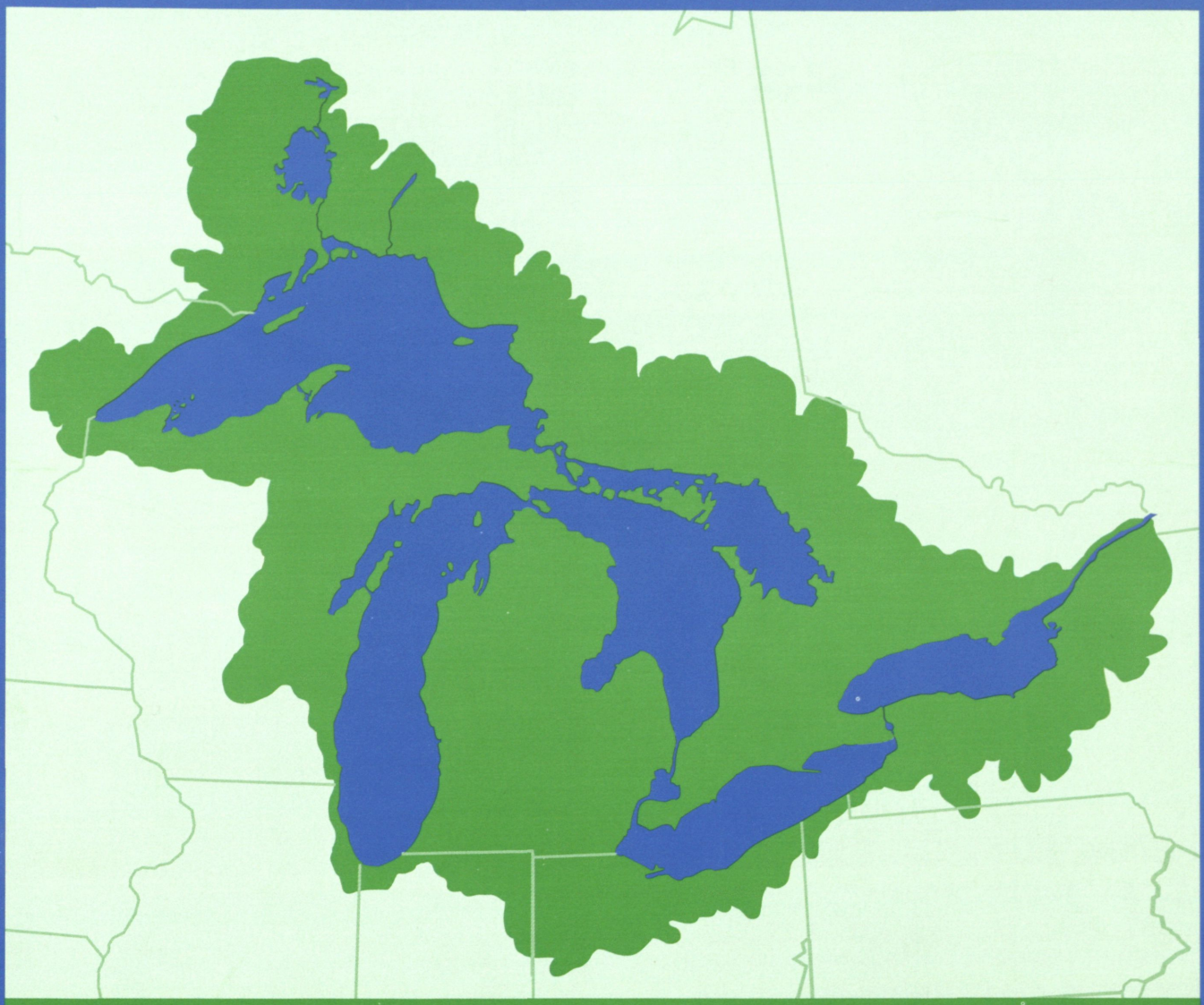
The Great Lakes Basin
Michigan State University
Michigan State University Extension
Comprised of bulletins E1865, 1866, 1867, 1868, 1869, 1870
Michigan Sea Grant Program
Issued October 2000
30 pages

The Great Lakes Basin



Great Lakes Basin Statistics

Volume	5,473 mi^3/22,809 km^3
Water Surface Area	94,676 mi^2/245,759 km^2
Drainage Basin Area	196,520 mi^2/ 510,160 km^2
Shoreline Length	10,054 mi/16,170 km (including islands)
Outlets	St. Lawrence River (east) Chicago Sanitary & Ship Canal (west)
Population	33,910,373
U.S.	27,476,773
Canada	6,433,600

In 1996, more than 63 million pounds (28,350,000 kg) of fish were caught commercially in the basin, bringing in more than $43 million (U.S.). The main species caught for commercial sale are lake whitefish, walleye, smelt and yellow perch.

Forestry: Forests cover 55 percent of the land in the Great Lakes region. This is almost 20 percent of U.S. timberland. Pulp and paper mills that process timber can be found throughout the region. The basin is also a leading Christmas tree producer, with Michigan alone producing 4 million trees in 1998.

Recreation/Tourism: The Great Lakes provide many opportunities for outdoor recreation, including boating, fishing, diving and beachcombing. Along their shorelines are 10 national parks and lakeshores in the United States and Canada, hundreds of state and provincial parks and 13 underwater preserves and parks — areas on the lake bottoms where shipwrecks and other valuable historic and geologic resources are protected. These parks host more than 70 million visitors each year. Recreational fishing in the Great Lakes is also a key economic sector.

One way to remember the names of the Great Lakes is to use the word HOMES as an acronym:

H = Huron
O = Ontario
M = Michigan
E = Erie
S = Superior

Industry: The Great Lakes region has a diverse range of industries, from steel and paper mills to chemical companies to auto manufacturing. The largest concentration of steel production in North America is in the metropolitan area surrounding southern Lake Michigan. Fifty-eight percent of all cars manufactured in the United States and Canada are made in the Great Lakes basin.

Shipping: Shipping has always been an important segment of the Great Lakes economy. The shipping industry brings in revenues and creates jobs in its own right and is an essential component of many other economic sectors. More than 301 million tons were shipped out of major U.S. ports on the Great Lakes in 1996. The three main commodities shipped on the Great Lakes are coal, iron ore and grain.

Natural Resource and Environmental Issues

Water Quality: Residential and municipal uses of the lakes, combined with runoff from agriculture and industry, add pollutants to the Great Lakes. Some of these pollutants can stay in the water for hundreds of years. Poor water quality caused by increased loadings of heavy metals, phosphorus and other nutrients can lead to degraded health in aquatic organisms and aesthetic problems. Pollution is usually most severe in waters near large urban areas and in rivers, harbors and connecting channels. In recent years, the U.S. and Canadian governments have listed 43 places on the lakes' shorelines as areas of concern, where beneficial uses have been impaired and environmental standards are not being met. One of these — Collingwood Harbour on Georgian Bay in Ontario — has been delisted because beneficial uses are now restored.

Aquatic Nuisance Species: Aquatic nuisance species are plants and animals that become established in habitats where they are not native. Once there, invading species often compete with native species for resources and can have damaging environmental and economic effects. Two of the most common and troublesome aquatic nuisance species currently in the Great Lakes basin are the sea lamprey and the zebra mussel.

Wetlands: Wetlands help to replenish and purify groundwater, prevent flooding and erosion, and support a wide diversity of plant and animal life. People have been filling in coastal wetlands and converting the land to industrial, agricultural or residential areas — a practice that can promote erosion and endanger the habitat of plants, fish and wildlife.

Urban Sprawl: Metropolitan areas in the Great Lakes basin continue to expand as people move outside the cities. Vast amounts of agricultural land and open space have been converted into residential and new urban areas, and loss of habitat threatens native wildlife. Longer work commutes increase pollution. In response to this problem, coastal planners and natural resource managers are encouraging sustainable development to create a balance between urban growth and ecological protection.

Sea Grant MICHIGAN

The Michigan Sea Grant College Program is a joint effort of the University of Michigan and Michigan State University, funded by the National Oceanic and Atmospheric Administration, to conduct research, outreach and education on Great Lakes and marine issues. MICHU-SG-00-406

October / 2000 Extension Bulletin E-1865

MICHIGAN STATE UNIVERSITY EXTENSION

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supposed route through the New World to the Pacific. The group did not find the riches of the Orient, but their discovery of the Great Lakes opened up a whole new realm of economic activity.

Soon after they arrived, the French began the first major resource extraction from the Great Lakes region — fur. Fur-bearing animals, particularly beaver, were popular and abundant, and the lakes provided a cheap and easy way to transport the goods east. The French realized the importance of good relations with the Native Americans and established trade that became economically and militarily profitable. The British also joined in the fur trade and eventually pushed the French out of the area in the French and Indian War.

Once the Great Lakes were recognized as important, fighting over the region was inevitable. At the end of the American Revolution, the Great Lakes became part of the boundary between the newly formed United States and British North America. The United States gained control over all of the land in the Great Lakes states and portions of Great Lakes waters. In the War of 1812, the Americans and the British again fought over control of the Great Lakes. Today, 1,270 mi/2,040 km of the U.S./Canadian border runs through lakes Superior, Huron, Erie and Ontario, part of the longest unfortified international border in the world.

The Great Lakes could cover the entire continental United States with almost 10 feet of water.

