OUR GREAT LAKES

OUR GREAT: LAKES: 1683

Father Hennipen's Map

OUR GREAT LAKES

UNIVERSITY OF WISCONSIN SEA GRANT COLLEGE PROGRAM

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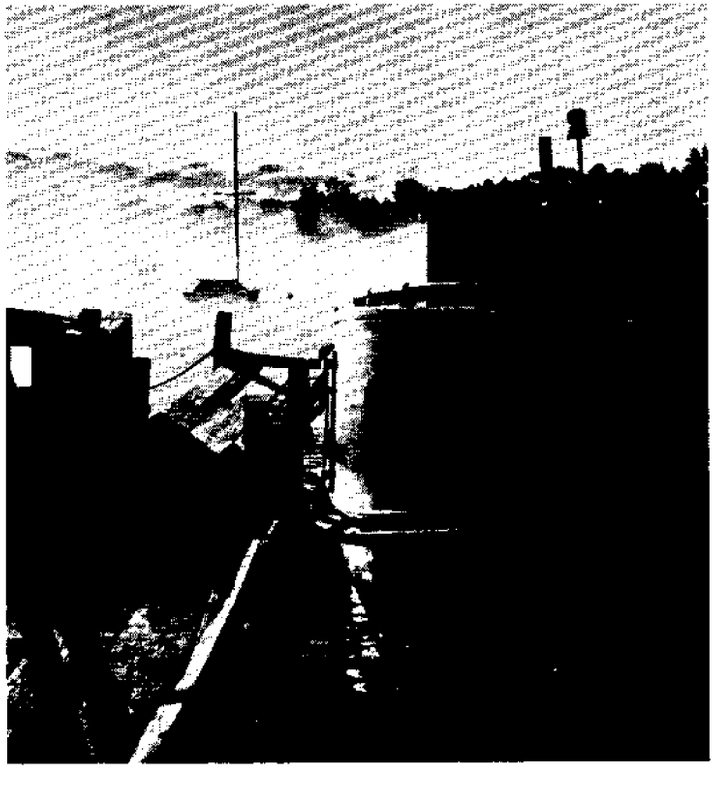
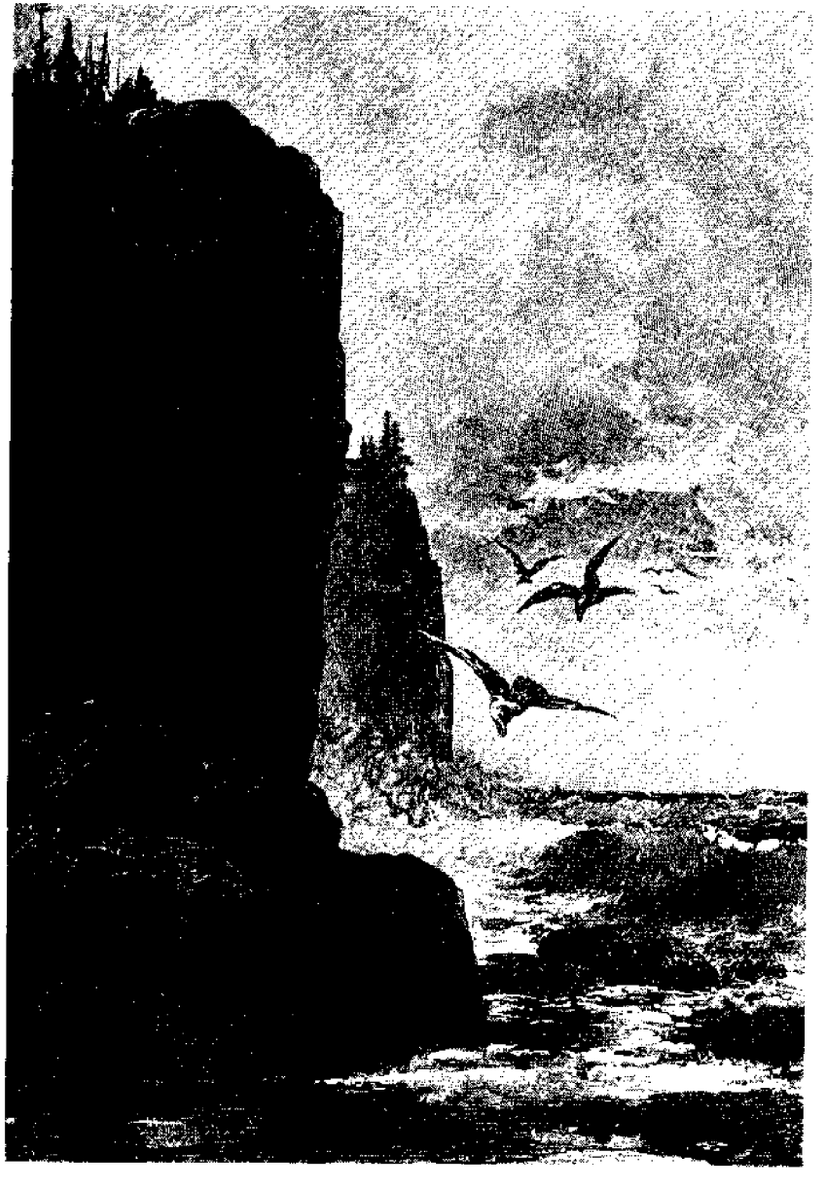




A Gift of the Glaciers

About 6,000 years ago, the retreating glaciers of the Ice Age left behind a sparkling necklace strung half-way across the North American continent – the five Great Lakes.

Superior, Michigan, Huron, Erie and Ontario. Awesome in their size, these lakes have earned their reputation as North America's inland oceans. Together, they cover an area of 95,000 square miles and constitute the largest reserve of fresh water in the world, an estimated 65 trillion gallons. If spread evenly over the continental United States, the waters of the Great Lakes would submerge our country to a depth of nine feet.

The Great Lakes not only look like oceans but behave like oceans. They are subject to many of the same hydrographic forces and, like the oceans, they exert a major influence over the weather of the neighboring region.

Draining off of the forests and plains of the upper Midwest, the lake waters flow west to east, ultimately running down through the chain of lakes, rivers and canals and out through the St. Lawrence River to the Atlantic Ocean.

Superior, the western-most lake in the chain, is the largest in the world in terms of surface area, and is the deepest in the Great Lakes system.

Superior, in turn, flows into Lake Huron. Though it is the second largest lake, Huron is remote and is probably the lake about which the least amount is known.

Dangling between Huron and Superior is appendix-shaped Lake Michigan. Michigan, the only lake which lies solely within the United States, has heavy concentrations of people and industry on its shores. But because it is a natural cul-de-sac, only relatively small amounts of lake water flow out through the bottleneck between Lakes Michigan and Huron. These geographical conditions conspire to make the flushing time of Lake Michigan very slow and to permit a build-up of foreign material in the system.

From Huron, the waters flow down the St. Clair River and through Lake St. Clair to arrive at Lake Erie, the smallest and shallowest of the Great Lakes. Despite its modest size, Erie is also the most famous. Lake Erie's water quality problems have become legendary, and the lake is frequently used as an example of the tremendous damage man can unwittingly do to his environment.

Lake Ontario, the last in the chain, receives much of its water from Erie and so it, too, suffers from many of Erie's water quality problems. Ontario is currently the object of a major scientific investigation launched by the United States and Canada under their International Field Year on the Great Lakes.

From Ontario, Great Lakes waters run out the St. Lawrence River to the sea, completing the 2,300 mile journey from Duluth, Minnesota. Every ten minutes, enough water leaves the Great Lakes via this route to supply the city of New York for a day.

Surrounding these inland seas are great concentrations of people and industry. Sixty percent of Canada's population is concentrated along the lakes' shores. In this country, while the Great Lakes Basin represents only 4% of the U.S. land area, 30 million Americans or 15% of the population lives there. In addition, 25% of the nation's industry is located in the basin and by the year 2000, industrial activity is expected to increase fourfold.

