Lake Great Lakes Basin
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THE GREAT LAKES

Formed over a span of 2 million years by glacial and geological action, the Great Lakes took their most recent form almost 10,000 years ago — at the end of the last ice age. Lakes Superior, Michigan, Huron, Erie and Ontario are joined by rivers and other connecting channels to form the largest surface freshwater system in the world.

Lake Superior has the largest surface area of any freshwater lake in the world. Lake Huron, the second largest of the Great Lakes, is the fifth largest lake in the world. Lake Michigan, the only Great Lake totally within U.S. boundaries, is the world's sixth largest lake. Lake Erie, the eleventh largest freshwater lake in the world (by surface area), is the shallowest of the Great Lakes. Lake Ontario, the smallest of the system in surface area, is the fourth deepest and the fourteenth largest lake on Earth.

WATER USE

The Great Lakes provide water for many purposes, such as domestic uses (residential, commercial, institutional); industrial processes; agricultural operations (irrigation and livestock watering); electric power generation (fossil fuel, hydroelectric and nuclear); navigation; sanitation; recreation; and habitat for aquatic life. In 1987, the Great Lakes basin states and provinces began to maintain more complete usage records, but not all jurisdictions were able to provide accurate information for each lake basin. The following are conservative estimates.

Total Usage: 655 billion gallons per day (bgd) or about 2.5 trillion litres per day (tld) are used for various purposes. This amount would fill a train of more than 19 million jumbo tanker cars, each 65 feet long, holding 34,000 gallons. The train would be over 237,000 miles long and would circle Earth at the equator more than nine and one-half times.

Ninety-four percent of the water passes through hydroelectric production plants and is returned to the Great Lakes ecosystem. Approximately 1,000 gallons per Great Lakes basin resident (37 bgd/140 bld) is used daily for other purposes. Almost 97 percent of this amount is returned to the system; the remaining 3 percent leaves the system either through evaporation or through incorporation into products and is considered "consumed."

Drinking Water: Approximately 25 million people get their drinking water from the Great Lakes and St. Lawrence River. This number includes 5 million

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Recreation/Tourism: Recreation/tourism is often called the region's second largest industry, and Great Lakes states have spent as much as $11 million on tourism promotion annually since 1986. Approximately 700,000 U.S.-registered recreational boats are used on the Great Lakes each year. In 1987, an estimated 800,000 pleasure boats registered in Ontario were used on the Great Lakes. Recreational diving on shipwrecks is a growing Great Lakes sport, especially in the eight underwater preserves and parks located in lakes Superior, Michigan and Huron. The average diver spent more than $1,200 (U.S.) on Great Lakes diving trips in 1986. Great Lakes recreation also includes such activities as windsurfing, kayacking, dune climbing, rockhunting, sunbathing, hiking, birdwatching and picnicking.

RESOURCE ISSUES

The Great Lakes ecosystem consists of the water, surrounding land, air and all living organisms (including humans) in the basin. The issues, problems and challenges facing the Great Lakes basin include water quality; fisheries management; transportation; widely fluctuating water levels, shoreline erosion and coastal flooding; diversions and consumptive uses; wetland drainage and land use; waterfront revitalization, public access, recreation and tourism; the complexity of management institutions; and research, monitoring, surveillance and enforcement of environmental laws and agreements.

The Great Lakes and the St. Lawrence River are bordered by eight states — Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania and New York — and two Canadian provinces — Ontario and Quebec. These jurisdictions, along with the federal governments of the two countries, are responsible for managing the lakes.

Water Levels: Great Lakes water levels fluctuate primarily because of variations in the amount of precipitation falling on the lakes and surrounding land and changes in evaporation from those surfaces. Levels normally vary somewhat from season to season — from high during winter and spring to low during summer. If there is exceptionally heavy rain/snowfall with cooler-than-average temperatures, the levels are likely to rise beyond the seasonal variation, and they can also decline quickly. Such wide fluctuation in lake levels can affect the shipping industry, power generation, recreational opportunities, shoreline erosion and wildlife habitat.

Michigan water, but many of whom live outside the basin boundary.