Once the Great Lakes region was open for settlement, people came from all over the western world. In the 1800s, war, famine and religious persecution plagued Europe, and many people went looking for a new land — the United States. Those who chose to settle in the Midwest were mostly farmers, and the majority were of German, Scandinavian or Dutch descent. This massive influx of immigrants had a major effect. Human settlement required that land be cleared for towns and agriculture. The forests in the basin were seen as important for supplying the rest of the country with lumber. The opening of the Erie Canal in 1825 provided a cheaper, easier and more timely route for shipping lumber. The combination of all these developments helped this period earn the nickname "The Big Cut." The "Big Cut" resulted in a great increase in stream bank erosion and in warming cool waters so important as fish habitat.

At about the same time, the commercial fishing industry began its ascent. Commercial fishing began in earnest in the 1820s and expanded greatly over the rest of the century. As more efficient fishing equipment became available and the industry continued to expand, over-harvesting fish became a problem. Added to this were exotic species, such as the sea lamprey, entering the lakes and decimating certain fish populations. During the last half of the 20th century, the fisheries began to recover slowly, fostered by careful planning and management.

The wealth of natural resources in the Great Lakes basin continues to be important to the cultures and economies of its people, influencing work, home and play. These resources require protection and management to conserve them for future generations.

Economy

The economy of the Great Lakes basin is also one of North America's most diverse. The area has many resources, including fertile land, forests, minerals and fish. In addition to this natural wealth, the Great Lakes provide the means to ship raw materials and products to the rest of the country. A look at various aspects of the Great Lakes economy shows its importance on a multinational scale.

Agriculture: Agriculture dominates the southern portion of the Great Lakes basin and is a leading industry in every Great Lakes state and province. Twenty-five percent of Canadian agricultural production and 7 percent of U.S. production occur here. Corn is the dominant crop in the basin, followed by soybeans and hay. Dairy and livestock production are also important. The Great Lakes region also prospers in smaller "niche" markets. Wisconsin leads in dairy and cheese production, and New York is fourth. Michigan is the national leader in tart cherry production, with Traverse City known as the "Cherry Capital of the World." Michigan is also the No. 1 producer of navy beans. Illinois ranks second in the country in exporting soybeans and soybean products, Minnesota is third, Indiana is fourth and Ohio is fifth. Ontario's production is approximately 25 percent of Canada's gross domestic product (GDP) in agriculture. Ontario is particularly strong in several areas of the food industry, producing 77 percent of Canada's GDP in the cereal and flour industry and 72 percent of its sugar and confectionery industry. In the beverage industry, Ontario produces 64 percent of the country's distillery industry output.

Fisheries: After years of careful management and the application of new scientific knowledge, the Great Lakes fisheries are beginning to thrive again. More than 2 million anglers fished the Great Lakes in 1996, and they added more than $1 billion (U.S.) to the region's economy.

From the rugged cliffs surrounding Lake Superior to the majestic dunes of Lake Michigan to the awe-inspiring Niagara Falls, the Great Lakes basin is full of wonders. The more than 11,000 miles/18,000 kilometers of shoreline have earned the Great Lakes the title of "the nation's fourth seacoast."

The Great Lakes — Superior, Michigan, Huron, Erie and Ontario — are known for their beauty and also for the wealth of resources within and around them. The lakes contain one-fifth of the world's surface freshwater, and they have often been called "sweetwater seas." The Great Lakes could cover the entire continental United States with almost 10 feet of water. They are large enough to influence the regional climate, cooling summers and tempering winters, as well as increasing amounts of rain and snow in the region. A world-renowned fishery, thousands of acres of forests, major mineral and metal reserves, and rich agricultural land provide a balance of economic opportunity within the basin. In addition, the lakes and their surroundings provide many recreational opportunities and an appealing place to live and work.

Shoreline Use

United States		Canada
26.5%	Residential	18.6%
6.7%	Commercial/Industrial	2.7%
1.5%	Agricultural	8.2%
65.3%*	Other	70.5%**

* U.S. "other" classification includes public, beaches, forests, barren lands.

** Canadian "other" classification includes transportation and communications, recreation, extraction, water, wetlands, forestry, grassland, barren and unknown.

Geology

The Great Lakes shoreline is the United States' fourth seacoast.

The Great Lakes began to form about 500,000 years ago, during the Great Ice Age. During this time, huge masses of ice, called glaciers, moved across the continent, at some points covering all of the land that now makes up the Great Lakes basin. These glaciers were up to 2 miles thick and could pick up huge boulders and level hills as they moved over them. At the beginning of the Great Ice Age, the Great Lakes did not exist. Instead, several rivers and streams were connected to the Mississippi River. As the glaciers moved into some of these streambeds, the ice pushed against the sides, greatly widening and deepening them. Soon the streambeds were the size of lakes. As the climate warmed and glaciers began to melt and retreat, meltwater filled these new lake basins. About 10,000 years ago, the lakes began to take their present shape.

Even today the lakes change slightly as the earth's crust slowly rebounds from the weight of the glaciers, so scientists periodically take new measurements of the lakes' elevation above sea level. The most recent of the measurements occurred in 1985, and the resulting elevations were used in the Great Lakes Profile.

Ecology

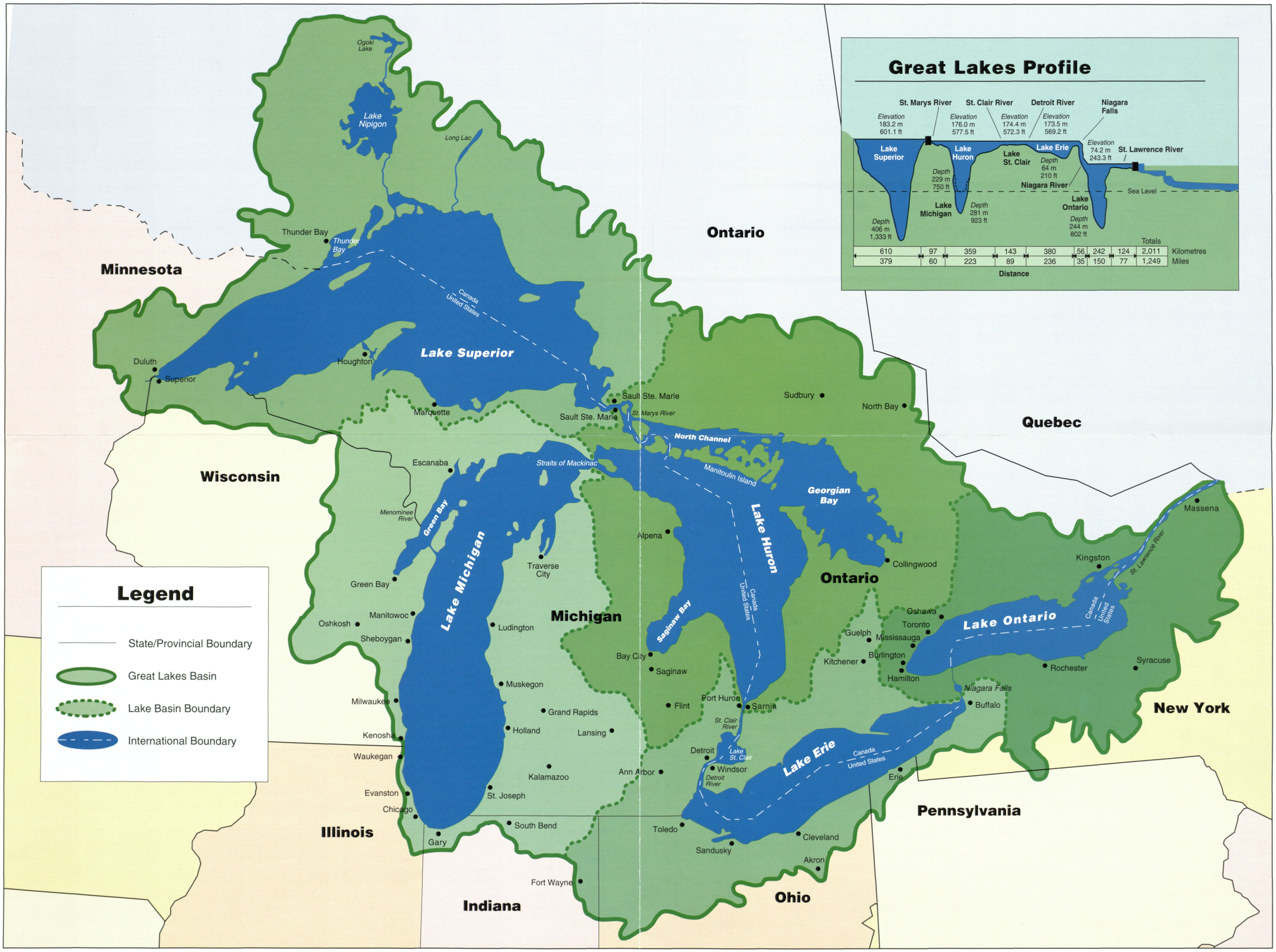
The Great Lakes ecosystem is quite diverse. The ground cover ranges from dense coniferous and northern hardwood forests in the north to grasslands and prairies farther south. Near the lakeshores are coastal marshes, wetlands and dune communities. More than 3,500 species of plants and animals live in the basin, including some that are found nowhere else in the world. Mammals include the black bear, fox, moose, coyote, gray wolf, elk, white-tailed deer, bobcat, beaver and Canada lynx. Amphibians and reptiles include more than a dozen species of frogs, turtles and the poisonous eastern massasauga rattlesnake. Many species of birds frequent the lakes and the coastal wetlands of the basin, including the great blue heron, bald eagle and snowy owl. The Great Lakes fishery consists of a blend of such native species as lake trout, lake whitefish, lake herring, lake sturgeon, yellow perch, walleye and bloater chubs, and non-natives such as alewife, coho and chinook salmon, and rainbow trout.