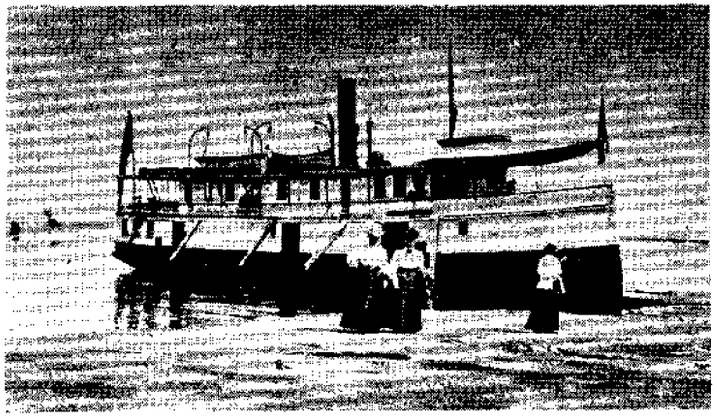
Such dense populations are a far cry from the scattered Indian bands that the early explorers found when they came west along the lakes over 300 years ago. The first white men on record to reach the Great Lakes were bent on finding a new trade route to the rich Orient.

In the mid-1500s the French navigator Jacques Cartier claimed the St. Lawrence River Valley for France. In 1618, two years before the Pilgrims landed at Plymouth Rock, Etienne Brule may have taken the full measure of the lakes as he penetrated half-way across the continent to the western reaches of Lake Superior. Despite this feat, Brule and other explorers of the time were disappointed and discouraged to find that these vast seas were not salty and did not herald a new trade route to the East. Little did they realize the treasure they had hit upon. Today, many consider the Great Lakes, per square foot, the most valuable bodies of water on earth.

Following the explorers came the white settlers, drawn to the region by its seemingly unlimited supply of natural resources — timber, minerals, furs and land, not to mention an abundance of fish and fresh water. The Great Lakes also provided them with a superb means of getting their goods to market — by ship.

Since the early settlement of the Midwest, man's major uses of the lakes haven't changed that much. Though the graceful wooden sailing ships of the past have given way to huge, steel-hulled lake freighters, shipping is still a major activity on the lakes. Last year, for example, more goods were shipped through the locks at Sault Sainte Marie between Lakes Superior and Huron than were shipped through the Panama Canal.

Shipping is now one of the two major uses of the Great Lakes. The second is recreation. Since World War II, the



recreation industry has exploded and today it is among the fastest-growing industries in the region. Around the Great Lakes, activities like boating, swimming, sports fishing, camping and hiking are booming. And, with 9,600 miles of scenic and varied shoreline, the Great Lakes are becoming even more of a mecca for tourists. According to projections of the Great Lakes Basin Commission, at this rate, by the year 2020, we will need more than 14 times the land and water areas now available for outdoor recreational use.

For this and other reasons, residents of the Great Lakes region are more dependent than ever on the lakes' fresh water resources. The United States, alone, withdraws about 25 billion gallons of water per day for municipal and industrial purposes. About one-half of this supply is used for electric power production. One-sixth of it is used by cities for drinking water or sewage treatment and the remainder is used by industries along the lakeshore.

But with man's use of the lakes has comes abuse. Misled by their sheer size and abundance, he has taken the Great Lakes for granted, carelessly dumping wastes and depleting lake resources. According to a U.S. Fish and Wildlife Bureau study, man's activities have accelerated the normal "aging" of the lakes to the point that they now age centuries in just a matter of decades.

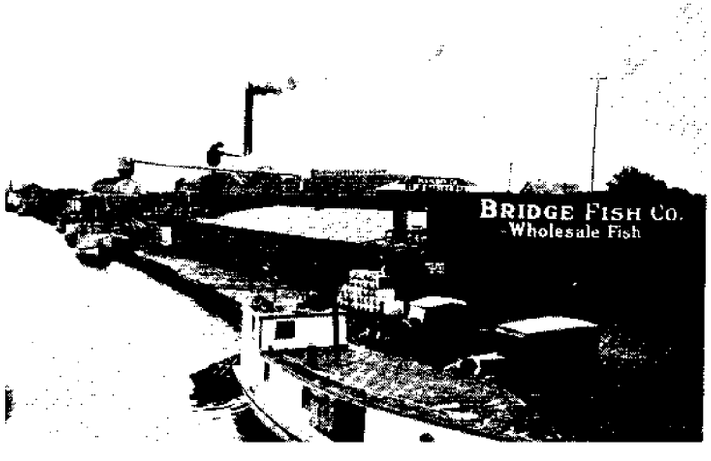
Of all the traditional activities on the Great Lakes, commercial fishing has probably suffered the most from man's abuse. When white settlers arrived in the Great Lakes region, they cashed in on the lakes' bountiful aquatic resources and soon established a thriving commercial fishery.

Every coastal town became a fishing port, and by the mid-1800s fishermen were hauling in tons of lake trout, sturgeon, whitefish, yellow perch, lake herring and chubs. The industry reached a peak in 1899 when landings in the U.S. and Canada exceeded 146 million pounds.

Since that time, however, the catches have declined, and with this decline has been a dramatic shift in the types of commercially important species. In 1967, 95% of Lake Michigan's commercial catch was made up largely of alewives and much smaller numbers of carp, smelt and yellow perch. The sturgeon is nearly extinct now, and the supply of lake trout and whitefish has dwindled.

To a large extent, the current fishery situation is a direct result of man's meddling with the lakes' ecosystems. Overfishing of stocks, the building of canals to enhance Great Lakes shipping activities and the pollution of lake water from coastal industries have been the most destructive influences.

The greatest catastrophe to befall the fisheries was the invasion of the sea lamprey, a salt-water eel which came into the Great Lakes through the St. Lawrence River and the Welland Canal. During the 1940s, these lampreys wiped out large numbers of commercially important species like whitefish and lake trout in Lakes Michigan and Superior. Behind them came the alewives who, in the comfortable absense of predators, moved into Lake Michigan and became the most abundant fish species.



A common lakefront scene in the heyday of commercial fishing

In the past few years, the sea lampreys have been brought under control, and the Michigan and Wisconsin Departments of Natural Resources have undertaken major fish stocking programs to replenish the ravaged lakes. They now stock large numbers of native lake trout and have even imported coho and chinook salmon from the Pacific Coast to feed on the alewives and provide excitement for area sports fishermen. Nevertheless, because of high concentrations of PCBs, these fish can't be caught commercially and transported across state lines. Though commercial fishing is still alive and profitable in the Great Lakes, the size and composition of the catch can no longer support the industry it once did.

The story of commercial fishing is only one illustration of how man's careless tampering with the lakes has had adverse consequences. But within this depressing scene are some encouraging signs. Canada and the United States have recently joined in an agreement to protect and upgrade Great Lakes water quality. Meanwhile, national, state and local governments are trying hard to put a stop to pollution and are developing new programs for coastal zone management.

We have taken a lot from the sparkling gift of the glaciers and in return, have depleted their resources and given them our wastes. But we are still dependent on the Great Lakes—for commerce, for food, for a leisurely holiday—and, continued abuse can only result in a tragic loss.