Power Generation: An average of 20 billion kilowatt hours of electricity are generated annually by using Great Lakes water. An average of at least 640.4 bgd was withdrawn for this purpose in 1987, and hydroelectric production used almost 97 percent (620 bgd/2.3 tld). This was by far the largest quantity of Great Lakes water withdrawn for a single purpose.

Agriculture: An average of 300 mgd in 1987.

Industry/Manufacturing: (self-supplied, that is, not served by a municipal system): 7.7 bgd in the jurisdictions reporting in 1987.

Diversions: In 1987, 1.9 bgd/7.2 bld of water were diverted into the Great Lakes system through the Long Lac and Ogoki diversions into Lake Superior. This amount was somewhat lower than the long-term average of 3.6 bgd/13.7 bld. In addition, 1.6 bgd or 6 bld is diverted out of the Great Lakes, most of it at Chicago into the Mississippi River basin.

ECONOMIC IMPORTANCE

The Great Lakes play an important role in the region's manufacturing, agriculture, transportation, tourism, and fishery. Many industries first developed near the lakes because of the availability of abundant, cheap clean water and a means of accessible, efficient transportation. Likewise, the Great Lakes region has a profound influence on the world's economy.

Great Lakes Shipping: The Great Lakes are an important inland transportation route for the large scale movement of coal, iron ore, limestone, sand and a variety of grains. In 1987, 63.3 million net tons of iron ore, 37.7 million tons of coal and 22.7 million tons of grain were transported on the Great Lakes. That year, 40 million metric tons of cargo moved through the St. Lawrence Seaway on some 5,000 vessels.

Industry: In 1986, about 17 percent of the United States' manufacturing industry was located in the Great Lakes basin.

Steel Production: 72 percent of Canadian and 45 percent of U.S. production occurs in the Great Lakes basin (70 percent in the Great Lakes states).

Shipbuilding: Two major shipyards are located on the Great Lakes, at Port Weller, Ontario, and at Sturgeon Bay, Wisconsin.

Auto Production: 41.5 percent of U.S. cars and 37.3 percent of U.S. trucks and buses are manufactured in the Great Lakes region. 94.7 percent of Canadian car and truck production occurs in the region.

Power Generation: Electric power generation in the Great Lakes states and Ontario is estimated at 826.9 billion kilowatt hours annually.

Agriculture: The Great Lakes help to moderate the region's climate and supply ample water for irrigation, so agricultural production ranks among the top three contributors to the region's economy. Great Lakes states produce 49 percent of U.S. corn and much of U.S. and Canadian beans, sunflower seeds and dairy products. Orchards, particularly apple and cherry, and vineyards are located along the shores of several Great Lakes. Cheese factories, breweries and canneries depend on Great Lakes water. Twenty-two percent of Canadian farms are located in the Great Lakes basin, and they account for 25 percent of total Canadian agricultural production.

Forestry: Almost half the United States' area of the Great Lakes basin is forested. Paper production has developed at Green Bay in the United States and throughout the Lake Superior region. However, some authorities think that lack of reforestation in some areas of the Great Lakes basin may reduce the forestry resource in the future.

Fishery: Commercial fishing — Ontario commercial fishers caught 48 million lb (22 million kg) in 1987; 41.2 million lb (18.7 million kg) were caught in the U.S. The dockside value of the fish caught commercially in Canada was about $46 million (Canadian dollars-CDN), while the value of U.S.-caught fish was nearly $18.8 million (U.S. dollars). The commercial fishery has a regional economic impact more than four times the dockside value (the money paid for the catch at the dock). Sportfishing — The Great Lakes states sold nearly 9.5 million fishing licenses in 1987, many of them for use on the Great Lakes or their tributaries. Anglers spent the equivalent of 46.4 million days sportfishing on the U.S. waters of the Great Lakes in 1985, with a regional economic benefit of about $1.56 billion (U.S.). Sportfishing on Canadian Great Lakes waters that year totalled more than 14.6 million angler days, with expenditures amounting to almost $351.5 million (CDN). In 1987, approximately 3,000 charter fishing boats were operating on the Great Lakes. Michigan charter fishing clients alone spent $39 million for charter fees and trip expenses.

the lakes is generally good. However, industrial, municipal and recreational uses of the Great Lakes add pollutants to the ecosystem. Some pollutants may stay in the water or lake sediments for hundreds of years and affect the ecosystem. The types of problems include: toxic substances in water, sediments, fish and other organisms living in or depending on the water; elevated levels of bacteria; high levels of phosphorus and other nutrients; heavy metals; and aesthetic problems. Pollution is usually most severe in major population centers on Great Lakes rivers, harbors and connecting channels. The types and severity of problems vary among these "areas of concern" (AOCs).

