper mills upstream in 1955.



(WHI Image ID 47153) Smokestacks from large industries pump gases, chemicals, and debris into the air. These pollutants harm waterways when they come back down as precipitation.



Resources game warden, holds fish taken from the Yahara River in Madison, Wisconsin, that were killed by industrial waste in 1949.



(Wikimedia Commons: Michael Pereckas) Road salt causes chloride levels in local waterways to increase. High salt concentrations make it hard for many aquatic species to survive.



(WHI Image ID 60301) Two men spray large amounts of DDT onto tall grasses near the water in Madison, Wisconsin. Years later, DDT was exposed as toxic to animals and people and was banned in the United States in 1972.



The Wisconsin
Department of Natural
Resources has identified
almost 1,700 bodies of
water in the state that
don't meet water quality
standards.

## Pollution can have far-reaching and unexpected effects.

Pollution is caused by many things. Storm water and overflowing sewers are two major sources of water pollution. Even life-saving drugs that enter the water supply become a form of pollution!

The most common source of water pollution in Wisconsin is runoff. Runoff happens when rain or melting snow cause water to flow across land into places where water collects. Runoff can carry pollutants such as road salt or pesticides throughout watersheds, areas of land that drain into the same waterway.

In the 1940s and 1950s, an insecticide called DDT was widely used to control pests. By the 1960s, evidence emerged that DDT was damaging the environment and wildlife. Through testimony before the Wisconsin Department of Natural Resources, much of the nation heard the full scientific case against DDT for the first time. Although DDT was banned nationwide in 1972, other pesticides still contribute to water pollution.



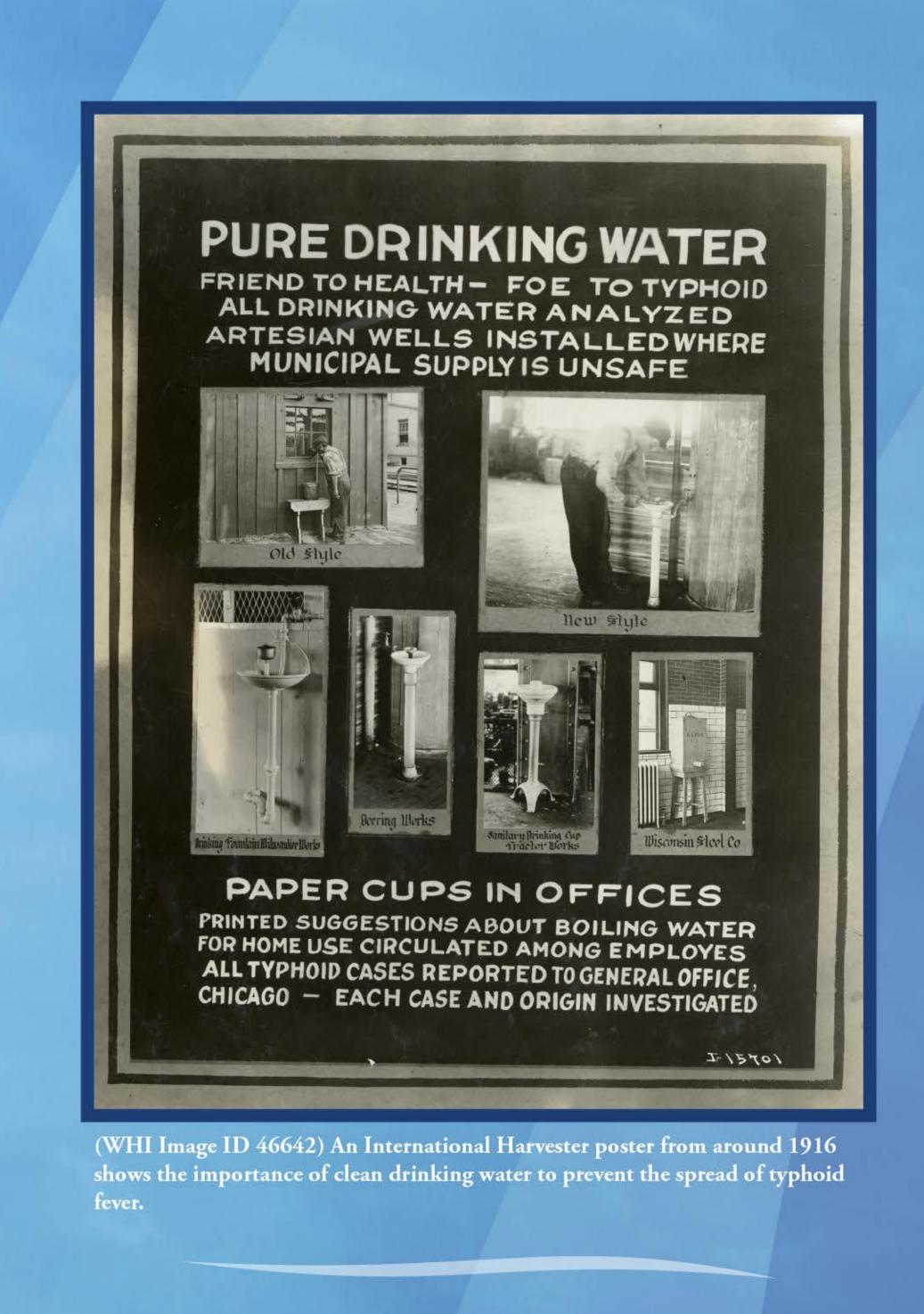
How can dirty water harm people?