History and Development

The first human inhabitants of the Great Lakes basin arrived more than 10,000 years ago, just as the lakes were taking their present form. The first groups to inhabit the area are called Paleo-Indians; they were mainly hunters. They were eventually succeeded by the group that anthropologists call the Old Copper Culture, a people who hunted and fished and began to practice agriculture. As their name suggests, they worked metal to form weapons, tools and jewelry, and they may have been the first people anywhere in the world to use copper extensively. The Old Copper Indians were succeeded by the so-called Woodland Culture. The Woodland Indians were the first to practice agriculture extensively in the Great Lakes region. Their descendants would form the Ojibwe (Chippewa), Menominee, Potawatomi and other Great Lakes tribes.

The first recorded contact between these cultures and Europeans came in 1615 when the Frenchman Samuel de Champlain and his crew "discovered" Lake Huron. Champlain was looking for the Northwest Passage, a

The Great Lakes Basin

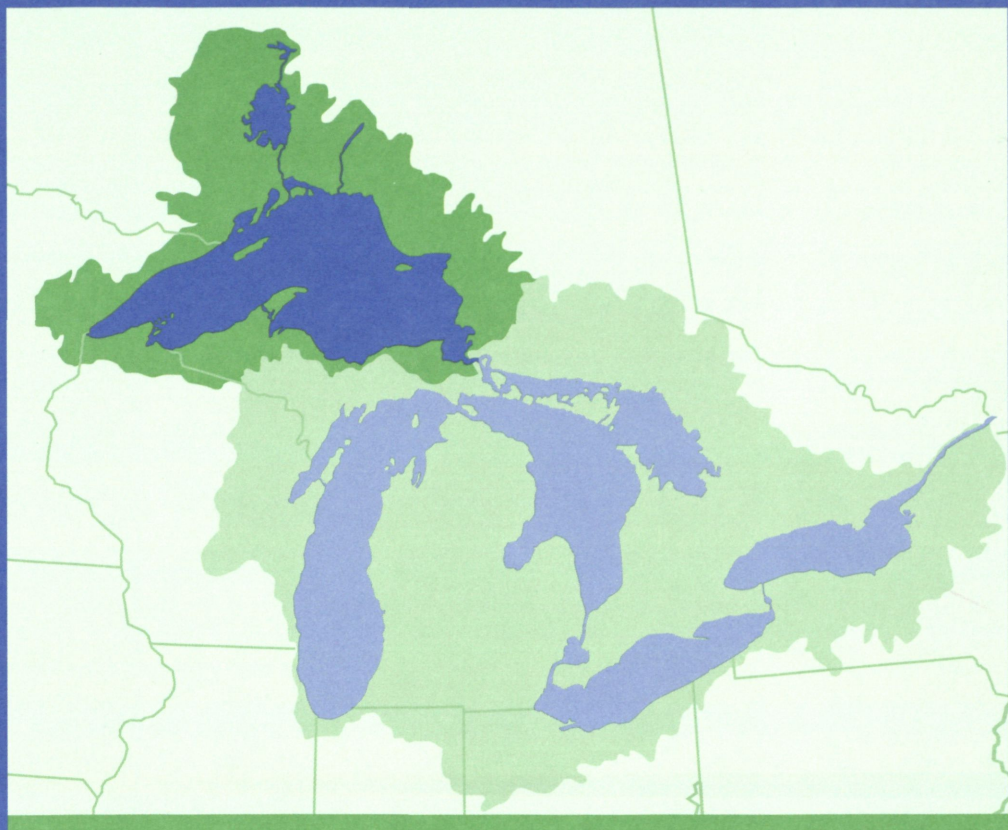


Legend

- State/Provincial Boundary
- Great Lakes Basin
- Lake Basin Boundary
- International Boundary

Great Lakes Profile

Lake Superior Basin



Lake Superior Basin Statistics

Length	350 mi/563 km
Breadth	160 mi/257 km
Depth	489 ft/149 m average; 1,333 ft/406 m maximum
Volume	2,935 mi^3/12,232 km^3
Water Surface Area	31,700 mi^2/82,097 km^2
Drainage Basin Area	49,300 mi^2/ 127,677 km^2
Shoreline Length	2,730 mi/4,393 km (including islands)
Elevation	601.1 ft/183.2 m
Outlet	St. Marys River to Lake Huron
Retention/Replacement Time	173 years
Population	672,116
United States	443,127
Canada	228,989

Natural Resource and Environmental Issues

The water in Lake Superior could cover both North and South America under a foot of water!

Lake Superior has not suffered from some of the extensive resource problems of the other lakes. The small population and relatively few heavy industrial processing and agricultural centers limit the amount of pollution that goes directly into the lake. Though pollution from these sources is not a significant problem, Lake Superior does have to contend with such resource issues as water quality and exotic species.

Water Quality: Lake Superior is not as threatened as the other Great Lakes by agricultural runoff or sewage disposal. Instead, most of its contamination is deposited by air currents from very distant locations. This pollution accounts for 93 percent of mercury loadings and 98.8 percent of PCB contamination in the lake. These toxins can be harmful to fish and wildlife. Consumption advisories have been placed on some Lake Superior sport-caught fish because of concern that mercury, PCBs and the pesticide chlordane might harm humans who eat fish in large amounts. The U.S. and Canadian governments have designated seven places as areas of concern on the Lake Superior shoreline where beneficial uses have been impaired and environmental standards are not being met.

Aquatic Nuisance Species: The sea lamprey was introduced into Lake Superior in 1938. This parasitic fish did substantial damage to Lake Superior fisheries, especially lake trout and whitefish. In the 1940s, the annual lake trout catch was 4.5 million pounds per year. That number plummeted to only 500,000 by the 1960s. Lamprey control programs have reduced the population of this invader to 10 percent of its former peak, but continual control is required to maintain the current number of lake trout in Lake Superior. Another exotic invader, the ruffe, is a threat to Lake Superior fisheries. This small, aggressive fish first entered Lake Superior in the 1980s, most likely in the ballast water of ocean vessels. Ruffe reproduce rapidly, and because they compete with native fish for food and resources, they may pose a serious threat to Lake Superior's fisheries.

Sea Grant MICHIGAN

The Michigan Sea Grant College Program is a joint effort of the University of Michigan and Michigan State University, funded by the National Oceanic and Atmospheric Administration, to conduct research, outreach and education on Great Lakes and marine issues. MICHU-SG-00-401

October / 2000 Extension Bulletin E-1866

MICHIGAN STATE UNIVERSITY EXTENSION

Mining: Minnesota is by far the largest producer of natural iron ore and taconite in the United States. Mines in the basin supply the United States with 97 percent of its iron ore.

Fisheries: More than 3 million pounds of fish were caught commercially in Lake Superior waters in 1996. The main species caught were lake herring, lake trout and whitefish. The Lake Superior recreational fishery is the smallest of the Great Lakes but still quite active. In 1991, more than 114,000 anglers spent more than 880,000 days fishing in U.S. waters; in 1985, more than 57,000 anglers fished 965,000 days in Canadian waters.

Lake Superior could contain all the other Great Lakes plus three more lakes the size of Lake Erie.

Shipping: Lake Superior ports ship iron ore, grain, coal and potash. In the United States, more than 76 million tons of cargo were shipped out of Lake Superior ports in 1996. Duluth-Superior is the busiest inland port in the country, with more than 1,000 vessels visiting annually.

Tourism/Recreation: Lake Superior is well known for its scenic beauty and offers many opportunities for recreation. Six U.S. and Canadian national parks and lakeshores are located in the region, including Isle Royale, the only island national park in the United States. More than 5 million people each year visit the national parks, along with the many state and provincial parks and underwater preserves in the basin. Underwater preserves are special areas in the lakes designated by states to protect shipwrecks and other cultural and geologic resources.

Ecology

The Lake Superior basin is unlike the other Great Lakes basins because its terrain is dominated by granite bedrock that is part of the Canadian Shield. This rock dates back to Precambrian times, the oldest era of geological history. The basin is heavily forested, and conifers dominate the landscape. Because the basin is so sparsely populated, it makes a suitable home for wildlife found nowhere else in the Great Lakes basin. Wolves and moose live on the mainland and on Isle Royale. Black bear, coyote, Canada lynx, bobcat, beaver, porcupine, white-tailed deer and red fox also live in the basin, along with a variety of birds, amphibians and more than 45 species of fish.

At its deepest point, Lake Superior would submerge the Empire State Building.

Lake Superior is the largest of the Great Lakes in both surface area and volume. It has the largest surface area of all freshwater lakes in the world. Lake Superior is the deepest, the clearest and the coldest of the Great Lakes. In addition to its natural sources of water, some water is transferred into the Lake Superior drainage basin through diversion structures at Long Lac and Ogoki Lake in Ontario. It takes almost two centuries for the water in Lake Superior to circulate completely through the lake and empty into the St. Marys River, where it will travel through three of the four other Great Lakes — Huron, Erie and Ontario. The basin's border runs through three states — Minnesota, Wisconsin and Michigan — and the Canadian province of Ontario. The basin is sparsely populated; less than 2 percent of the Great Lakes basin's population lives there. Lake Superior is rich in natural resources and scenic beauty. It is particularly known for its cold, clear water, rocky shoreline and agate beaches.