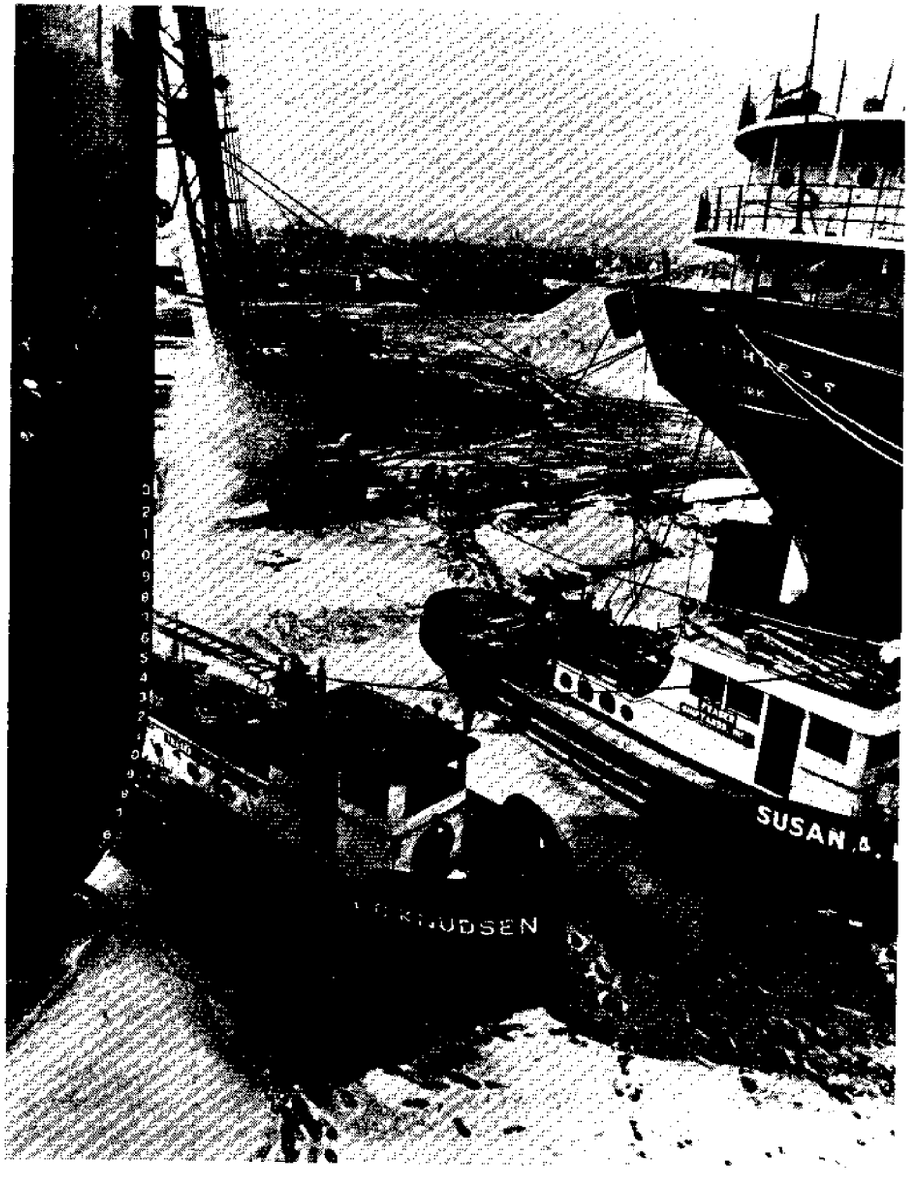
Our Great Lakes is a look at the inland oceans. The discussions focus on Lakes Michigan and Superior but they deal with all the Great Lakes and man's interactions with them. The overall motive is not to belabor the villainy of man but to consider the worth of the lakes and to look for the silver linings in their clouded future.

Measured Miles of Great Lakes Shoreline in the United States.

MINNESOTA	180 miles – (Superior)
WISCONSIN	785 miles – (Superior and Michigan)
ILLINOIS	63 miles – (Michigan)
INDIANA	45 miles – (Michigan)
MICHIGAN*	2,232 miles – (Superior, Huron, Michigan, and Erie)
OHIO	312 miles – (Erie)
PENNSYLVANIA	51 miles – (Erie)
NEW YORK	371 miles – (Erie and Ontario)

from New York Times Encyclopedic Almanac, 1970

*Michigan has the longest shoreline of any state in the continental United States



The Shape of Shipping

The five Great Lakes and their connecting waterways form a 2,342-mile artery, linking the heart of North America and the vast Atlantic Ocean. Over the past 20 years this route has become a lifeline for the Midwest, connecting her ports with the markets of the world.

Last year, over 200 million tons of cargo traveled the Great Lakes, four times the amount shipped through the Panama Canal. Of this, about 53.6 million tons moved into and out of the lakes through the St. Lawrence Seaway; this cargo alone was valued at more than five billion dollars. Iron ore, limestone, coal and grain made up the majority of commodities shipped across Great Lakes waters, but many other products like flour, steel and manufactured goods came and went by ship.

History of Great Lakes Shipping. Early in 1973, the first ships from the Soviet Union arrived at Great Lakes ports to take on huge shipments of grain for Russia, opening up a whole new trade opportunity for the Midwest.

Fittingly enough, grain was also the cargo on the first Great Lakes commercial voyage ever recorded. The ship was a ten-ton sailing vessel, launched in 1678 to transport supplies up the Niagara River to an army post above the Falls.

The great stimulus to development of shipping on the Great Lakes was the opening of the Northwest Territory (Illinois, Indiana, Michigan, Ohio, and Wisconsin) in 1798. Ships carried grain from midwestern farms as well as furs and timber harvested from the rich, newly-opened territory.

Then, in 1825, the Erie Canal was built and the Illinois prairies became joined by water with the Atlantic Coast. Between 1836 and 1867, the total tonnage shipped between the Midwest and the Atlantic Seaboard grew from 54,000 to 2,130,000 tons. But, as shipping grew, a major difficulty of Great Lakes commerce became apparent.

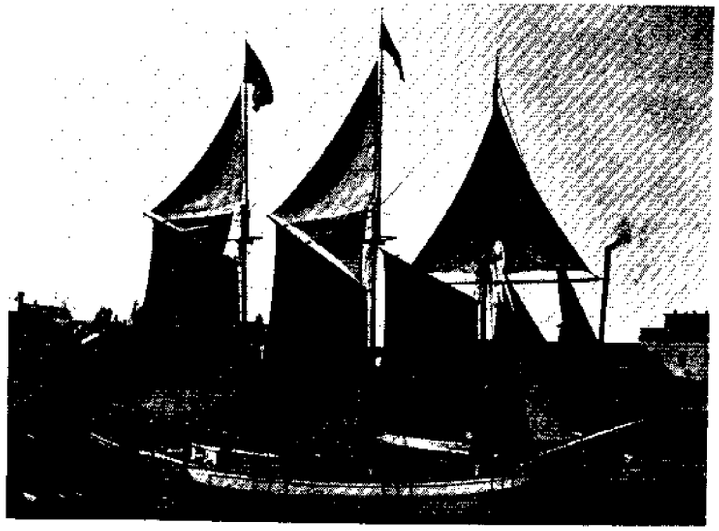
In order to carry goods from the Great Lakes to the Atlantic, a number of natural barriers had to be surmounted. Among them were the 246-foot rise in the St. Lawrence River from the ocean to Lake Ontario; the 326-foot lift over the Niagara escarpment to Lake Erie; and the 19-foot lift on the St. Mary's River which runs out of Lake Superior into Lake Michigan.

The answer to surmounting these natural barriers was the lock and the canal. The Lachine Canal was completed in 1825, and by 1850 a nine-foot deep channel existed from Lake Ontario to Montreal. The first Welland Canal across the Niagara Peninsula was opened in 1829, and the improvements and modifications which formed the second Welland Canal were completed by 1844. About this time, the demand for steel exceeded the capacity of eastern iron ore reserves, and the mines of northern Michigan, Wisconsin and Minnesota became competitive.

A canal to bypass St. Mary's Falls at Sault Sainte Marie was completed in 1854, and the first ship lock there went into operation. This new channel facilitated economic delivery of ore to Pittsburgh furnaces and other steel centers; and midwestern cities like Milwaukee, Chicago, Detroit and Cleveland became growing centers of commerce and industry.

By 1833, there were over 1,500 vessels of all descriptions operating on the Great Lakes, carrying about $60 million worth of cargo per year.

In 1932, a new Welland Ship Canal was built between Lakes Erie and Ontario which could accommodate any of the lake freighters of its day. However, it wasn't until the completion of the St. Lawrence section of the seaway in 1959 that the really large ships, capable of carrying 25,000 to 28,000 tons, were able to pass through, and that Great Lakes ports were put on the map in terms of international shipping.



The St. Lawrence Seaway. The St. Lawrence Seaway was the key that opened the Great Lakes to larger international trade. Today the seaway accounts for about 1% of the total income of Great Lakes states – about $700 million per year.