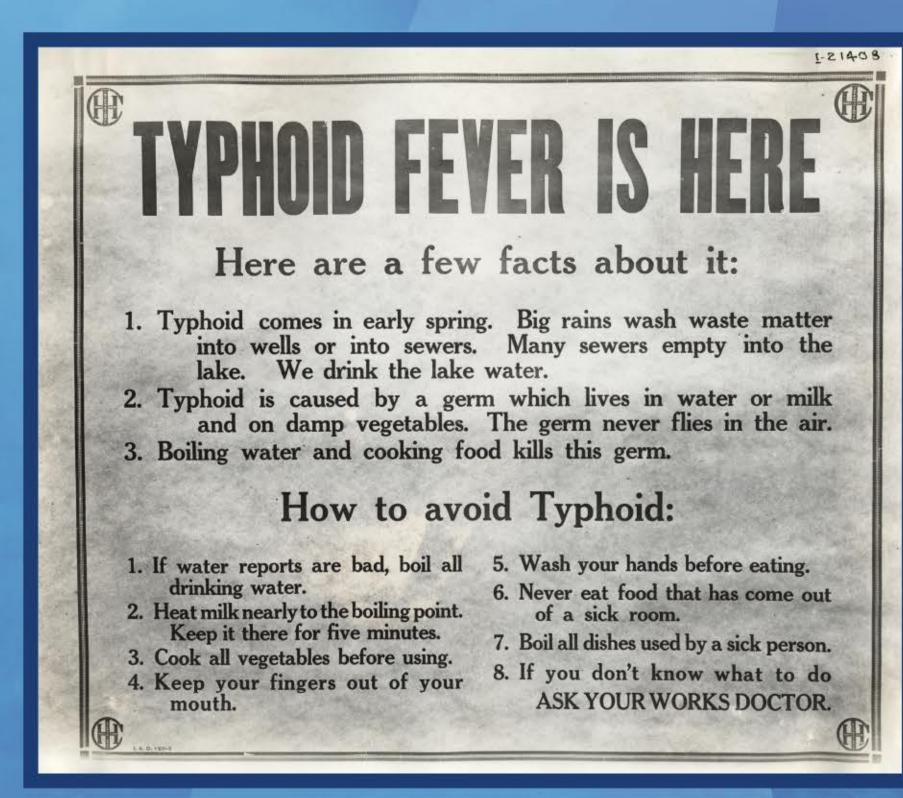
### Clean water is critical to our health, but not everyone has access to safe water.

In many places, water is taken straight from rivers or lakes for cooking, cleaning, and drinking. This water can be contaminated with bacteria, waste, and chemicals. Unclean water is a major cause of illnesses such as typhoid fever and cholera.

Even in Wisconsin, unclean water can be dangerous. In April 1993, Milwaukee suffered outbreaks of cryptosporidium, a parasite that causes severe diarrhea. An estimated 403,000 people became ill. Sixty-nine people died. The outbreak came from contaminated tap water from a local water treatment plant. After the outbreak, Milwaukee improved its water treatment processes. It now has some of the safest drinking water in the world.

There are still many places in the world, even in the United States, that struggle to provide safe water to their people.

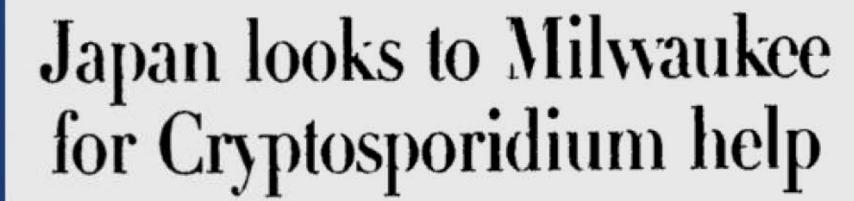




(WHI Image ID 49022) A typhoid fever poster used in International Harvester factories around 1921 educates workers on disease prevention.



(The Milwaukee Sentinel, Courtesy of the Wisconsin Historical Society Archives) People with severely weakened immune systems were especially vulnerable to cryptosporidium. Ninety-three percent of the people who died in the outbreak were AIDS patients.



By Don Beiim of the Journal Sentinel staff

Japan met Cryptosporidium for the first time in June.

The gut-wrenching union was similar in many ways to Milwaukee's 1993 introduction to the health-threatening parasite, a group of five Japanese health

group of five Japanese health and water industry officials said during a visit here last week. They came seeking advice on how to prevent outbreaks.

In early June, diarrhea and stomach cramps swept through the small community of Ogose, and schools were left vacant as children called in sick, said Hiroshi Ono, deputy director of water supply for Japan's Ministry of Health and Welfare. Ogose is 35 miles northwest of Tokyo.

Health and Welfare. Ogose is 35 miles northwest of Tokyo.

Ogose physicians were unable to determine why a growing number of people were ill and why over-the-counter medications did not comfort the afflicted, Ono told a dozen Milwaukee health and water works officials.

Two weeks after the Ogose outbreak began, one doctor decided to look for Cryptospo-

ridium in his patients' stool samples. He found it. On June 19, residents began boiling water and the town's purification plant was shut down. A survey by Japanese health offi-cials later determined that 70% of the town's 13,000 residents were sickened after drinking contaminated water. The source of the parasite has not been determined. The same is true here, although the list of suspects includes overflowing sewers or manure that might have washed off upstream fields. "We can help you," Carrie Lewis, Milwaukee's water quality manager, told the visitors. Step by step, Lewis and others explained the new equipment and precautions that have been installed at the Howard Ave. and Linnwood purification plants in Those include: monitoring water quality continuously, extending the water pipeline serving the Howard Ave. plant into deeper water farther from the Milwaukee River and harbor, replacing filters and planning to

(The Milwaukee Journal Sentinel, Courtesy of the Wisconsin Historical Society Archives) After Milwaukee improved its water treatment systems, it became a model for other cities facing water crises.



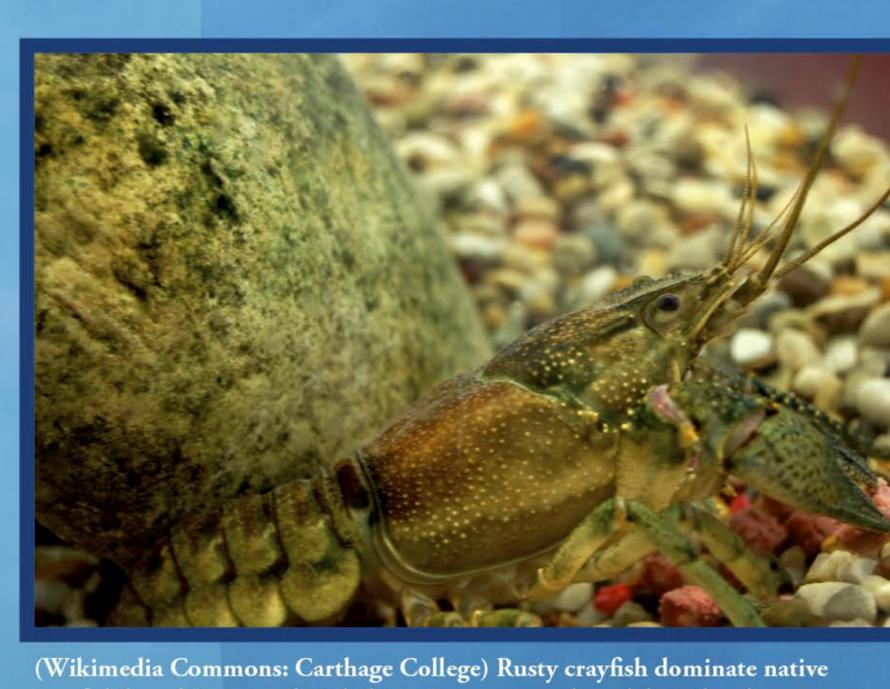
Diarrhea caused by drinking or having contact with dirty water kills as many as 1.8 million young children worldwide every year.