Lake Superior contains 3 quadrillion gallons of water. This is 10 percent of the world's fresh surface water and half of the water in the Great Lakes basin.

Shoreline Use

United States		Canada
14.9%	Residential	8.5%
5.0%	Commercial/Industrial	3.0%
.2%	Agricultural	1.0%
79.8%*	Other	87.5%**

* U.S. "other" classification includes public, beaches, forests, barren lands.

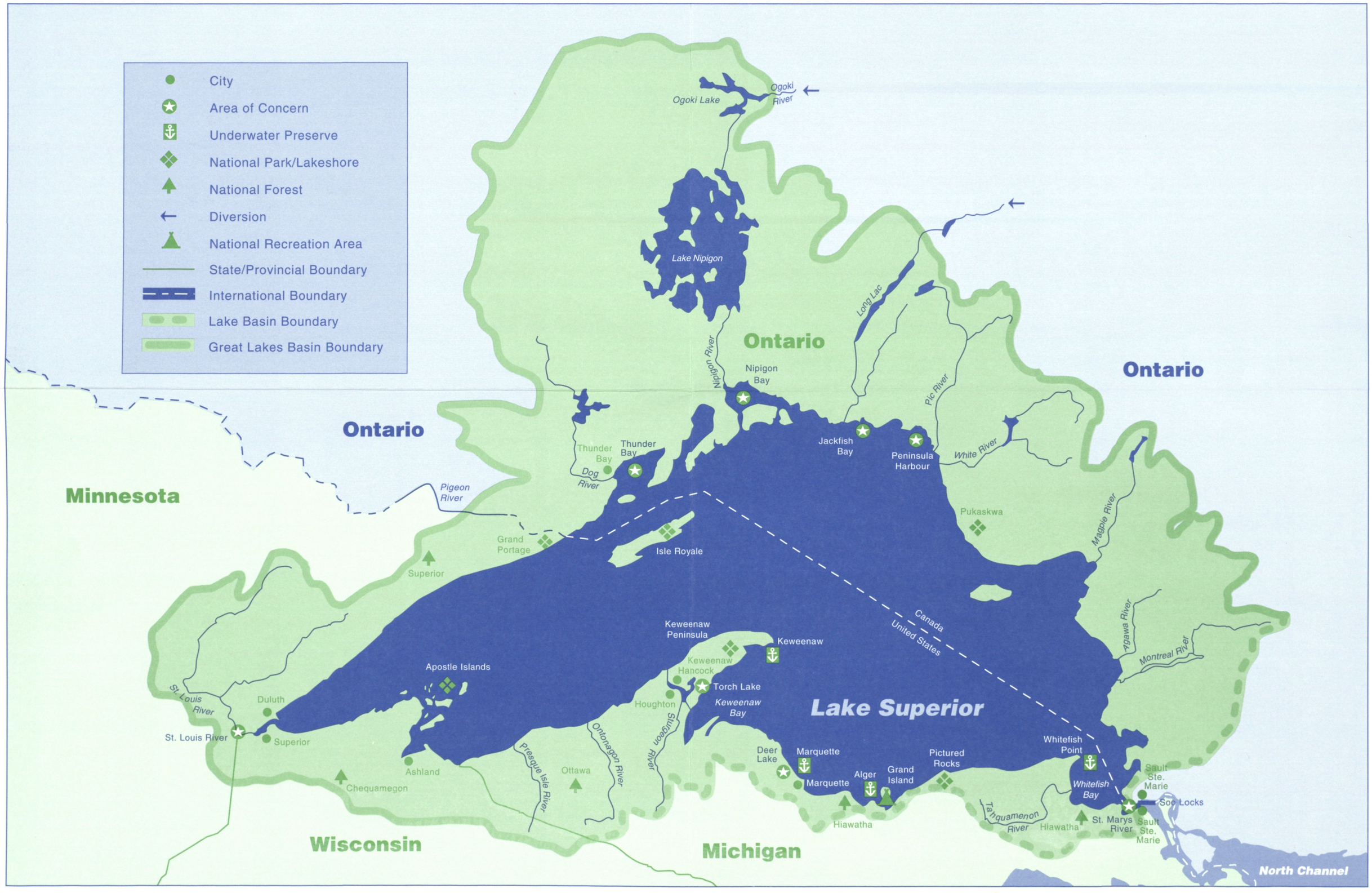
** Canadian "other" classification includes transportation and communications, recreation, extraction, water, wetlands, forestry, grassland, barren and unknown.

Economy

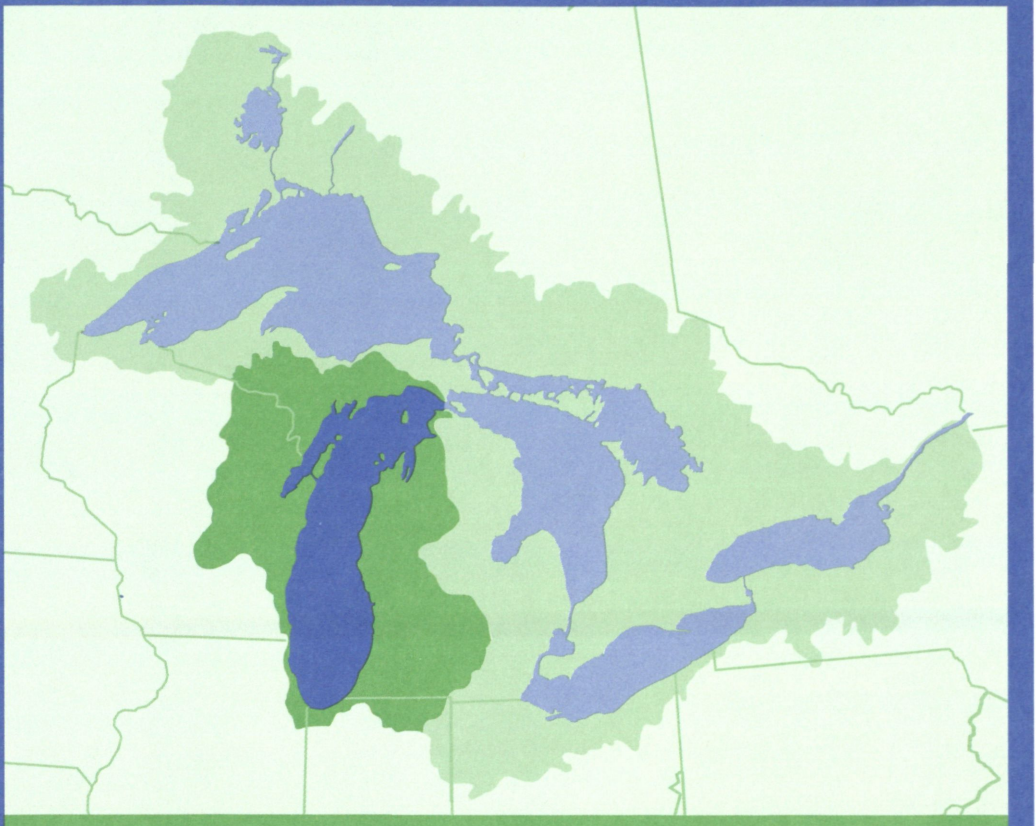
The Lake Superior drainage basin is not very suitable for agriculture because of the cold climate and poor soils. Therefore, its population is economically dependent largely on tourism and the natural resources in the basin, which include metals, minerals and forests.

Forestry: The Lake Superior drainage basin is an important region for producing pulp, paper and lumber in Canada and the United States. Of the 21 northern states, Michigan is the richest in timberland. The U.S. portion of the Lake Superior basin produced more than 256 million cubic feet of timber in 1996.

Lake Superior Basin



Lake Michigan Basin



Lake Michigan Basin Statistics

Length	307 mi/494 km
Breadth	118 mi/190 km
Elevation	577.5 ft/176.0 m
Depth	279 ft/85 m average 923 ft/281 m maximum
Volume	1,180 mi^3/4,918 km^3
Water Surface Area	22,300 mi^2/57,753 km^2
Drainage Basin Area	45,600 mi^2/118,095 km^2
Shoreline Length, Including Islands	1,640 mi/2,639 km
Outlet	Straits of Mackinac to Lake Huron
Retention/Replacement Time	62 years
Population	12,052,743*

* Includes metropolitan Chicago, which is not part of the **drainage** basin now but which uses Lake Michigan for drinking water.

Lake Michigan contains almost 1.3 quadrillion gallons of water. That's enough to fill 3 billion bathtubs.

development encroaches upon their habitats. In response to this problem, coastal planners and natural resource managers are encouraging sustainable development to create a balance between urban growth and ecological protection.

Water Quality: Lake Michigan's water quality problems are difficult to tackle because of the lake's long retention time and cul-de-sac formation. Toxins and pollutants remain in the water where they damage the physical environment and adversely affect wildlife. Poor water quality is found mostly near urban areas where water from storm sewers is discharged into the lake, bringing with it pesticides, herbicides, oils and heavy metals. Another pathway of pollution into Lake Michigan is the atmosphere, carrying emissions from distant factories. One leading atmospheric pollutant is mercury; others include lead and PCBs. These toxins can harm fish and wildlife. Consumption advisories have been placed on some Lake Michigan sport-caught fish because of concern that mercury, PCBs and the pesticide chlordane might harm humans who eat fish in large amounts. The U.S. government has designated 10 places on the Lake Michigan shoreline as areas of concern where beneficial uses have been impaired and environmental standards are not being met.