The federal governments developed the Boundary Waters Treaty (1909) and the Great Lakes Water Quality Agreement (1972, 1978 and amendments in 1987), along with laws and programs such as the U.S. Clean Water Act, the Canadian Environmental Protection Act and the $125 million Great Lakes Action Plan to protect and improve the ecosystem. In 1985, the Great Lakes states and provinces agreed to clean up and restore 42 AOCs. Responsible jurisdictions are developing "remedial action plans" (RAPs) to control and stop existing sources of pollution and restore water quality in each AOC. The states have signed a Toxic Substances Control Agreement, and the Province of Ontario has begun a Municipal-Industrial Strategy for Abatement (MISA). The Council of Great Lakes Governors has established a Great Lakes Protection Fund to support research on toxic substances problems.

Fisheries: 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 others such as coho and chinook salmon and rainbow trout, that were introduced and are restocked regularly by state and federal fishery management agencies to enhance recreational opportunities for the public. Between 1958 and 1984, more than 450 million fish of various species were planted in the Great Lakes. Some introduced species are beginning to reproduce naturally in the lakes.

Among the challenges to the fishery are (1) maintaining a sustainable forage base; (2) controlling exotic species such as sea lamprey, river ruffe and zebra mussels; and (3) eliminating toxic substances. The states and provinces cooperate in Great Lakes fishery management through the Great Lakes Fishery Commission and have developed cooperative fish consumption advisories.

Great Lakes Basin

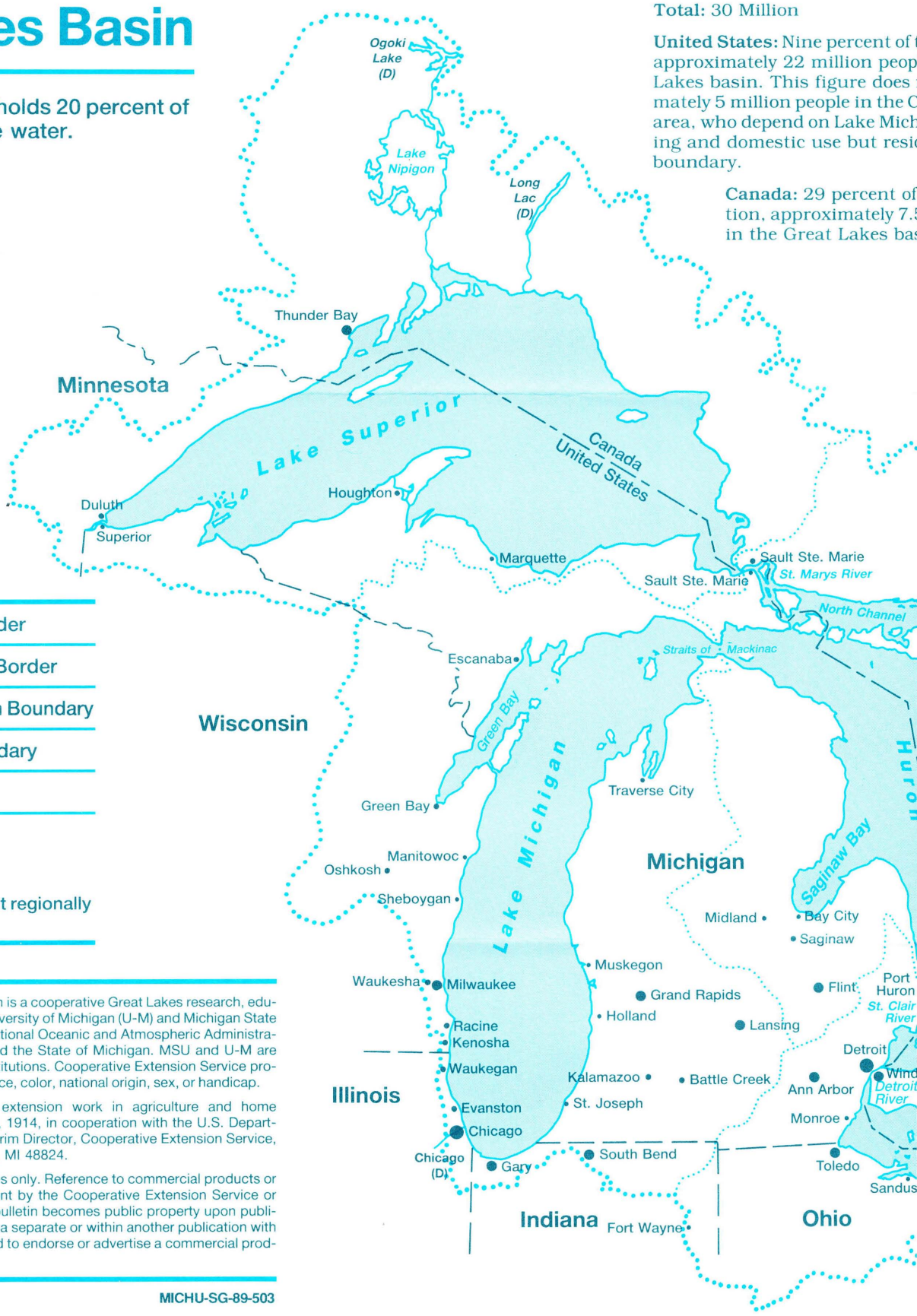
The Great Lakes system holds 20 percent of the world's fresh surface water.