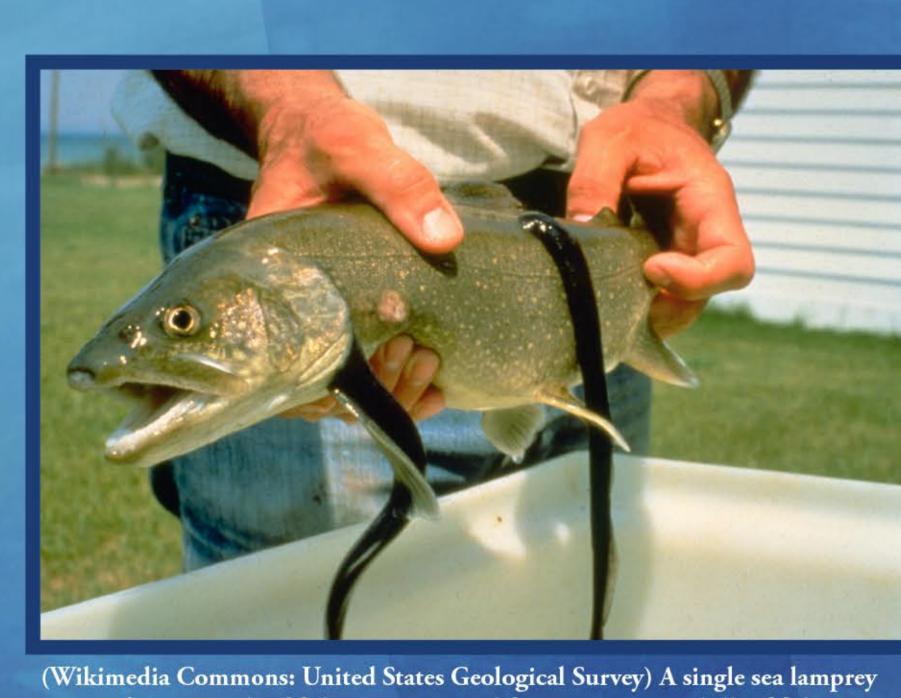
How does the introduction of organisms affect waterways?

### Invasive species threaten our native organisms and cultural resources.





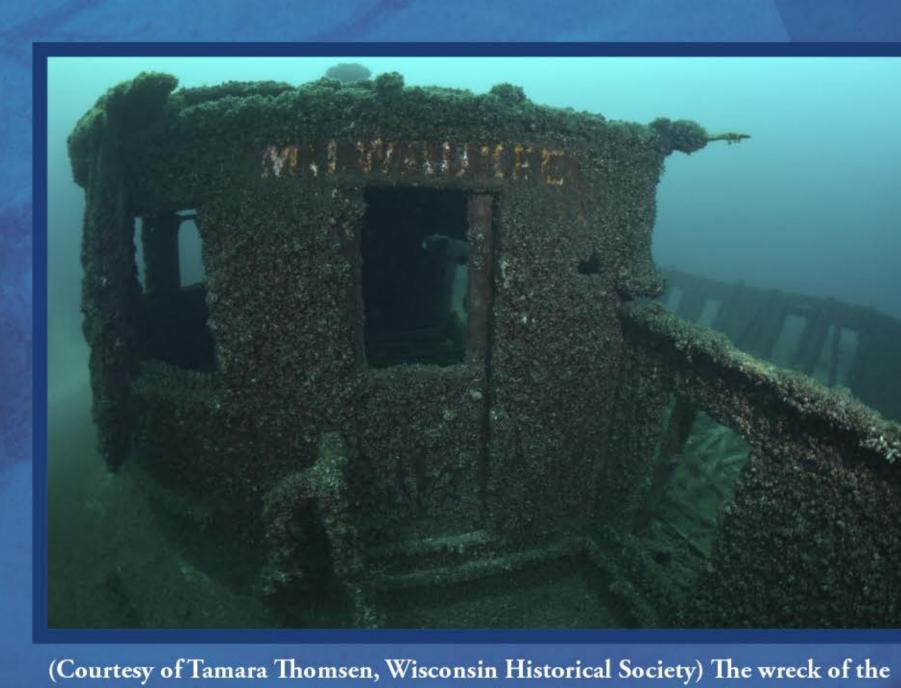
crayfish by taking over their habitat. In some northern lakes, they have eaten most of the aquatic plants.



can eat forty pounds of fish or more in its lifetime. Lampreys kill off fish many Wisconsin fishermen rely on to make a living.



invasive species native to the Atlantic Ocean, are an important resource for the Lake Michigan salmon fishing industry but are harmful to native lake trout and



iron-hulled railroad car ferry "Milwaukee" has been colonized by invasive quagga mussels. Mussels' waste acidifies the water around it, making metal shipwrecks deteriorate faster.

An invasive species is a non-native plant or animal that threatens an ecosystem. Invasive species often out-compete local species for resources like food and habitat. Invasive species may also prey on another species as a food source. This decreases the population of the native plants or animals.

Aquatic non-native species are often brought to new waterways in the ballast water of ships. Wisconsin's common aquatic invasive species include rusty crayfish, sea lampreys, alewives, and zebra mussels.

Quagga mussels are closely related to zebra mussels, but they are even more harmful. Quagga mussels are extreme water filterers. They can remove large amounts of phytoplankton and other particles from lakes and streams. This disrupts the food web and can even make lakes clearer. That can result in higher lake temperatures, which are harmful to native species.



Some researchers believe that Lake Erie's dead zone may be caused by mussels' nonstop feeding!



How can researching our water resources inspire change?

## Wisconsin has a long history of environmental research, continued today to ensure the responsible use of our water resources.