Aquatic Nuisance Species: Lake Michigan is threatened by the arrival of new aquatic nuisance species and also plays a key role in the spread of such species because its drainage system is connected to the Mississippi River via a diversion of the Chicago River into the Chicago Sanitary and Ship Canal.

One species that has begun its spread is the zebra mussel. These small, striped molluscs are causing widespread ecological and economic problems. They destroy native mussels and compete with other species for food. They cluster inside water intake pipes, disrupting normal inflow. They can also affect recreation if large numbers of dead ones wash ashore, produce a foul odor and leave behind their sharp shells.

Another Lake Michigan nuisance species is the round goby, a fish first found there in 1993. Gobies are suspected of competing for food with native species such as darters and sculpins, and driving native species from their preferred habitat. They prey on the eggs of important sport species such as lake trout, whose reproductive capacities are already limited, and on zebra mussels.

Sea Grant MICHIGAN

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October / 2000 Extension Bulletin E-1867

MICHIGAN STATE UNIVERSITY EXTENSION

Forestry: A significant pulp and paper industry has developed in Michigan's Upper Peninsula and Wisconsin's Fox River valley. At the southern tip of Lake Michigan, Chicago is a major publishing center.

Fisheries: The Lake Michigan fishery has been valued at nearly $100 million. In 1996, more than 14 million pounds of fish were caught commercially in Lake Michigan waters. The main species were lake whitefish, chubs and smelt. Lake Michigan's recreational fishery is also strong. In 1996, 715,000 anglers fished in Lake Michigan waters and spent $490 million on fishing trips and related items. Among the most popular sport species are yellow perch, chinook and coho salmon, lake trout and steelhead.

Tourism: Lake Michigan supports a multimillion dollar outdoor recreation industry, including fishing, diving and boating. Some of the basin's greatest attractions are the magnificent freshwater dunes that line the Michigan, Illinois and Indiana lakeshores. More than 20 million people each year visit national lakeshores, state parks and underwater preserves in the basin. Underwater preserves are special areas in the lakes designated by states to protect shipwrecks and other cultural and geologic resources.

Ecology

Perhaps Lake Michigan's most striking natural feature is the freshwater dunes along its shoreline, the largest coastal sand dunes in the world. The basin also has three types of forests — northern hardwood, oak-hickory and pine. In addition to its outstanding land forms and flora, the Lake Michigan basin is also home to a diversity of animal species, including black bear, bobcat, coyote, beaver, white-tailed deer, porcupine, 12 species of frogs, the bald eagle and snowy owl, and more than 68 species of fish.

Natural Resource and Environmental Issues

Loss of Wetlands: Lake Michigan coasts support close to 40 percent of Great Lakes coastal wetlands, nearly double that of any of the other lakes. Wetlands help to replenish and purify groundwater, prevent flooding and erosion, and support a great diversity of plant and animal life, but they continue to be drained and filled in for agriculture and development. This practice promotes erosion and may endanger the plants and wildlife living in these areas.

Urban Sprawl: Populations in the Lake Michigan basin are shifting outward and the suburbs of large cities such as Chicago and Milwaukee are expanding. Vast amounts of agricultural land and open space have been converted into residential and urban areas. Longer work commutes increase pollution, and native wildlife are threatened as

Lake Michigan is the sixth largest freshwater lake in the world and the third largest Great Lake. Its northern edge joins Lake Huron at the Straits of Mackinac, making the two lakes hydrologically inseparable. Lake Michigan is a long, narrow cul-de-sac, with almost all of its water flowing out through the straits after circulating in the lake for almost 100 years. A small amount is diverted to the Mississippi River basin through the Chicago Sanitary and Ship Canal.

Four states — Michigan, Illinois, Indiana and Wisconsin — border the lake. The northern part of the Lake Michigan basin is covered with forests and is sparsely populated, whereas the southern portion is rich in agriculture and also heavily industrialized with large metropolitan centers such as Chicago and Milwaukee.

Lake Michigan is the only Great Lake completely within the United States.

Shoreline Use

Residential	27.7%
Commercial/Industrial	5.6%
Agricultural	1.2%
*Other	65.5%

*"Other" classification includes public, beaches, forests, barren lands.

Economy

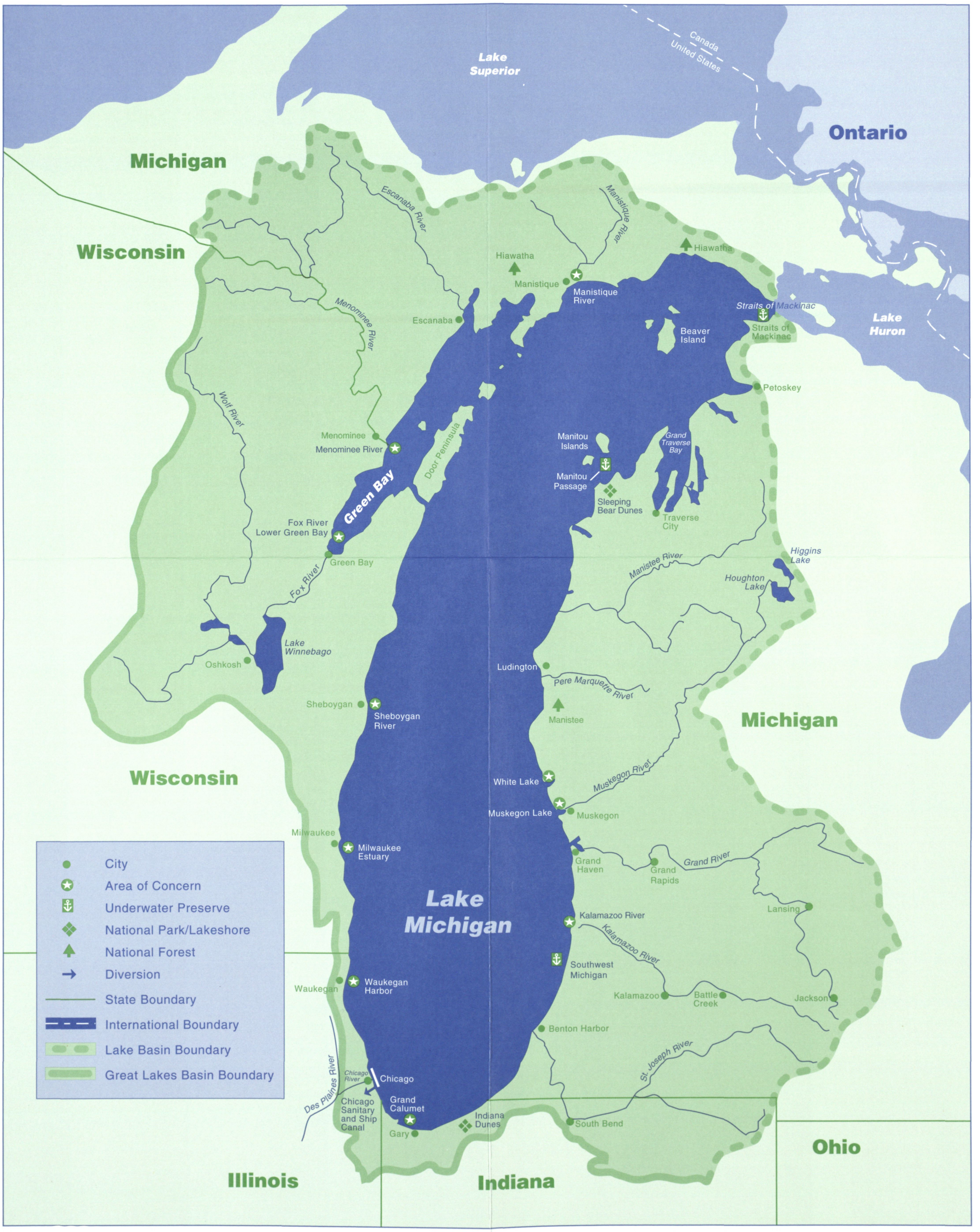
The geographic diversity of the Lake Michigan basin makes it suitable for a wide range of economic sectors.

Industry: The largest concentration of steel production in North America is in the metropolitan areas surrounding southern Lake Michigan, including Chicago, Illinois, and Gary, Indiana.

Agriculture: Six of the top 10 agricultural counties in Michigan are in the Lake Michigan basin. Traverse City, on the shores of northern Lake Michigan, has been named the "Cherry Capital of the World." Seventy-five percent of the national tart cherry crop is produced in the area. Michigan also produces the fourth largest grape harvest in the nation. Cool winds off the lake help prevent premature budding. The grapes are used primarily for juice, but 21 Michigan wineries also use them. Christmas tree production is another facet of agriculture in the Lake Michigan basin, with Michigan producing 4 million trees in 1998.

Shipping: More than 90 million tons of cargo were shipped in and out of Lake Michigan by boat in 1996, including iron ore, coal, steel, limestone, grain and other farm products.

Lake Michigan Basin



Lake Huron Basin

Lake Huron Basin Statistics

Length	206 mi/332 km
Breadth	183 mi/ 295 km
Depth	195 ft/59 m average 750 ft/229 m maximum
Volume	849 mi^3/3,538 km^3
Water Surface Area	23,000 mi^2/59,565 km^2
Drainage Basin Area	50,700 mi^2/131,303 km^2
Shoreline Length (including islands)	3,830 mi/6,164 km
Elevation	577.5 ft/176.0 m
Outlet	St. Clair River to Lake Erie
Retention/Replacement Time	21 years
Population	2,960,359
United States	1,483,872
Canada	1,476,487

Natural Resource and Environmental Issues

Loss of Wetlands: Thirty-seven percent of all coastal wetlands in Michigan are in the Lake Huron basin. Wetlands help to replenish and purify groundwater, prevent flooding and erosion, and support a wide diversity of plant and animal life. However, wetlands continue to be drained and filled — mostly on the U.S. shoreline, where it is estimated that 50 percent of the original Saginaw Bay wetlands have been lost to urban encroachment, cottage development and agriculture.