Directly or indirectly, the seaway employs 86,000

Night scene: the locks at Sault Sainte Marie

people – 4,500 of them are in Wisconsin. All over the Great Lakes, ports have expanded and built new facilities to accommodate the steadily increasing seaway traffic. Seven of Wisconsin's 14 Great Lakes ports can handle seaway ships.

The opening of the 1200-foot long Poe Lock at Sault Sainte Marie in 1968 further stimulated the growth in shipping and vessel size. Today nearly 500 ships ply the waters of the Great Lakes, together capable of carrying about five million tons of cargo per trip.

As the amount of shipping has increased, so has the size of the ships. In 1887, for example, the average vessel passing through the canal at Sault Sainte Marie weighed 600 tons. But, in 1972, a 1,000-foot long carrier passed through the Soo canals, capable of carrying 58,000 tons of iron ore in its holds.

Problems of Great Lakes Shipping. In spite of the boom in shipping, a number of factors have conspired to challenge the competitive position of Great Lakes ports in relation to those along the eastern seaboard.

Since the mid-1880s railroads have posed stiff competition to the Great Lakes shipping industry. Though it has always been cheaper to send goods by ship than by rail, the convenience and speed of the railroads have put them at an advantage for hauling some products, and the problems of the winter freeze-up and the shortened shipping season have been an added disadvantage to the shippers. This has increased their operating costs since ships must be redeployed orlaid up for part of the year, and the region incurs social costs as sailors and dock-side employees face unemployment or relocation during the winter. These conditions have caused some high volume shippers to use seaboard ports year-round.

The winter freeze has also hurt the seaway's economic potential, forcing it to close down for nearly four months of the

year. But now, with the help of icebreakers and modern technology, the United States and Canada are trying a bold experiment to lengthen the shipping season on the Great Lakes.

Although a year-round seaway season is still unrealistic, a massive effort by Canada in 1972 succeeded in extending the closing date for the Montreal-Lake Ontario section of the seaway to December 23rd.

In the United States, the federal government is involved in a $6.5 million, three-year experiment to extend the shipping season on the Great Lakes. Although the season is usually closed from mid-December to early April, the government has been able to extend it in the Upper Lakes to the beginning of February for the past two years.

Besides using icebreakers, they have installed new equipment to keep shipping lanes open and safe. Underwater wire guidance systems and laser beams were used to keep ships on course during blizzards and at night. Ice booms prevent ice chunks from blocking the water intakes at electric power stations.

But winter shutdown is only one of several difficulties facing the seaway and Great Lakes shipping. Perhaps the most worrisome has been the complete revolution in shipping technology over the past few years.

Although the St. Lawrence Seaway is only 14 years old, many of the ports it services are already outmoded. Cargo handling methods are changing so fast and ship size and numbers are growing at such a fantastic rate that many ports cannot keep pace with them.

Twenty years ago, for example, a freighter weighing 25,000 tons was considered large, but today ships ten times that size are commonplace on the oceans. About 800 ships are already too big to fit into the lakes, and ship size keeps growing.

Inevitably, these super-ships will be locked out of the Great Lakes because of inadequate channels, locks and ports, but Great Lakes shippers and port managers are hoping for the development of medium-sized lighter ships that can ferry goods from larger ships or seaboard ports through the seaway and into the lakes.

Another challenge to Great Lakes ports has been the growth of container shipping. The containerized ship moves goods – already boxed and sealed – quickly, cheaply and efficiently. Such a ship can load and unload in 24 hours, much faster than a conventional cargo ship.

But most Great Lakes ports do not have adequate facilities for handling container ships even though these now transport more than half the world's general cargo. In midwestern ports, most cargo is still handled conventionally in barrels, boxes, bales and drums.

The container revolution has created a crisis in Great Lakes shipping. The longshoremen handling containers on the Atlantic Coast are more than twenty times as productive as the longshoremen handling cargo conventionally in many lake ports. The situation is so severe that the port director of Chicago has said that if Chicago doesn't get adequate container facilities in the next five years, Chicago's port will go out of business.

One proposed solution to the container dilemma is to develop two well-equipped regional container ports – one in Lake Michigan and another in Lake Erie. A second possibility is to encourage new, modified container ships that carry their own cranes and a fleet of cargo barges.

Despite the problems, the Great Lakes and the seaway still form a great transportation route for the region's rapidly growing commerce. New business and trade opportunities are being spurred throughout the Midwest by the development of natural resources, new markets, growth of the population and rising standards of living.

To keep pace, the role of our inland seas and their connecting waterways in the drama of shipping and resource development must also change. Maintaining the vitality of Great Lakes shipping requires that the region, and especially the ports, be alert to needed changes. And it requires their flexibility to convert these changes into opportunities.

Recreation- -Boom or Bust ?

The resources of the Great Lakes are measured in many ways – in pounds of fish, tons of sand and gravel, gallons of water or tons of cargo shipped across Great Lakes waters. But how do you measure a sunset on the lakes, a walk along the beach or the thrill of landing a feisty chinook salmon?

Perhaps you can't, and yet these are the resources that are becoming increasingly important to people as leisure time increases and the recreation industry enjoys the greatest boom in history.

On a nationwide scale, recreational activity is expected to triple over the next 50 years, growing more than twice as fast as our nation's population. More than half of this recreational growth will take place along our coasts. Today, coastal recreation is expanding at a rate of 10-12% per year. The Great Lakes are no exception to this trend.

Recreation in the Great Lakes region started after the Civil War, but it wasn't until the rise of the automobile in the 1930s and the "age of travel" that recreation blossomed. Since World War II, recreational activity on the Great Lakes has increased severalfold, putting tremendous pressure on existing public lands and facilities around the lakes.

With a total U.S. coastline of 4,039 miles along eight states, the Great Lakes offer a wide variety of recreational opportunities – swimming, boating, hiking, camping, fishing and sightseeing.

Wisconsin itself has a vast and varied Great Lakes shoreline. Lake Superior's 156-mile Wisconsin shoreline is lined with scenic bluffs, islands and quaint towns, while the 403 miles of shoreline along Lake Michigan offer some of the finest beaches to be found in the Great Lakes region. Today tourism and recreation constitute the state's fastest growing industry and bring in millions of dollars annually.

But this activity is not without its price. Overcrowding in campsites, parks, beaches, and boating and fishing facilities already exists. Cars, campers, and our expanded highway system have increased people's recreational mobility even more these past few years, compounding the problems of crowding.

The service costs of many communities are rising astronomically as the number of summer homes and people increases. Recreation is taking out more than it's bringing in to

some of these communities. Private shoreline development has restricted public access to the lakes and in many cases has caused undesirable side effects on the lakes themselves.

The most fragile characteristic of the lakes in this regard is their water quality. This quality frequently suffers the most from man's many activities around the lakeshore, and yet the main determinant to intensive recreational use is the availability of high quality water, suitable for a variety of uses.

To appreciate the boom of recreational activity in recent years and the problems it has created, one need only to look at the three most intensive recreational uses of the Great Lakes – boating, fishing and swimming.

Boating. In 1947, there were about 2.5 million pleasure boats registered in the United States. Today, there are four times that number. Boating equipment is now a billion-dollar business, and Wisconsin is one of the top ten states involved in this industry.

There are now about 500,000 boats in Wisconsin, and the number is expected to double by the year 2000; but this doubling will also necessitate a doubling of the current boating facilities.

Boating faces many problems in the Great Lakes. The often unpredictable weather, for one, can be very dangerous. Rough water, dense fogs, and severe storms coupled with a scarcity of protected ports and harbors makes boating on the Great Lakes hazardous. As a consequence, most pleasure boating on the lakes takes place close to shore and within a five mile radius of existing ports and harbors.

Water quality can also be a problem. Boating demands a relatively clean water supply – algae and debris tend to discourage boaters. Beyond this, the growth of boating has created its own problems. The lack of harbors, legal access, breakwaters, ramps, channels, storage space and landing facilities are all problems that increased boating activity on the Great Lakes has created. Wisconsin is the only Great Lake state that does not have a state program for matching funds to develop these facilities on the Great Lakes.

Fishing. With increased boating has come increased sports fishing. The new boom in this activity is partially the result of large-scale salmon and trout stocking programs in Lakes Michigan and Superior carried out by the Wisconsin Department of Natural Resources.