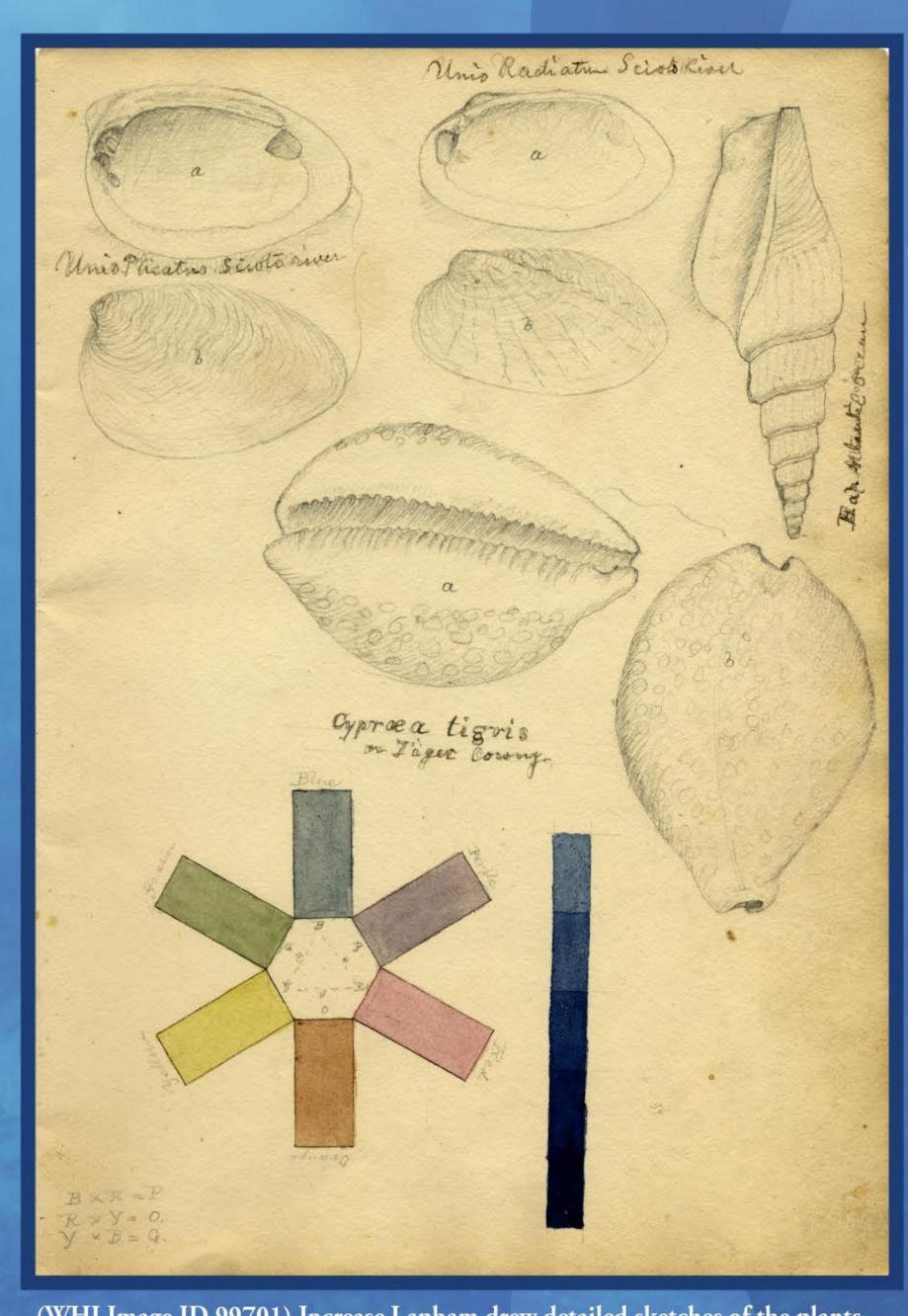
People began researching the environment early in Wisconsin's history.
For example, Increase Lapham was Wisconsin's first great scientist. He spent his life studying the climate, biology, and geology of the state. Edward Asahel Birge was a professor of zoology and later president of UW-Madison. He helped found the field of limnology, the study of lakes and rivers.

Wisconsin is still known as a center for water research. UW-Milwaukee's School of Freshwater Sciences focuses on Great Lakes research. Scientists there study the connection between humans and our water resources. This includes everything from how freshwater systems work, to looking at health and using technology to study fish.

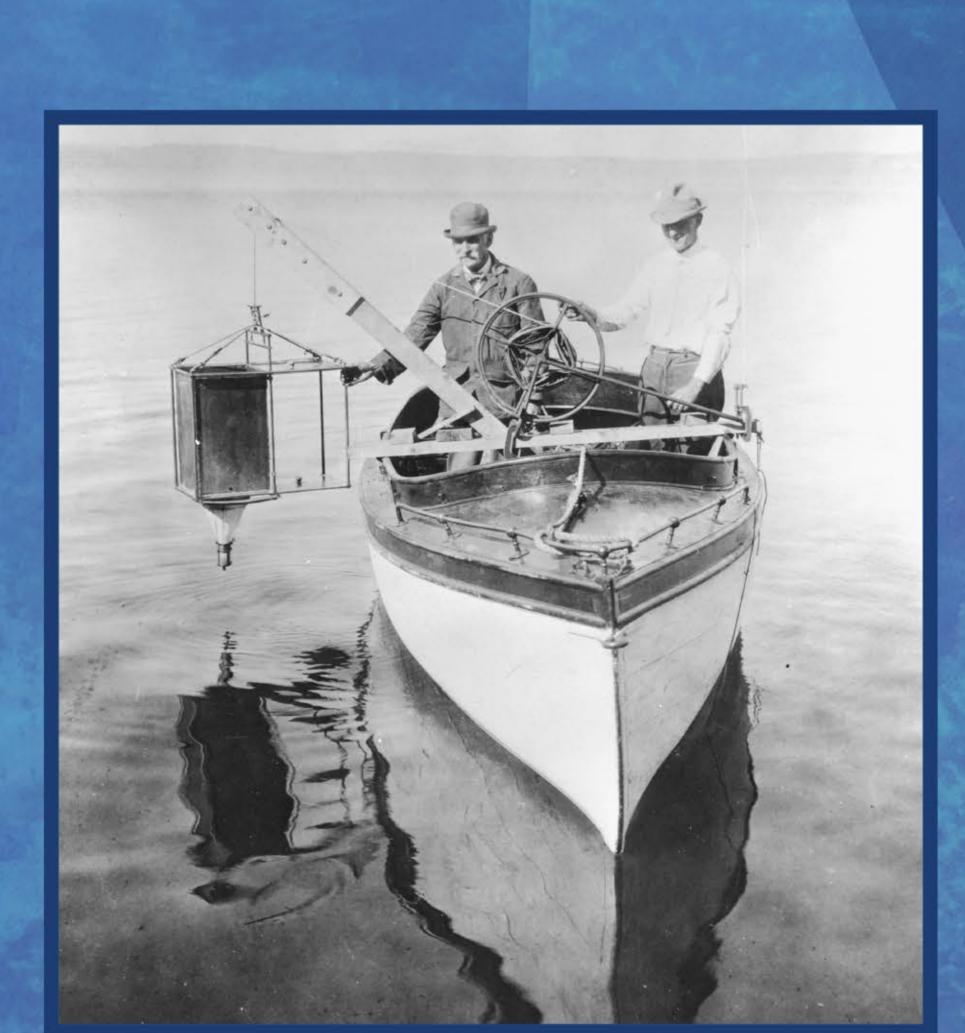
The Water Council works to bring together the freshwater research community and water-related industries. This allows for greater collaboration in developing new ways to address water issues worldwide.