Water Quality: Pollution is not as severe in Lake Huron as it is in some other Great Lakes basins, but problem areas do exist. The sources of this pollution are agricultural runoff, industrial plants and municipal wastewater treatment plants. Toxins enter the lake from direct discharge and atmospheric deposition. These toxins can be harmful to fish and wildlife. Consumption advisories have been placed on some Lake Huron sport-caught fish because of concern that contaminants may affect humans who eat fish in large amounts. The U.S. and Canadian governments have designated three places on the Lake Huron shoreline as areas of concern where beneficial uses have been impaired and environmental standards are not being met. Improvements have occurred in the Lake Huron basin, however. One result of these efforts was the delisting of one area of concern — Collingwood Harbour at the southern end of Georgian Bay — the first in the Great Lakes Basin to be removed from the list.

Exotic Species: Several aquatic nuisance species have found their way into the waters of Lake Huron and are disrupting its ecological dynamics. Sea lamprey, which entered Lake Huron in 1932, prey on and have decimated valued species of fish such as lake trout, whitefish and chinook salmon. Because these lampreys have no natural predators in the Great Lakes, alternative control methods are being used to sustain important fisheries. Zebra mussels have also caused ecological and economic problems in Lake Huron. These small, striped mussels cluster inside water pipes, disrupting normal inflow necessary for industry, agriculture and residential use. In addition, they can affect recreation if large numbers of them wash ashore, leaving behind their sharp shells and producing a foul odor. Zebra mussels are damaging populations of native mussels by attaching to their shells, impairing the natives' ability to function, and eventually killing them.

Sea Grant MICHIGAN

The Michigan Sea Grant College Program is a joint effort of the University of Michigan and Michigan State University, funded by the National Oceanic and Atmospheric Administration, to conduct research, outreach and education on Great Lakes and marine issues. MICHU-SG-00-403

October / 2000 Extension Bulletin E-1868

MICHIGAN STATE UNIVERSITY EXTENSION

Shipping: Lake Huron functions as a conveyer within the Great Lakes system. Vessels loaded with raw materials and finished goods move from Lake Superior and Lake Michigan through Lake Huron to the urban and industrial centers along Lake Erie and Lake Ontario. The lock system in the St. Marys River at Sault Ste. Marie makes this transfer possible.

Agriculture: Huron County in Michigan's Thumb region produces more dry beans than any other county in the nation. Other crops grown in the basin include soybeans, potatoes, cucumbers, corn and sugar beets.

Fisheries: In 1996, Lake Huron produced a commercial harvest of more than 9 million pounds of fish, primarily lake whitefish and chubs. Recreational fishing is also important, attracting 230,000 U.S. anglers in 1991 and 443,000 Canadians in 1985.

When Lake Huron's 30,000 islands are included, the lake has the longest shoreline of any of the Great Lakes.

Tourism/Recreation: Many vacation cottages cluster on the Lake Huron shoreline, and each year more than 6.5 million people visit national, provincial and state parks, and underwater preserves/parks in the Lake Huron basin. Underwater preserves/parks are special areas in the lakes designated by Michigan/Ontario to protect shipwrecks and other cultural and geologic resources. In 2000, Michigan's Thunder Bay Underwater Preserve near Alpena, Michigan, also became the United States' first National Marine Sanctuary in the Great Lakes.

Ecology

Many types of forests are located in the Lake Huron basin, including northern hardwood and pine forests in the north and oak-hickory forests in the south.

Thirty-seven percent of all wetlands found in Michigan are in the Lake Huron basin. Lake Huron's coastal wetlands are home to more than 40 species of rare plants, five species of reptiles and more than 80 species of fish. Birds in the basin include the bald eagle, great blue heron and snowy owl.

A wide array of mammals live in the Lake Huron basin, including moose, elk, black bear, gray wolf, Canada lynx, beaver, coyote, porcupine and flying squirrels, along with 10 species of frogs and Michigan's only poisonous snake, the eastern massasauga rattlesnake.

Lake Huron is the second largest of the Great Lakes and the fourth largest freshwater lake in the world. It is hydrologically connected to Lake Michigan at the Straits of Mackinac, so the two could actually be one lake. Lake Huron also includes the two largest bays on the Great Lakes — Georgian Bay and Saginaw Bay. Georgian Bay alone is large enough to be one of the world's 20 largest lakes. Lake Huron has inflow from both Lake Superior and Lake Michigan but has a shorter retention time than either — 21 years.

The state of Michigan and the province of Ontario surround Lake Huron. The United States/Canada border divides Lake Huron almost exactly in half. The southern portion of the Lake Huron basin is more developed than the northern portion and is dominated by residential areas and agriculture. The northern portion of the basin is heavily forested, sparsely populated, scenically beautiful and economically dependent on its rich natural resources.

Shoreline Use

United States		Canada
27.3%	Residential	13.9%
5.0%	Commercial/Industrial	1.0%
0.3%	Agricultural	1.7%
67.5%*	Other	83.4%**

* U.S. "other" classification includes public, beaches, forests, barren lands.

** Canadian "other" classification includes transportation and communications, recreation, extraction, water, wetlands, forestry, grassland, barren and unknown.

Economy

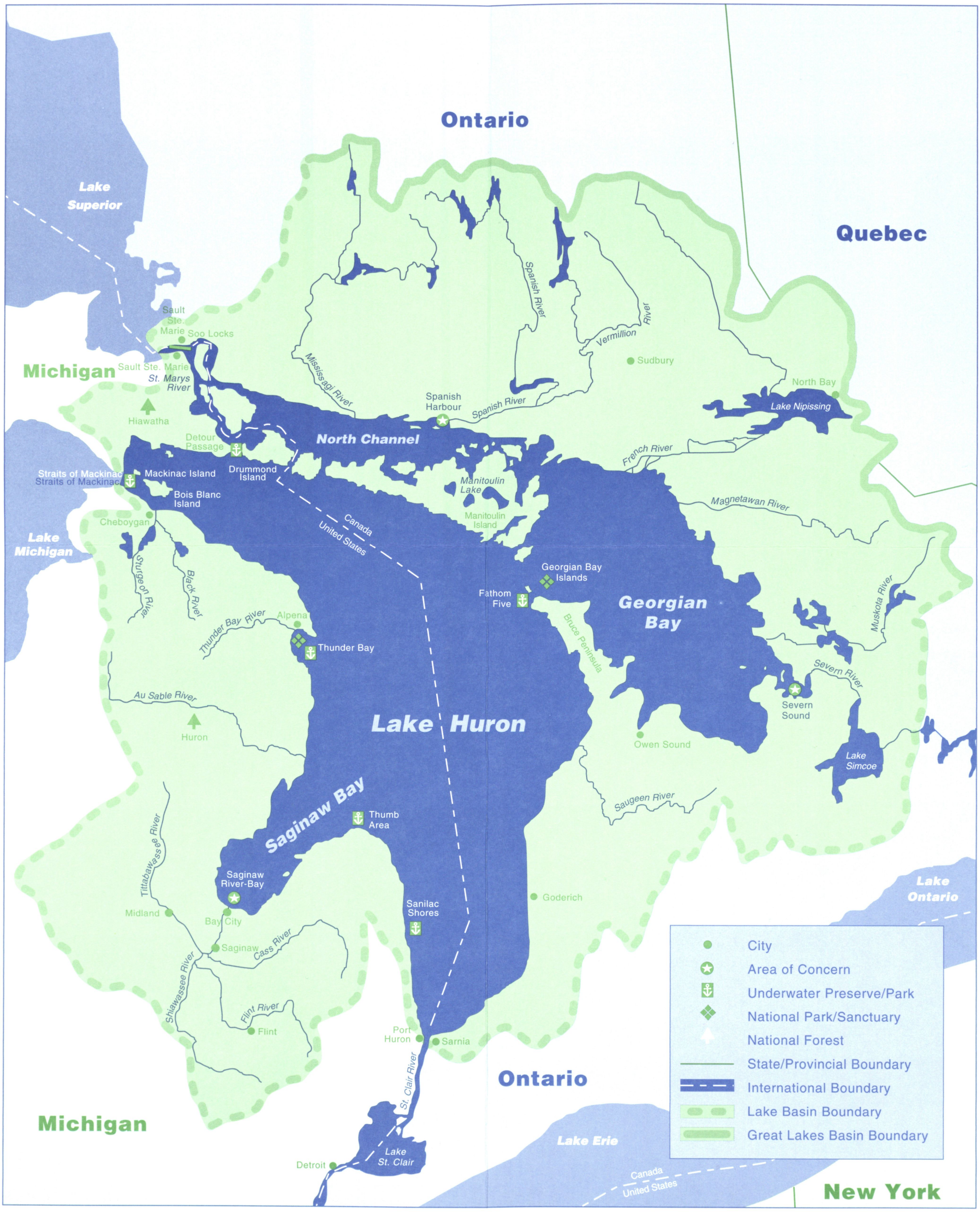
The Lake Huron basin supports a varied economy with strong industrial, agricultural and recreational sectors.