Since Michigan and later Wisconsin began their stocking programs in the 1960s, sports fishing has skyrocketed. The net value for Wisconsin fisheries from both Lakes Superior and Michigan rose from $3,600,000 in 1970 to $5,150,000 in 1971.

In the Wisconsin waters of Lake Michigan alone, the sports catch approaches one-half million pounds per year, and in 1971 almost 116,000 trout and salmon were caught at an estimated value of eight dollars apiece.

One advantage that sports fishing has over other water sports is that it is not necessarily seasonal – it can take place all year round. Though most of the activity does take place during summer and fall, charter boats are limited only by the weather and ice conditions and can go out even in winter. During the winter of 1971-72, there was only one boat equipped for year-round fishing. Now more and more boats are fishing year round, and by 1974 a whole fleet is expected to be in operation.

Many towns along the coast are taking advantage of the fishing boom. Algoma, Wisconsin, located along the shores of Lake Michigan, is one example. In 1966 there were no charter fishing boats working out of Algoma. Today there are 19, with a total estimated income of $400,000.

Restaurants, motels, sports shops and campgrounds are springing up in Algoma and many other coastal communities, making sports fishing a million-dollar business.

Fishing at Cave Point, along Lake Michigan

Swimming. Swimming is also a popular sport along the Great Lakes. Because of the cold water, swimming activities are limited in Lake Superior. But along Lake Michigan, swimming activities are on the rise. Lake Michigan has some of the finest beaches in the Great Lakes region, about one-third of them publicly owned. The demand for swimming beaches is great, particularly around crowded cities like Milwaukee and Chicago.

Unfortunately, these are the areas which often have the greatest water quality problems, and pollution poses the greatest threat to swimming. Since the 1960s, beaches, particularly near big cities, have been have been periodically shut down as a result of unsafe pollution levels. Some, like lower Green Bay's Bay Beach, have been altogether eliminated because of poor water quality.

Recreation around the Great Lakes is not limited to swimming, boating and sports fishing, although these are the most popular uses of the lakes at present. Camping, hiking and sightseeing are becoming increasingly popular, as are more specialized activities like scuba diving and snorkeling.

As recreation continues to increase on Lakes Michigan and Superior, so do the problems of accommodating the extra demand on existing facilities and on coastal waters. And use of the water for industrial purposes or municipal sewage treatment often lowers the lakes' water quality and conflicts with recreational uses. After 300 years of unchecked exploitation, much of the coast is becoming unacceptable for water-based recreation. At current rates, our recreational waters are diminishing in both quantity and quality, with the three most threatening problems being water pollution, lack of public access and conflicting uses of the lake waters.

Many planning committees feel that with unchecked growth the recreation boom in Wisconsin and along the Great Lakes shoreline will carry no benefits in the long run. Currently, economic considerations seem to be the overriding motivation for expanding recreational activities and developing the shoreline, but it is becoming increasingly evident that, in our own best interests, environmental considerations must play a more important role in these decisions.

The recreation explosion in Wisconsin and along the Great Lakes has been both a boon and a bane. Conflicting uses of our coastal waters and unplanned development have created many problems, but there is no denying the economic benefits these activities have brought to the state. The remaining task is to maintain some balance, using the lakes as best we can, but keeping them clean and accessible to the thousands of people who are becoming more and more dependent on them for a leisurely break.

decay, they place a biological demand on the water's supply of dissolved oxygen. If such "eutrophic" conditions persist, oxygen levels fall to the point where prize game fish like trout and salmon, which depend on cold, clear, oxygenated water, disappear. Only catfish, carp, and other rough fish survive.

Industrial. Manufacturing processes release a great number and variety of chemical elements into the vast sinks of the Great Lakes. Chlorides and sulfates in their increase are symptomatic of this industrial contamination. Other elements frequently in the news for the hazards they pose are phenols, ammonia, and heavy metals like zinc, copper, mercury, cadmium, and nickel. The oil-derived phenols cause taste and odor problems in drinking water. In large quantities other contaminants like mercury can be injurious to humans and toxic to aquatic life.

Agricultural. Farm runoff includes both animal waste and the chemical compounds used in farming. Animal waste, like human waste, contributes excessive amounts of nitrogen and phosphorus to the lakes, causing eutrophic conditions. However, it is the synthetic compounds in pesticides, herbicides, and chemical fertilizers that pose the most worrisome threat to the Great Lakes. Production of pesticides rose from 34 million pounds in 1953 to 119 million pounds in 1965, and it is still rising. With about 58% of this material reaching the farm, more and more of it is ending up in the lakes and their organisms. This threat has been recognized and counteracted somewhat by federal actions such as the banning of DDT and other pesticides, but sizeable amounts of these chemical compounds are still running off into Great Lakes waters.

Shipping. Boats of all types too often release wastes into the lakes, notably sewage and oil. Lacking the necessary holding tanks for on-board toilets, boat operators have traditionally dumped these wastes in open waters, although recent rulings, which require that all boats have holding facilities, now make this practice illegal. In fairness, it should be noted that some responsibility for these dumping violations lies with those harbors that have not updated their facilities to receive these wastes. Freighters which have no convenient means to flush their bilges have been similarly guilty of Great Lakes pollution.

Two other general practices have contributed to the pollution problem. In the maintenance of harbors and channels, the Environmental Protection Agency (EPA) now forbids dumping of dredged materials in open waters of any of the lakes. However, there is still the risk that the initial dredging operation, as it scoops up bottom sediments and disturbs heavily contaminated areas, will release toxic materials to drift to other parts of the lakes.

The other practice suggests a more subtle form of pollution. Water pumped out of the lakes by industrial and power plants along the shores for cooling purposes may be returned to the lakes as much as 15-20°F warmer. These thermal effluents are of great concern because of their possible effects on nearby fish and plant life, which can be extremely sensitive to changes in temperature.

Though they remain the most remarkable system of inland waters in the world, the Great Lakes are nonetheless vulnerable to pollution from these sources. How well they resist the wear of intensive use depends on a variety of factors – such as the depth and temperatures of each lake, the flow and intermixing of their currents and layers, the chemical make-up of the waters, and the "residence time" or the time it takes the water of a lake to flush out and be completely replaced.

Because of their unique combination of these factors, some lakes are suffering more than others from man and his activities. A "Cook's Tour" of the Great Lakes, traveling from east to west along the chain of lakes, reveals the following conditions.

Lake Ontario inherits 86% of its water from Lake Erie, which must be considered its biggest source of pollution. Like its upstream sister, Lake Ontario is subject to intensive farm runoff, urban-industrial wastes, and is periodically overgrown with heavy algae blooms.

Lake Erie, over the past 50 years, has suffered accelerated "aging" because of the loss of dissolved oxygen. Conceded by almost everyone to be the most polluted of the Great Lakes, Erie is nevertheless the most productive and "alive" of them all – too alive, in fact. In recent years, algae has seasonally formed a two-foot thick mat spread over 800 square miles of Erie's western basin. But, though some feel the outlook for Lake Erie is grim, others point out that things are improving. Last year, for example, anglers reeled in more than 1,200 salmon from Erie waters, and the lake still supports the largest perch fishery in the Great Lakes.

Lake Huron retains a purity close to that of Lake Superior. However, intensive shoreline development and the municipal-industrial effluent along the Saginaw River and Bay have caused considerable pollution and algae growth in adjacent waters.

Lake Michigan, though much less polluted than Lake Erie, is perhaps in greater jeopardy. While Lake Erie replaces its entire supply of water every 2.5 years, Lake Michigan takes about 100 years to flush itself out because of its long "finger" shape and its cul-de-sac southern basin, which is somewhat isolated by a barrier of underwater ridges rising up from the lake bed. In effect, any general decline in water in Lake Michigan is certainly long-term, if not irreversible.

At the lake's southern end a contaminated crescent of inshore waters extends from Milwaukee around to the Michigan state line. Here, Chicago "uses" and returns 4.25 billion gallons of lake water a day. And Calumet River and Bay are a receptacle for iron, cyanide, and phenol compounds from shipping and industrial processes. Intensive urban and industrial development in this area also contributes a major portion of the 15 million pounds of phosphorus entering the lake each year, while farm runoff accounts for about one-third of the amount.