(WHI Image ID 1944) Increase Lapham, photographed here around 1871, believed that weather could be predicted if data were reported and mapped. The National Weather Bureau, a forerunner of today's National Weather Service, was established with his help in 1870.



(WHI Image ID 99701) Increase Lapham drew detailed sketches of the plants animals, and minerals of Wisconsin's natural environment. Lapham drew this sketch around 1828.



(WHI Image ID 3176) E. A. Birge and Chancey Juday use a plankton trap in Lake Mendota off Madison, Wisconsin in 1917. The limnology program Birge helped establish in Madison expanded into research on long-term ecology, climate change, and ecosystem ecology.



(Courtesy of the UW-Milwaukee School of Freshwater Sciences) A UWM School of Freshwater Sciences researcher shows students the correct way to show



(Courtesy of the Water Council) At the Water Council, researchers and members of industry use a state-of-the-art flow lab to test projects like water filtration systems.



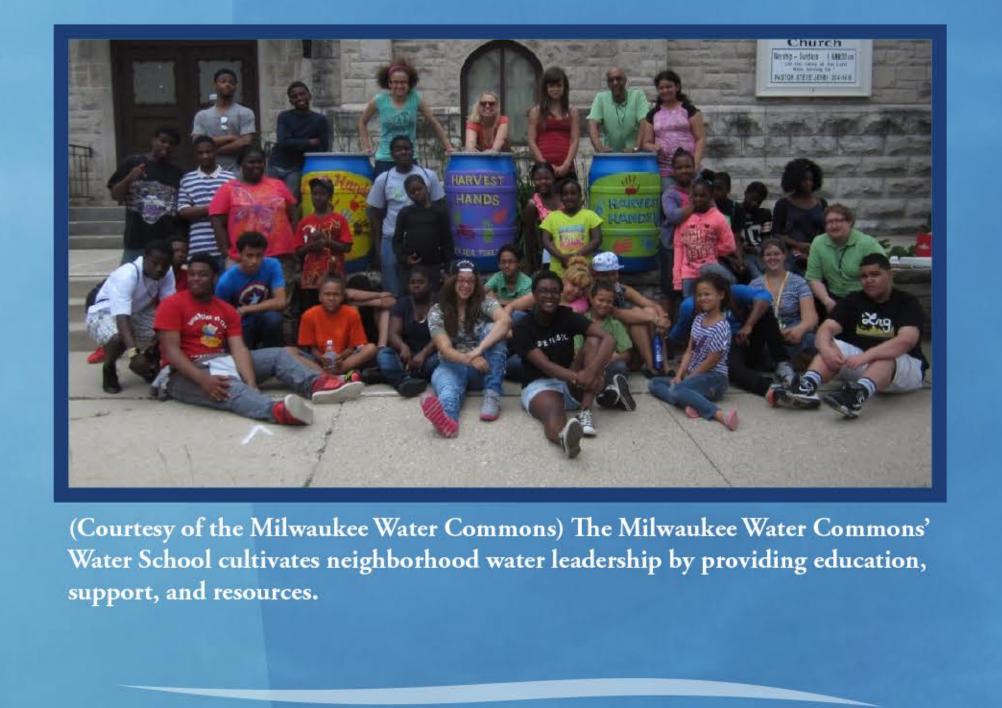
How can we encourage the conservation of water resources?

### Wisconsin believes that raising awareness about the environment is crucial to the conservation of our water resources.



(Courtesy of the Aldo Leopold Foundation, www.aldoleopold.org) Writer, scientist, and scholar Aldo Leopold is considered the father of wildlife ecology. Here, he holds freshly caught trout from the Flathead River in Wisconsin in

Wisconsin has long been a center of conservation thinking and activity. UW-Madison professor Aldo Leopold published A Sand County Almanac in 1949. He believed that people needed moral rules to tell them how to treat the environment. This "land ethic" would help preserve nature for future generations.

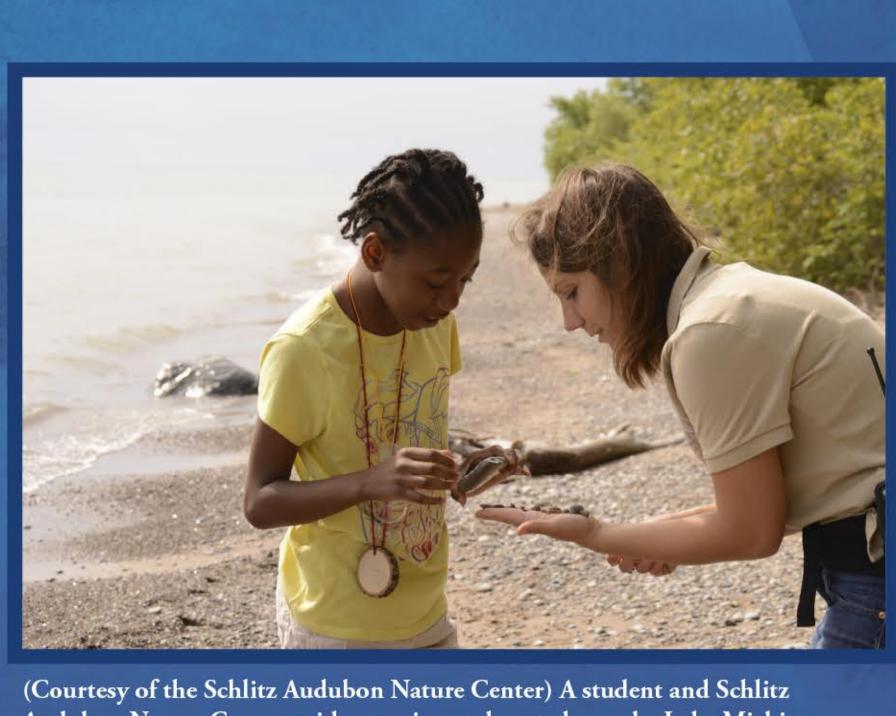


(Courtesy of Milwaukee Riverkeeper) Each spring, nearly 4,000 people participate in Milwaukee Riverkeeper's Annual Spring Cleanup, removing tons of trash from waterways.

Today, there are many local, national, and international organizations working on environmental issues. The Milwaukee Water Commons and Milwaukee Riverkeeper work to protect our local watersheds so they can be enjoyed by all people. At the Urban Ecology Center and Schlitz Audubon Nature Center, you can wade into the Milwaukee River or Lake Michigan to test water quality or examine wildlife. Programs like these help teach us about our impact on the



in Milwaukee and Ozaukee County.