Industry: One of the largest U.S. chemical producers is located in the basin at Midland, Michigan, and one of Canada's largest petrochemical centers is at Sarnia, Ontario.

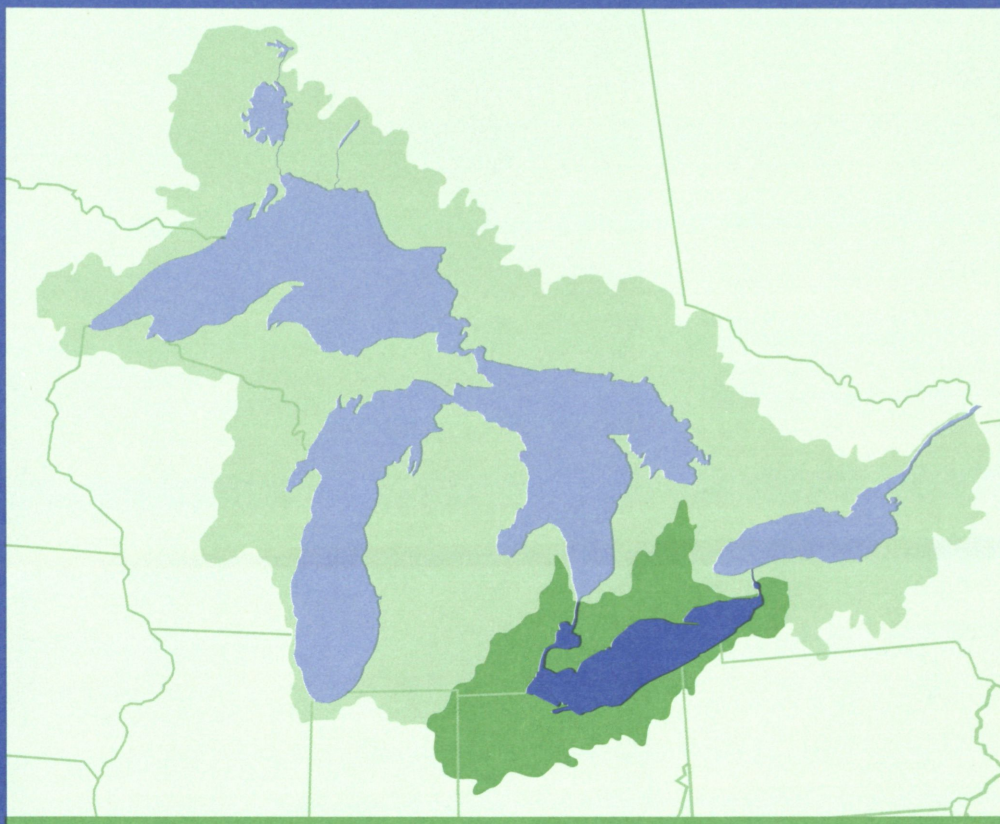
Mining: Large nickel reserves are located in Ontario just north of the lake. The world's largest limestone quarry is located in the basin near Rogers City, Michigan.

Manitoulin Island is the largest freshwater island in the world. On that island is a lake (Manitoulin Lake), which is the largest lake on an island in a lake in the world. Manitoulin Lake has an island that is the largest island on a lake on an island in a lake in the world!

Lake Huron Basin



Lake Erie Basin



Lake Erie Basin Statistics

Length	241 mi/388 km
Breadth	57 mi/92 km
Depth	62 ft/19 m average 210 ft/64 m maximum
Volume	116 mi^3/483 km^3
Water Surface Area	9,910 mi^2/25,655 km^2
Drainage Basin Area	22,700 mi^2/58,788 km^2
Shoreline Length	871 mi/1402 km (including islands)
Elevation	569.2 ft/173.5 km
Outlets	Niagara River and Welland Canal
Retention/Replacement Time	2.7 years
Population	12,532,977
United States	10,640,671
Canada	1,892,306

some detergents. The large amounts of phosphorus released into the lake caused an increase in algae growth. When this excess algae died, its decomposition depleted oxygen at the bottom of the lake. Without oxygen, only the most tolerant life forms could survive there. In recent years, after implementation of Canadian and U.S. environmental legislation, Lake Erie has improved significantly. The U.S. and Canadian governments have designated nine locations on connecting channels and the Lake Erie shoreline as areas of concern where beneficial uses have been impaired and environmental standards are not being met.

Fisheries: Lake Erie's fishery tops the Great Lakes in commercial production, and its walleye fishery is widely seen as the best in the world. Despite the evident success of this resource, some of Lake Erie's fisheries are threatened. Thirty-four species of Lake Erie fish are rare, endangered, threatened, extinct or of special concern. Species such as the sturgeon and the brook trout, which were once abundant, are declining. Causes of this decline include toxic contamination, overharvesting and invasion by aquatic nuisance species. Other species, such as the lake's famous walleye, are intensively managed to keep them productive. Still other species, such as yellow perch and lake whitefish, are now stable or increasing. These are examples of the success of cooperative fish management between the four Lake Erie states and the Canadian province of Ontario.

Exotic Species: Lake Erie has had to contend with several aquatic nuisance species, the most notable being the zebra mussel. This mollusk is causing widespread ecological and economic problems in many Great Lakes basin locations. Large colonies of zebra mussels cluster inside water pipes, disrupting normal inflow necessary for industrial, agricultural and residential use. In addition, zebra mussels are creating problems for native mussels by encrusting their shells, which impairs their ability to function and kills them.

Another significant aquatic nuisance species is purple loosestrife. This plant takes over wetlands, reducing habitat for native animals and plants that depend on wetlands for their survival. Another Lake Erie aquatic nuisance species is the round goby, introduced to the lake basin in 1993 and well established in the central basin by 1994. Gobies are suspected of competing for food with native fish species such as darters and sculpins, driving native species from their preferred habitat and preying on the eggs of lake trout, whose reproductive capacities are already limited.

Sea Grant MICHIGAN

The Michigan Sea Grant College Program is a joint effort of the University of Michigan and Michigan State University, funded by the National Oceanic and Atmospheric Administration, to conduct research, outreach and education on Great Lakes issues. MICHU-SG-00-404

October / 2000 Extension Bulletin E-1869

MICHIGAN STATE UNIVERSITY EXTENSION

Fisheries: Lake Erie's commercial fishery is as productive as the fisheries of the other four Great Lakes combined, with a catch of more than 33 million pounds in 1996. The Lake Erie walleye fishery is widely seen as the best in the world, with more than 12 million pounds caught in 1996. Other major species harvested are smelt and yellow perch. Lake Erie is also the most popular of the lakes with recreational anglers, who also fish for walleye and perch.

Agriculture: The Lake Erie basin has the largest percentage of land in agriculture in the Great Lakes. Agriculture dominates the economy of the western and northern shores of the lake. Lake Erie waters help to moderate coastal temperatures, making the growing season there last up to three weeks longer than farther inland, benefiting fruit farms, orchards, nurseries and vineyards along the shoreline.

Shipping: Ten major commercial ports on Erie's shores serve as major distribution centers for iron ore, coal, manufactured goods and grain. More than 100 million tons were shipped out of Lake Erie ports in 1996.

Tourism/Recreation: More people visit parks in the Lake Erie basin than visit those around any of the other Great Lakes. In 1997, more than 30 million people visited state, provincial and national parks in the United States and Canada.

Ecology

Lake Erie is the most nutrient-rich and the warmest of the Great Lakes and is, therefore, the most biologically productive. Its coastal wetlands thrive in this climate and contain the greatest diversity of plant and animal species in the Great Lakes. The lake and its marshes are home to more than 100 species of fish — walleye, perch and bass are among the most popular. More than 300 species of birds have been documented in the wetlands within the Lake Erie basin. Mammals in the region include gray and red foxes, white-tailed deer, woodchuck, raccoon, and various mice, voles and shrews. The lake basin lies within the deciduous forest region of eastern North America. Little of the original forest remains today, but major plant communities include the beech-sugar maple forest and the mixed conifer-hardwoods forest.

Natural Resource and Envrionmental Issues

Water Quality: In the 1970s, Lake Erie showed severe effects of pollution. Years of chemical dumping and the release of millions of gallons of untreated sewage and non-point runoff had polluted the waters and triggered severe effects on the lake's ecology and economy. One of the pollutants was phosphorus, found in sewage, fertilizers and

Lake Erie is the 11th largest lake in the world (by surface area). It is the fourth largest of the Great Lakes in surface area and the smallest by volume. Four states — Michigan, Ohio, Pennsylvania and New York — and the Canadian province of Ontario border the lake. Lake Erie is the shallowest of the Great Lakes and the only one whose bottom is completely above sea level. Ninety-five percent of Lake Erie's inflow comes from the upper lakes — Superior, Michigan and Huron — Lake St. Clair and through the connecting channels of the St. Clair River, Detroit River and numerous tributaries. The rest comes from precipitation. Lake Erie was the last of the Great Lakes to be discovered by European explorers, but its basin has grown to become the most densely populated of all and has several large metropolitan areas — Detroit, Toledo, Cleveland and Buffalo.

Point Pelee National Park, which juts out into the lake, is the southernmost point on Canada's mainland.

Shoreline Use

United States		Canada
32.6%	Residential	21.4%
11.3%	Commercial/Industrial	.7%
3.9%	Agricultural	1.3%
52.2%*	Other	76.6%**

* U.S. "other" classification includes public, beaches, forests, barren lands.