In recent years pollution has impaired recreation on Lake Michigan. Health authorities have closed several beaches when the water tested significantly high in levels of coliform bacteria. Intermittently in force near Milwaukee, Chicago, and other heavily settled regions, such bans have closed Hammond, Indiana beaches for more than 15 years and have permanently closed beaches in the southern end of Green Bay.

In contrast to such localized contamination of inshore water, the central deep waters of the lake remain cold and relatively pure. This high quality is threatened, however, by early signs of accelerating eutrophication, especially in the lower basin, and by increasing evidence of pesticides in farm runoff. Since 1971, Lake Michigan fish have carried levels of DDT and Polychlorinated-biphenyls (PCBs) sufficiently high to warrant their ban from interstate commerce.

Red clay erosion on Lake Superior

Lake Superior ranks as the world's largest body of fresh water in surface area and is second only to Russia's Lake Baikal in volume. Scientists term its water "oligotrophic" as opposed to "eutrophic" because it is cold and clear and contains high levels of dissolved oxygen.

In Lake Superior, the risks of pollution arise primarily from erosion and mining. Erosion of red clay along the shoreline is discoloring southern inshore waters and interfering with the municipal water supply of several cities. Mining operations at the lake's western end, about 50 miles northeast of Duluth, are dumping 67,000 tons of taconite tailings a day. Tailings from this disposal have scattered over hundreds of square miles of the lake bottom, and there is evidence that resulting particulate matter has drifted even further into the body of the lake. Although chemically potent in the lake's soft water, even very low amounts of these elements can seriously influence water quality.

Industrial chemicals remain at low levels in Lake Superior. However, significant levels of pesticides have been found in Lake Superior. Applied in the management of surrounding forests, these compounds easily leach out of the thin soils of the surrounding regions and drain into the water.

Experts believe Lake Superior, while the most favored of the Great Lakes, is in a delicate ecological balance simply because the low alkaline levels in its cold, pure water are a weak buffer against further contamination. In like manner, its native fish – lake trout, whitefish, and lake herring – are especially sensitive to pollutants.

Can anything be done to clean up the lakes? Numerous approaches at state and federal levels are seeking to cope with the tangle of interrelated problems.

Reducing the growth of algae and the resulting eutrophication of water is a prime concern. The lack of dissolved oxygen is known to reduce the capacity of water to assimilate other

forms of contamination, which makes solving this water quality problem doubly important.

So far, chemicals have proven neither safe nor permanently effective. Although copper sulfate can control algae in some small bays for recreation purposes, its side effects are uncertain and the nutrients remain to generate new plant growth when treatments stop.

Another approach is to limit the nutrients getting into the lakes. Early on, attention focused on phosphorus as one of the largest nutrient sources in the lakes – each year, for instance, Lake Huron receives 3.2 million pounds and Lake Michigan 17.1 million pounds. To effectively curtail unwanted plant growth, this phosphorus must be blocked from reaching the lakes.

In 1968, the states around Lake Michigan agreed to remove 80% of the phosphorus in municipal sewage. Targeted to begin in 1972, this pledge has meant the installation of secondary sewage treatment plants in cities around the lake. Since 1972, only the EPA has had power to grant 180-day extensions on appeal.

Today, Canada and the United States are jointly aiming for 85% and in some areas 90% phosphorus reduction in the sewage effluent reaching Lakes Erie and Huron. To achieve this, many districts will install tertiary, or third-step sewage treatment plants.

Other government regulations seek to control lake pollution. The 1969 National Environmental Policy Acts grants authority to the Army Corps of Engineers to reject proposed projects on the basis of their environmental effects.

The EPA further directs the Corps to dispose dredged materials in diked areas along selected shore sites or within island containments. These fills, not always satisfactory as land-fill projects, at least temporarily avoid the practice of dumping into open water the 10 million cubic yards of sediments dredged annually on the Great Lakes. However, some harbors cannot now be dredged because adequate land disposal sites for dredge spoil are not available.

In 1972 the United States and Canada negotiated the Great Lakes Water Quality Agreement (GLWQA). This comprehensive program to exchange information and coordinate Great Lakes management remains in effect until 1975. The Environmental Protection Agency, closely involved in this coordinated program, is funding related research on the Great Lakes.

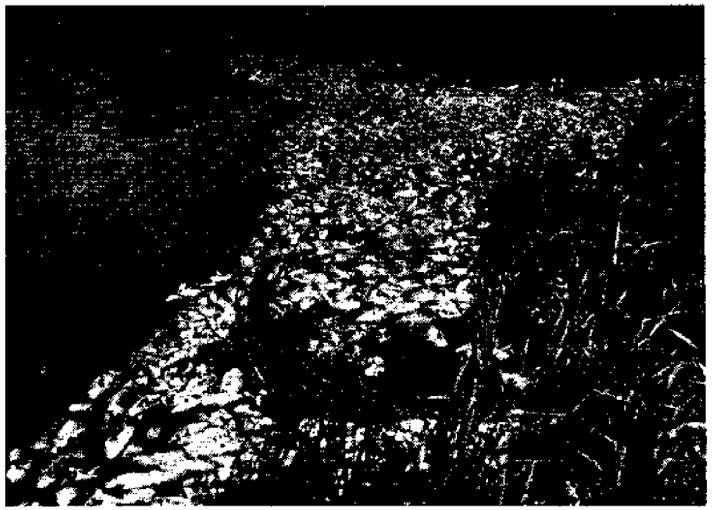
All programs for environmental restoration require money. Since 1952 the United States has invested $15 billion for 7,500 municipal sewage plants. The Council on Environmental Quality estimates that further prevention and control of water pollution around the country will require $38 billion.

The Great Lakes may claim much of this outlay. Cleaning Lake Huron, for instance, could take more than $115 million and Lake Michigan between $2 and $10 billion, according to a 1970 report of the Federal Water Pollution Control Administration, now part of the Environmental Protection Agency.

Conditions that must be improved include the older combination storm and waste sewer systems, inadequate treatment plants, uncontrolled farm runoff, industrial processes that do not clean and recycle their water, boats and pleasure craft without holding tanks and inadequate harbor facilities for handling boat wastes.

No set of goals will guarantee health and long life to the Great Lakes if the pressures of civilization continue to mount, but the stakes are high. In 1970, municipal-industrial uses withdrew from the lakes 25 billion gallons a day, in the U.S. alone. It is estimated that by the turn of the century, communities in the Great Lakes Basin will depend three times as much on lake water to supplement their ground water supplies. This makes a high standard of water quality desperately imperative.

It has become clear that without continued action – and more of it – the quality of the Great Lakes will continue to decline, while the eventual cost to halt this decline will undoubtedly rise sharply. With these pressures at work, the present initiatives and the programs being developed to clean up the Great Lakes are a twofold investment in both the economic and environmental future of the Great Lakes Basin.



Eroding Shores

In the spring of 1973, the community of Green Bay, Wisconsin was clobbered with the worst flooding in its history. Fifty-five mile-per-hour winds brought ten-foot waves crashing into the city, while 20-foot waves pounded the neighboring shoreline.

Eight hundred people fled their homes, and Green Bay was declared a disaster area. After a few days, Green Bay residents returned to their waterlogged homes to face five to six million dollars in damage, strong evidence of the overwhelming harm that wind-driven surges at record high lake levels can do.