Audubon Nature Center guide examine rock samples at the Lake Michigan



What changes can restore and protect Wisconsin's waterways?

environment.

## Wisconsin strives to change how we affect our environment so we can protect our water resources.

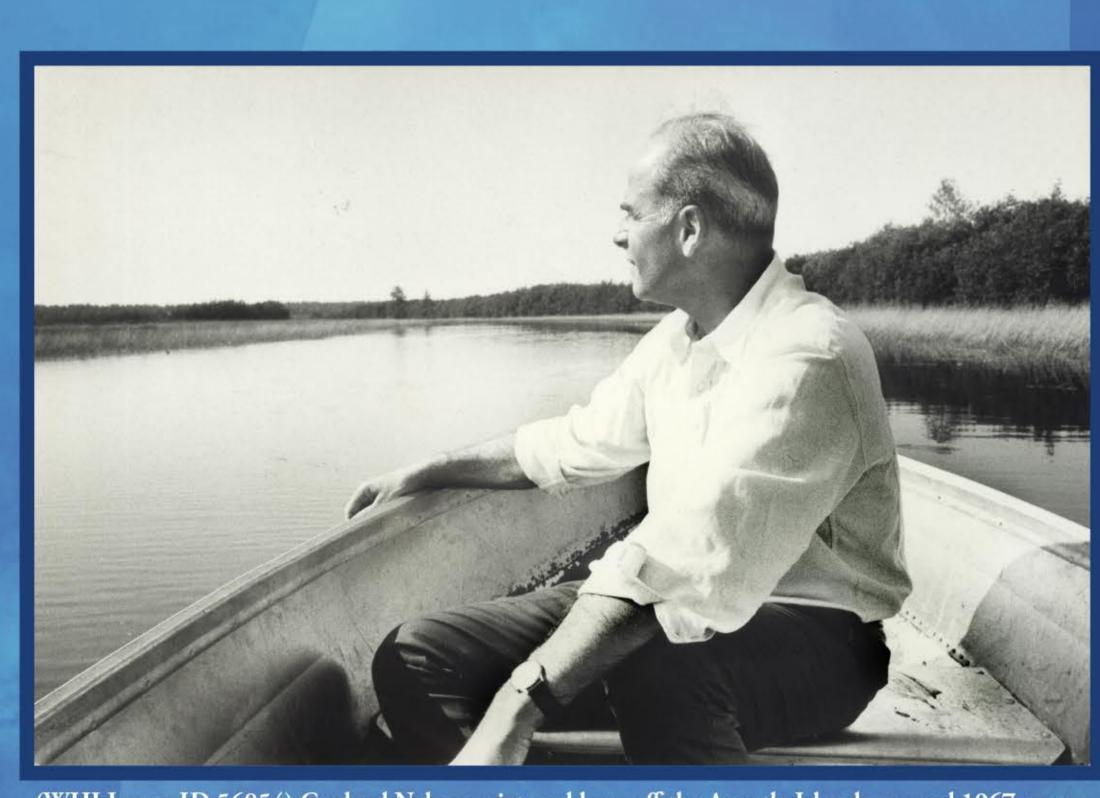
The efforts of conservationists have led to many changes. Wilhelmine La Budde introduced conservation education in all Wisconsin public schools. Former Wisconsin Senator Gaylord Nelson was the founder of Earth Day. His Outdoor Recreation Act inspired the federal government to pass laws that improved water and air quality nationally.

Now, changes are being made to restore and protect
Wisconsin waterways. Dams have been removed from many rivers to help restore natural wildlife. The greenspace that is reclaimed after dam removal is helping revitalize waterfront communities.

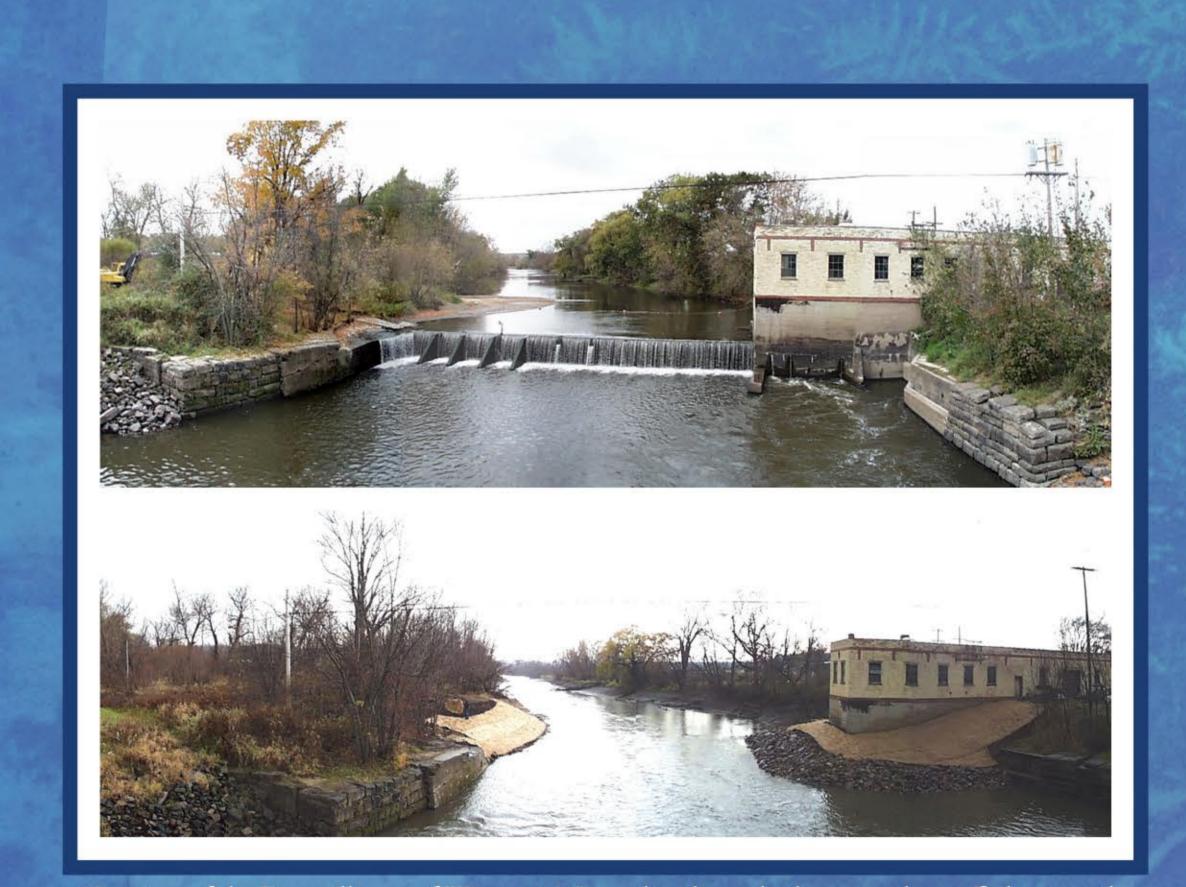
Cities are doing their part to help the environment, too. The Milwaukee Metropolitan Sewerage District's Fresh Coast project combines changes both big and small. They install rain barrels, plant rain gardens, and use porous pavement in alleys, streets, and parking lots to conserve water and prevent runoff. These projects help ensure the future of water quality.