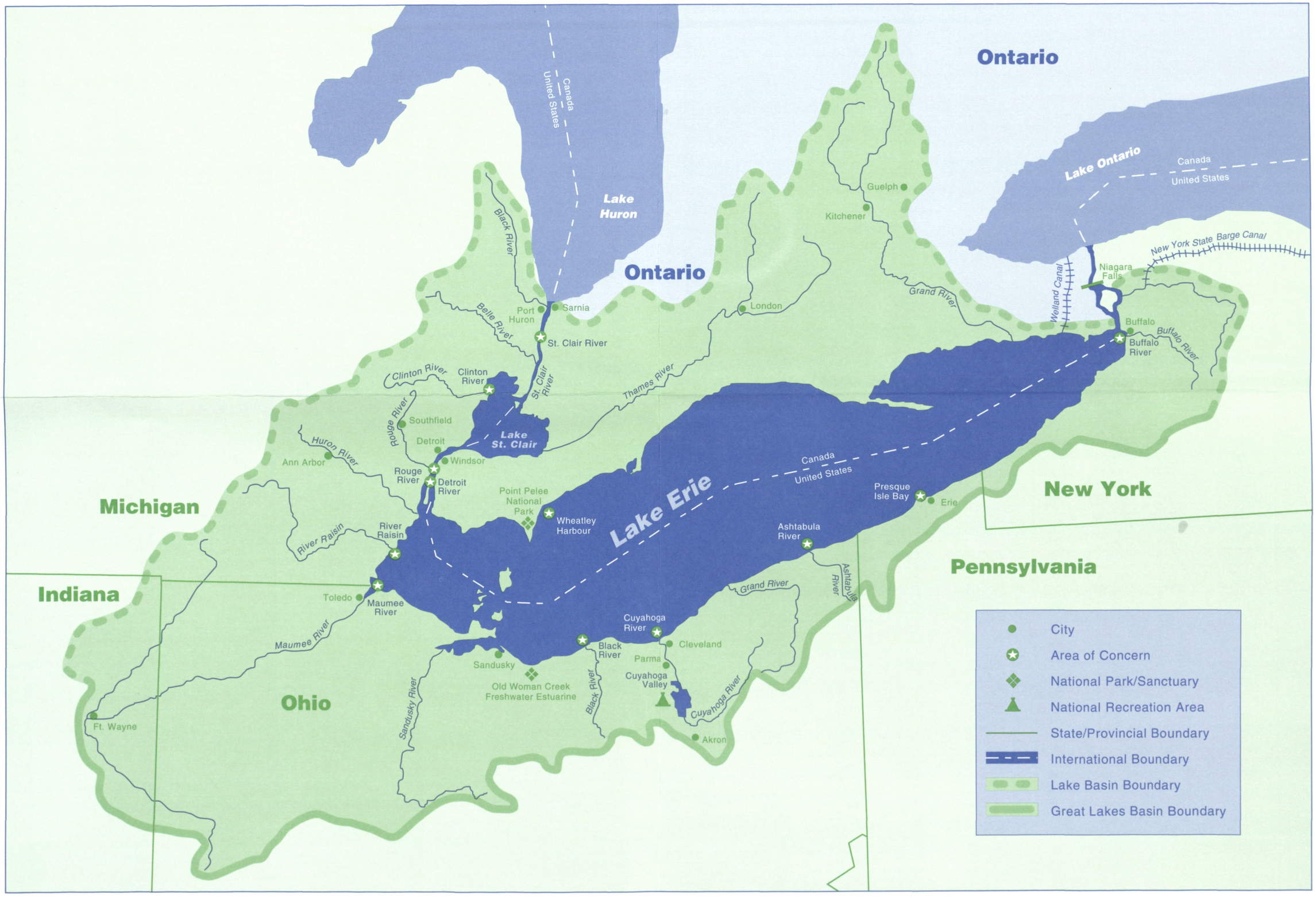
** Canadian "other" classification includes transportation and communications, recreation, extraction, water, wetlands, forestry, grassland, barren and unknown.

Economy

The Lake Erie basin supports a varied economy with strong industrial, agricultural and recreational sectors.

Industry: The Lake Erie basin supports a very important automobile manufacturing center. In 1996, 30 percent of all automobiles produced in the United States and Canada were produced in the Lake Erie basin. One of the largest sandstone quarries in the world is in South Amherst, Ohio. Large salt mines are located on the south shore of Lake Erie. Large reserves of natural gas are located under the lake. Glass manufacturing is another significant industry.

Lake Erie Basin



Lake Ontario Basin

Lake Ontario Basin Statistics

Length	193 mi/311 km
Breadth	53 mi/85 km
Depth	283 ft/86 m average 802 ft/244 m maximum
Volume	393 mi^3/1,639 km^3
Water Surface Area	7,340 mi^2/19,009 km^2
Drainage Basin Area	23,400 mi^2/60,601 km^2
Shoreline Length	712 mi/1,146 km (includes islands)
Elevation	243.3 ft/74.2 m
Outlet	St. Lawrence River to the Atlantic Ocean
Retention/Replacement Time	6 years
Population	5,692,178
U.S.	2,856,360
Canada	2,835,818

Natural Resource and Environmental Issues

Loss of Wetlands: Wetlands are important to the lake ecosystem because they help to replenish and purify groundwater, prevent flooding, and support a wide diversity of plant and animal life. Many of the major cities in the Lake Ontario basin are located on land that was once coastal wetlands. An estimated 60 percent of the original wetlands on the U.S. side of the lake have been lost already, mainly because of the expansion of urban areas near Oswego and Rochester.

Water Quality: Water from all four of the other Great Lakes and the Niagara River flows into Lake Ontario. With that water come pollutants. Adding this influx to the agricultural runoff, urban sewage, stormwater and industrial waste discharges that enter the lake from point and nonpoint sources within the basin results in extensive water quality problems. In addition, certain toxins such as PCBs, dieldrin, lead and mercury enter the lake from the atmosphere. A commercial fishing ban has been placed on eels in Lake Ontario because of airborne release of dioxins and PCBs into the lake. Some effects of this pollution are closed beaches, human health risks, contamination of fish and wildlife, and economic losses in tourism and fisheries. The U.S. and Canadian governments have designated 11 places on connecting channels and the Lake Ontario shoreline as areas of concern where beneficial uses have been impaired and environmental standards are not being met.

Niagara Falls, located between lakes Erie and Ontario, is one of North America's most famous geographic features and is considered by some to be one of the natural wonders of the world. The normal flow over the falls is 100,000 cubic feet per second.

Sea Grant MICHIGAN

The Michigan Sea Grant College Program is a joint effort of the University of Michigan and Michigan State University, funded by the National Oceanic and Atmospheric Administration, to conduct research, outreach and education on Great Lakes issues. MICHU-SG-00-405

October / 2000 Extension Bulletin E-1870

MICHIGAN STATE UNIVERSITY EXTENSION

Agriculture: More than 7,000 farms are located on the U.S. side of the Lake Ontario basin. In 1997, the market value of their products was more than $1.1 billion. Major agricultural commodities include apples, onions, cabbage, and meat and dairy products.

Fisheries: In 1996, 1.8 million pounds of fish were commercially harvested in Lake Ontario waters. The main species caught were lake whitefish, bullheads and yellow perch. Lake Ontario also has a very important recreational fishery centering on trout and salmon.

Tourism/Recreation: More than 20 million people annually visit Niagara Falls. In addition, more than 10 million visitors annually visit state, provincial and national parks in the Lake Ontario basin. In 2000, the state of New York designated the first underwater park in Lake Ontario to protect shipwrecks and provide recreational opportunities for divers. Toronto provides an urban alternative and is one of Canada's major tourism and convention centers.

Ecology

Lake Ontario is bounded by the powerful Niagara Falls on the west and the picturesque Thousand Islands on the east. In addition to these notable features, the Lake Ontario basin also has important forested areas and wetlands. The majority of the basin is forested, dominated by northern hardwoods such as maple and beech and conifers such as red and white pines. Coastal sand dunes are another important feature. The basin's forests are home to more than 3,500 species of plants and animals, including the bald eagle, great blue heron, beaver, coyote, porcupine and flying squirrel. More than 44,000 acres of wetlands line Lake Ontario's shores. This important ecosystem is home to 17 rare species of plants and 90 species of fish.

Lake Ontario, the 14th largest lake in the world, is the smallest of the Great Lakes in surface area. It ranks fourth among the Great Lakes in maximum depth but is second only to Lake Superior in average depth. The state of New York and the Canadian province of Ontario surround the lake.

The basin's land area is largely rural overall, and nearly half of its land area is forested. Agriculture is dominant in the U.S. portion. By contrast, Ontario's largest city, Toronto, and some other large urban and industrialized areas are located on the Canadian shoreline.

Shoreline Use

United States		Canada
42.1%	Residential	13.4%
3.3%	Commercial/Industrial	6.0%
4.6%	Agricultural	22.7%
50.1%*	Other	57.9%**

* U.S. "other" classification includes public, beaches, forests, barren lands.

** Canadian "other" classification includes transportation and communications, recreation, extraction, water, wetlands, forestry, grassland, barren and unknown.

Economy

Industry: Generating stations at Niagara Falls produce one-fourth of all the power used in New York and Ontario. Two-thirds of Canada's steel production occurs in the province of Ontario, much of it in the Lake Ontario basin near Hamilton.

Shipping: Lake Ontario has 13 major ports through which iron ore, limestone and coal are shipped.

The oldest lighthouse on the U.S. side of the Great Lakes was built at Fort Niagara.

Lake Ontario Basin