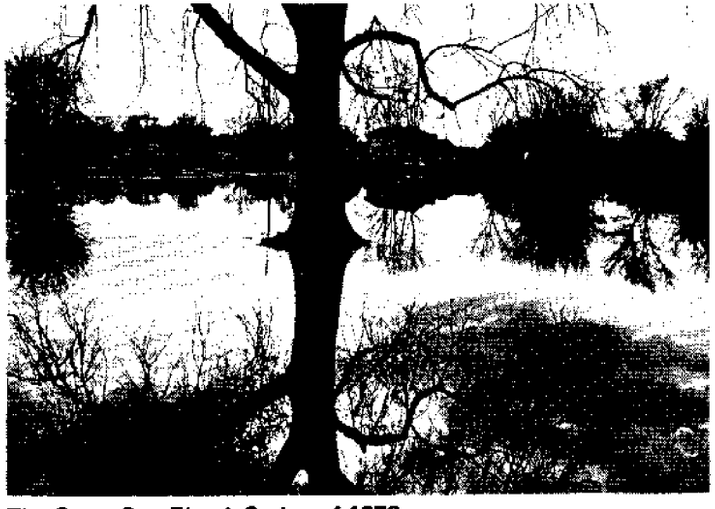
Winds from the same storm system also pushed water up onto the western shore of Lake Erie. There, 10,000 people were evacuated and property damage soared into the millions of dollars – the second such disaster in this area in six months. High water and resultant flooding in November 1972 had caused an estimated $22 million damage.

Extremely high water levels in the Great Lakes were in the news all year. As of June, Lakes Michigan, Huron, and Erie were two feet above normal and were still rising. While bad enough, this high water was accompanied by flooding and erosion which washed away many roads, beaches, and cottages. In addition, cliffs, protective vegetation, piers, and other shoreline structures toppled into the Great Lakes as the waves came rolling in.

A recent national shoreline study reveals that nearly one-third of the U.S. Great Lakes shoreline (1,300 of the 4,000 U.S. miles) is subject to significant erosion. Soft glacial deposits along the waters' edge offer little resistance to the lakes' currents and waves.

Moreover, the Army Corps of Engineers has released figures showing that of this 1,300 miles of shoreline, 200 miles are subject to critical erosion like the red clay region along the southern edge of Lake Superior. The report also revealed that 300 miles of the shoreline are subject to critical flooding, like the area around Green Bay.

Erosion is a natural and continuing process that results from the impact of four natural forces: wave action, ground water seepage, frost and ice action, and surface runoff. When water levels are high, normal wave action can cause erosion. When



The Green Bay Flood, Spring of 1973

rainfall saturates the ground, water runs off under the topsoil, slippage occurs and cliffs can literally collapse and slide down into the water. Winter's frost and ice can wear away at the beaches, and surface water runoff can gouge sediment from stream beds and valleys.

Other natural phenomena can accelerate erosion. When lake levels are high, some of the natural buffer zones such as beaches and cliffs wash away, leaving shoreline areas unprotected. Also, high storm winds in spring and fall can tilt the lake surface by piling up water at one end of a lake or bay. Such fluctuations occur, particularly in shallow parts of the Great Lakes such as Green Bay, both ends of Lake Erie, and Saginaw Bay in Lake Huron.

Red clay is another erosion problem and is peculiar to Lake Superior. Long stretches of lake bottom, as well as the Wisconsin and Michigan shoreline, consist of soft red clay which is eroding. This natural erosion is creating turbidity in the water which is showing up in the Superior-Cloquet water line, as well as having possible harmful effects on the aquatic life in western Lake Superior.

Man is not entirely innocent in the erosion process. He has accelerated this wear on land forms by grazing cattle, clearing land of protective vegetation, and building roads and other structures perilously close to the coastline. And his remedies to mitigate erosion have not been adopted with a view toward their side effects. Structures in the lakes such as breakwaters and groins – as well as the forceful discharge of water into the lakes from power plants – interrupt the normal flow of sand drifting in the near-shore current. Without this steady influx of sand, beaches can become "starved" – or eroded.

The erosion problem is aggravated by high lake levels. The predominant factor influencing lake levels is the amount of rain and snow that falls into the Great Lakes Basin. Currently levels are high because precipitation has been above normal for the past eight years. In 1972 alone, precipitation was 4-1/2 inches above normal. Of course, water levels are affected by ground water, runoff, and evaporation. But all these factors have limited effect relative to the immense capacity and slow drainage of the Great Lakes. Slow to change, lake levels are a product of nature, and man can influence them only to a small degree.

Since the 1860s, lake levels have been recorded by the Lake Survey Center in Detroit, Michigan – part of the U.S. Department of Commerce. A computer analysis of the lake levels reveals no predictable water level cycles for the Great Lakes. The last high levels on Lakes Michigan and Huron occurred in the fifties, inflicting extensive damage. But below normal rainfall from 1962 to 1964 sank these two lakes to all-time lows in 1964 and 1965.

Other factors besides rainfall affect the lake levels. For example, levels are higher in summer than in winter due to increased water from the spring thaw. Then during the growing season, water is absorbed by vegetation so that less ground water and surface runoff reach the lakes.

The Great Lakes contain the largest reserve of fresh water on earth, holding 5,500 cubic miles of water. This immense size and storage capacity cause the levels of the lakes to change very slowly. Thus lake levels may persist and reach their extreme several seasons after the climate has returned to normal.

The drainage pattern also affects Great Lakes levels. The lakes are drained by relatively short and narrow straits. As a result, when extra water comes into the system, these narrow outlets aren't able to handle the water and the levels rise.

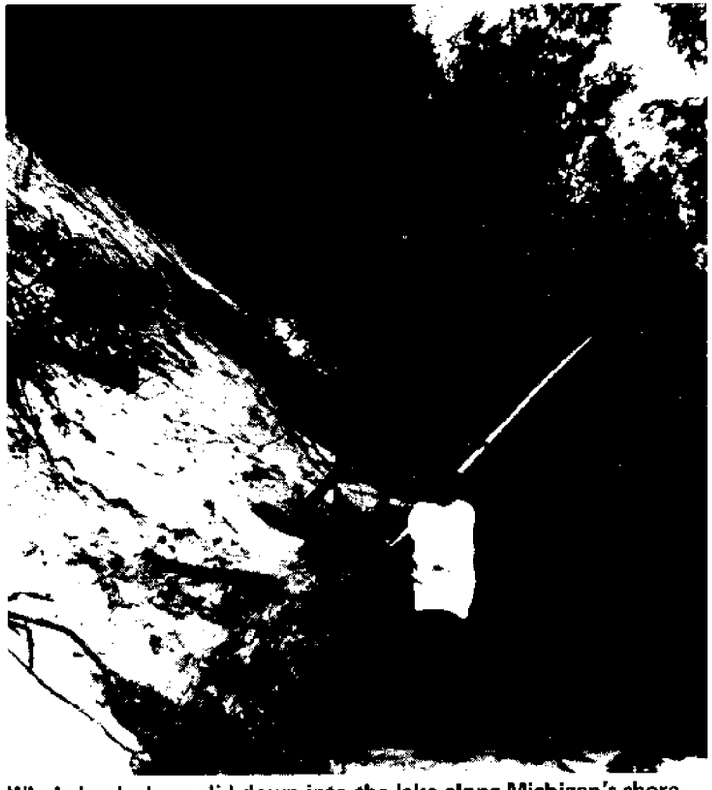
Man depends upon the lakes and their vast supply of water for many things, and concern about the lake levels depends on your point of view. Shipping interests, for example, prefer high water so they can float heavier cargos. Power companies prefer high water to insure that water intake and outflow pipes are usable. On the other hand, recreation demands average levels to insure that beaches are intact and boat ramps are usable, and that other shoreline recreation areas are not under water. Low levels, on the other hand, adversely affect almost all our uses of the lakes – navigation, power production, recreation and wildlife habitats.

To a very limited extent, man can control the Great Lakes system through manipulating its water levels. In 1909, an International Joint Commission (IJC) was set up between Canada and the United States to implement these controls. The Army Corps of Engineers now has the major responsibility for supervising lake levels in this country.

However, changing the lake levels, even with the international mechanism of the IJC, is not effective in an emergency due to the slow, inexorable rise or drop of the lakes. An Army Corps report entitled, "Regulation of Great Lakes Levels and Flows," concludes that engineering and technical controls over the lake levels can be increased, but the measures necessary are neither feasible nor economically justifiable at this point.