(The Milwaukee Sentinel, Courtesy of the Wisconsin Historical Society Archives) Under Wilhelmine La Budde's leadership, the Wisconsin Federation of Women's Clubs advanced legislation to plant greenery along highways to decrease erosion from deforestation. This newspaper headline is from 1934.



(WHI Image ID 56854) Gaylord Nelson, pictured here off the Apostle Islands around 1967, was a national leader in environmental protection. His Outdoor Recreation Act helped to fund environmental planning, land acquisition, and easements along state highways to ensure scenic values.



(Courtesy of the River Alliance of Wisconsin) Second to direct discharges and runoff, dams are the biggest source of pollution and water quality degradation in Wisconsin waterways. The River Alliance of Wisconsin promotes the selective removal of obsolete dams to restore rivers and water quality.



(Courtesy of the Milwaukee Metropolitan Sewerage District) Green roofs, like that seen here at the Milwaukee Metropolitan Sewerage District headquarters, limit water pollution by keeping excess rainwater out of sanitary sewer systems.

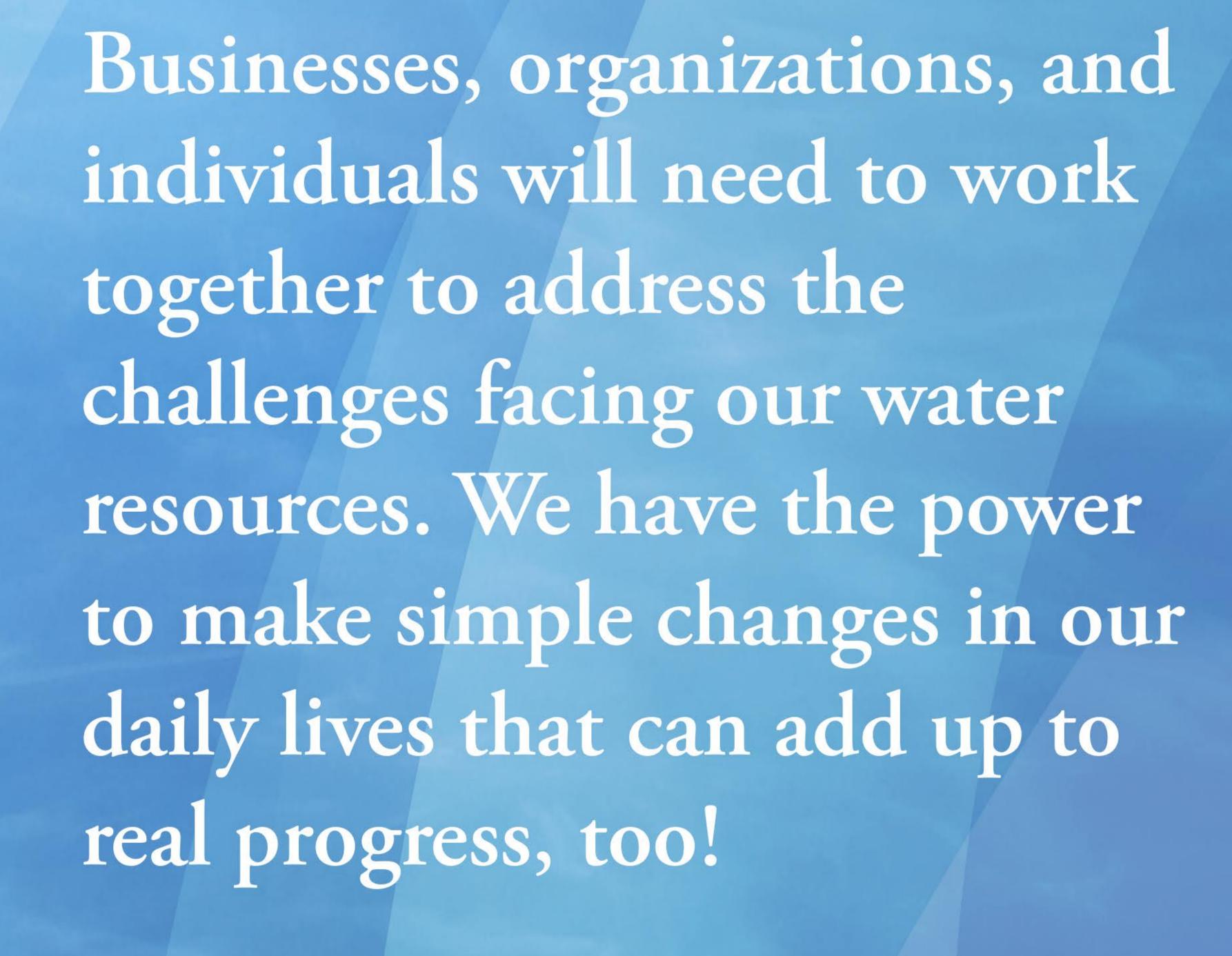


What can we do to reverse the damage we have inflicted on our water resources?