POPULATION

Total: 30 Million

United States: Nine percent of t
approximately 22 million peop
Lakes basin. This figure does
mately 5 million people in the C
area, who depend on Lake Mich
ing and domestic use but resi
boundary.

Canada: 29 percent of
tion, approximately 7.5
in the Great Lakes bas



LEGEND

- International Border
- State/Provincial Border
- Great Lakes Basin Boundary
- Lake Basin Boundary
- (D) Diversion
- Metro Areas
- 100,000+
- 50,000-99,999
- less than 50,000 but regionally important

The Michigan Sea Grant College Program is a cooperative Great Lakes research, education and Extension program of The University of Michigan (U-M) and Michigan State University (MSU). Funding is from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and the State of Michigan. MSU and U-M are Affirmative Action/Equal Opportunity Institutions. Cooperative Extension Service programs are open to all without regard to race, color, national origin, sex, or handicap.

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outside the basin

Canada's popula-
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DIMENSIONS

Volume: 6 quadrillion gallons of fresh water; one-fifth of the world's fresh surface water (only the polar ice caps and Lake Baikal (USSR) contain more); 95 percent of the U.S. supply. Spread evenly across the continental U.S., the Great Lakes would submerge the country under about 9.5 feet of water.

Total Area: Over 94,000 mi^2/244,000 km^2 of water (larger than the states of New York, New Jersey, Connecticut, Rhode Island, Massachusetts, Vermont, and New Hampshire combined, or about 23 percent of the province of Ontario). In the watershed (the area where all the rivers and streams drain into the lakes), about 295,000 mi^2/767,000 km^2.

Total Coastline: United States and Canada — 11,232 mi/18,059 km (including connecting channels, mainland and islands). The Great Lakes shoreline is equal to almost 45 percent of the circumference of the earth, and Michigan's Great Lakes coast totals 3,288 mi/5,294 km, more coastline than any state but Alaska.

SPONSORS/INFORMATION SOURCES

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Other publications in this series are: Lake Superior (E-1866, MICHU-SG-89-504); Lake Michigan (E-1867, MICHU-SG-89-505); Lake Huron (E-1868, MICHU-SG-89-506); Lake Erie (E-1869, MICHU-SG-89-507); and Lake Ontario (E-1870, MICHU-SG-89-508). For additional copies, contact one of the organizations listed above, your county Extension office, or the MSU Bulletin Office, 10-B Agriculture Hall, East Lansing, MI 48824-1039.