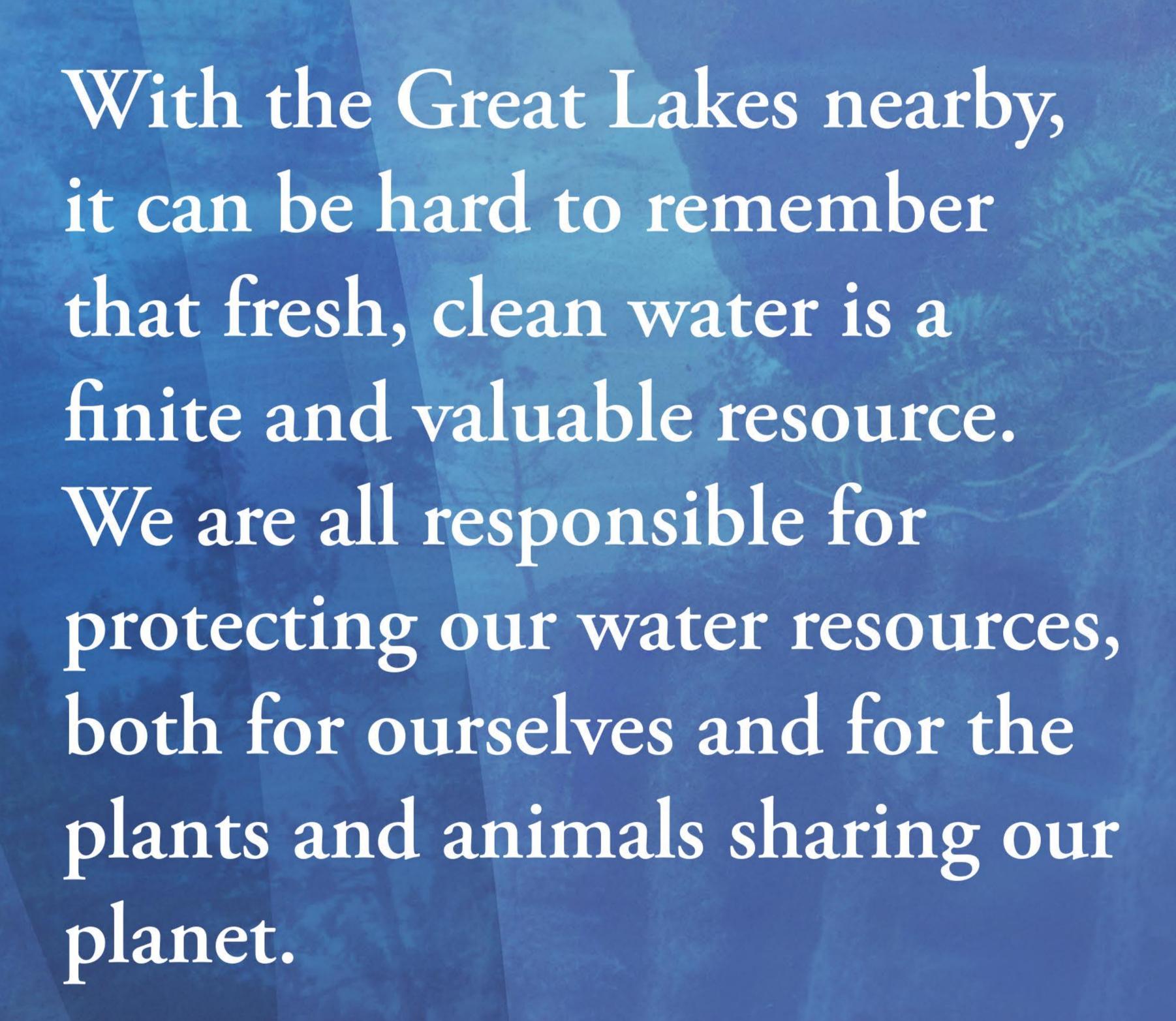
### Water's importance to life here and everywhere cannot be measured.

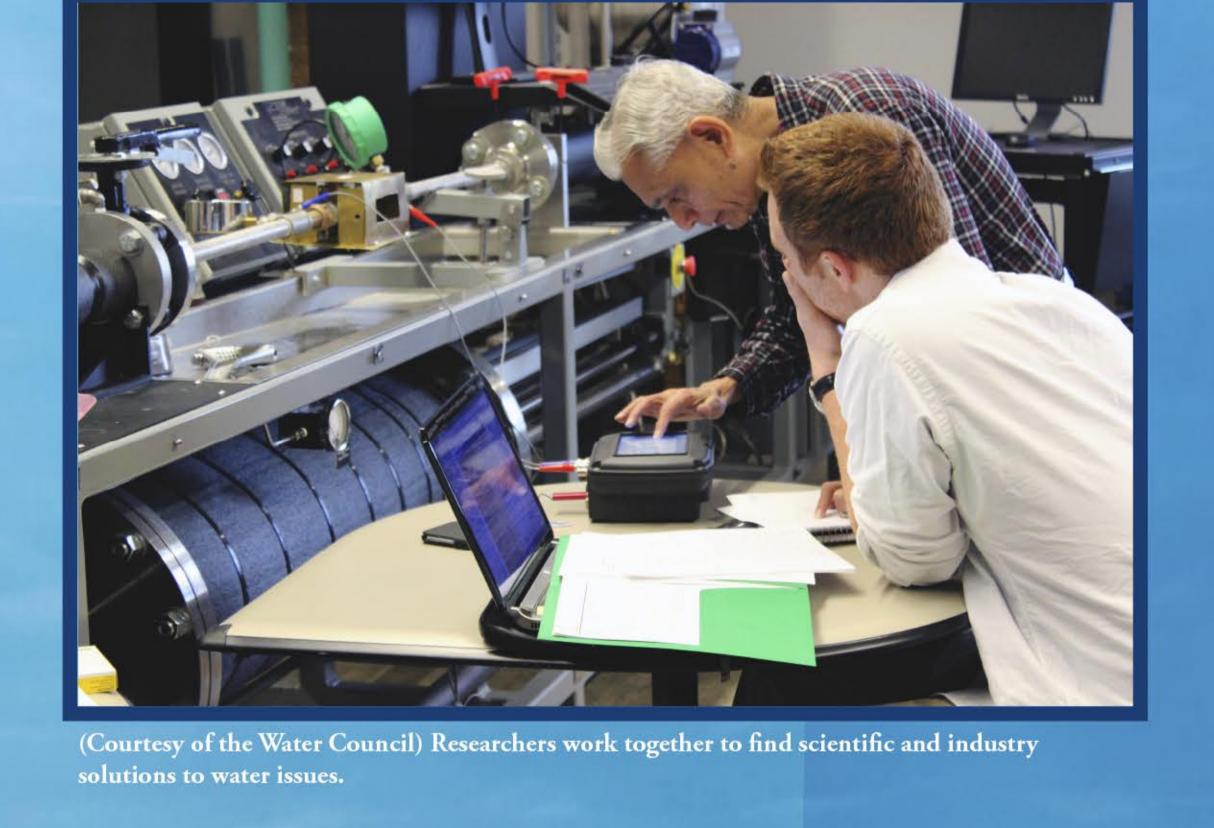


(WHI Image ID 74155) Conservation advocate Sigurd Olson stocks smallmouth bass near the



Take a short shower instead of a bath. Fix a leaky faucet. Use the washing machine and dishwasher only when they're full. Turn off the tap while brushing your teeth. And never pour paint, oil, or bleach down the drain—always take them to a recycling center instead. These small changes can add up to a big impact!





(Courtesy of Maddie Bird, Urban Ecology Center) Young naturalists at the Urban Ecology Center learn that Wisconsin's waterways are for everyone.





many organisms in Lake Michigan.

WISCONSIN HISTORICAL S O C I E T Y

We must make changes now to preserve our water resources for future generations.





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and
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