The points where man does have some leverage are the rivers and channels into or out of the lakes. A system of dams and locks regulates Lake Superior and Ontario. Early in 1973, the IJC restricted water out of Lake Superior by shutting all but one of the 16 control gates on the St. Mary's River, which links Lake Superior with Huron and Michigan. The outflow was restricted to 55,000 cubic feet per second as compared to almost three times that much the year before. By June, this restricted outflow from Superior had reduced Lakes Michigan and Huron levels by one inch. In effect, while the problem on the lakes is in feet, man can alter the lakes only by inches.

Another point of control is the Illinois Waterway, which drains water out of Lake Michigan at Chicago. This could take almost twice as much water out as it now carries. But the Mississippi River is at flood stage this year and cannot handle any more water.

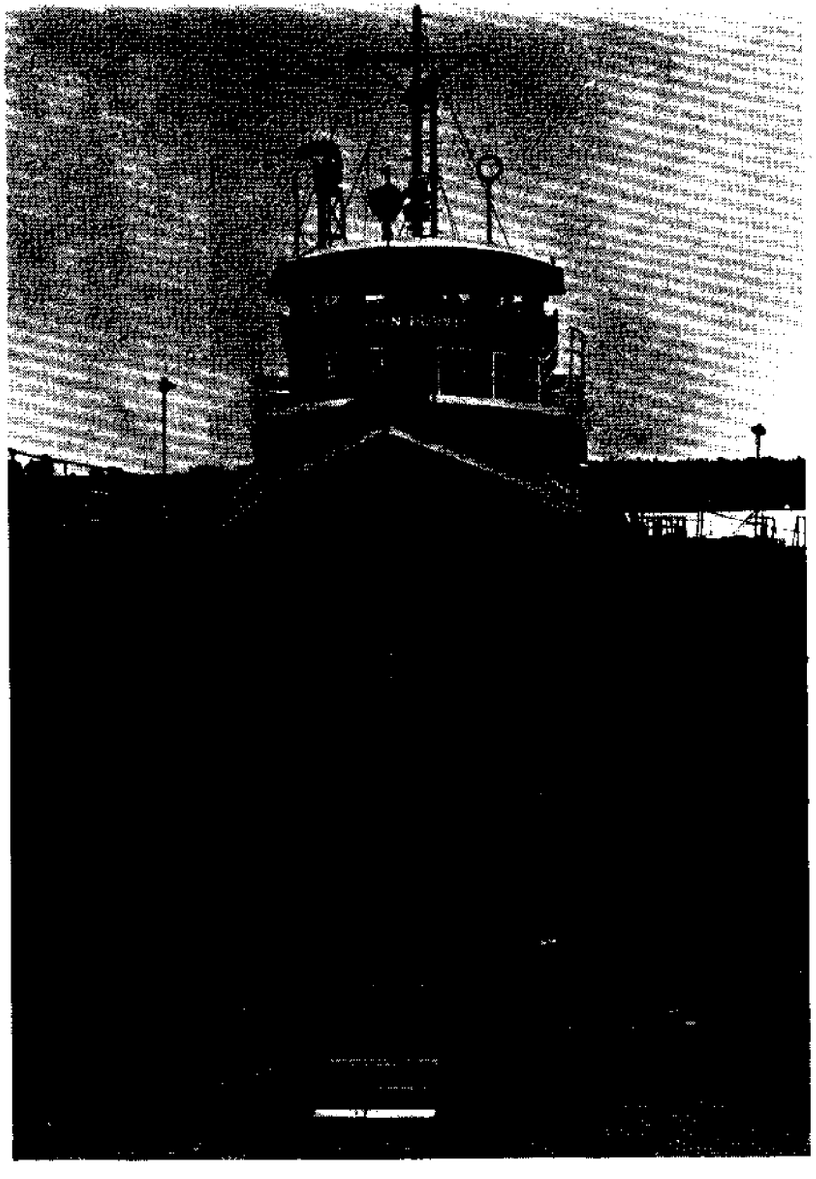


Whole banks have slid down into the lake along Michigan's shore .

With such a limited ability to control lake levels, it is necessary to consider other defenses against erosion. A common defense is protective shoreline structures. Besides the natural protection of high beaches, there are man-made constructions that can shield vulnerable portions of the shore from the wave forces and others that reduce or prevent flooding of lower lands. Many communities, plagued by high water and erosion problems, have built make-shift dikes out of sandbags. Others have bulldozed protective breakwaters and dikes along the shoreline, or have been forced to install permanent structures such as retaining walls to hold back the water.

Whatever the case, fighting erosion is costly to the individual and to the community. Expenditures can range from hundreds to a million dollars per mile for shoreline protection. The Army Corps of Engineers can provide technical assistance for communities which plan such shoreline protection, but for the most part, the project costs to the community are astronomical and require two or more years to be completed. By that time, levels may have receded again.

And so, despite man's limited ability to control the lakes and his varied attempts at shoreline protection, erosion continues to take place, most severely when levels are high. Erosion can cause millions of dollars in damage and affect thousands of people around the lakes. But no matter how badly man wants to prevent it, erosion is a natural process over which man's control has historically proven too little and too late.



Great Lakes Management

As the number of problems in the Great Lakes has increased, so has the number of people and organizations geared to solve them. Government at every level – from international to local – has claimed all or parts of the Great Lakes for inclusion in its sphere of influence. Public and private organizations are constantly being added to the expanding collage of interlocking, intersecting, and overlapping jurisdictions and missions. There is evidence of a recent tendency toward coordination of functions at some levels, but the average citizen interested in Great Lakes problems must remain disheartened by the apparent confusion of institutional arrangements. This section is designed to help relieve some of the befuddlement by providing a broad outline of who is responsible for what in the Great Lakes.

It should be remembered, however, that the primary responsibility for managing the Great Lakes shoreline still resides with local communities. Local ordinances relevant to the lakes vary drastically from one community to the next, and a citizen seeking immediate relief for some lake-related problem would be well advised to start at home.

International

Over one-third of the boundary between the United States and Canada cuts through the Great Lakes, and the two nations share the responsibility for all but one of them. Only Lake Michigan remains completely within U.S. jurisdiction.

The **International Joint Commission,** established in 1909 by the Boundary Waters Treaty, was designed to oversee international use of the lakes. The IJC's primary responsibility is to regulate lake levels and navigation on the lakes and other boundary waters. In addition, the commission is often requested by the two national governments to make recommendations on specific problems that may arise along the lakes' boundaries. This responsibility has provided the basis for the commission's increasing involvement in pollution and other problems. In 1972 the two countries signed a new agreement to help insure higher water quality in the lakes by providing for some immediate actions to stop pollution and by laying out the procedures for arriving at future agreements.

To assist the IJC in meeting its responsibilities under the 1972 Water Quality Agreement, an 18-member Great Lakes Water Quality Board has been set up. With nine members from each of the two countries, the board will assist the commission in coordinating programs and insuring that water quality objectives are being met.

The **Great Lakes Fishery Commission (GLFC)** is another important international organization concerned with Great Lakes problems. Established in 1955, its main function is to plan and implement fisheries research in the lakes for the U.S. and Canada. The GLFC is also charged with the task of eradicating or minimizing the population of sea lampreys, a pest once confined mainly to marine waters, but now a lake denizen and a plaque on the lakes' fisheries.

Besides these two formal commissions, a number of other organizations foster international cooperation in the lakes, particularly for research purposes. These include the International Association for Great Lakes Research and the International Field Year on the Great Lakes.

Canada

The Great Lakes are important to the United States, to be sure — about 14% of our nation's population lives within the Great Lakes Basin. But for Canada, the lakes are vital. Over 60% of the population and economy of Canada is concentrated around the lakes and the St. Lawrence Basin.

Ontario Department of Lands and Forests. All of the Canadian waters of the Great Lakes and part of the St. Lawrence River lie within the Province of Ontario. The responsibility for administering all living natural resources, including fisheries on Crown Lands in the province, rests with the Ontario Department of Lands and Forests, which has both regulatory and research functions.

The **Canada Centre for Inland Waters** is the major interdisciplinary water resources research institute in Canada. The centre has three federal departments: the Department of Energy, Mines and Resources, the Department of National Health and Welfare, and the Department of Fisheries and Forestry (Fisheries Research Board). In addition, the Association of Universities and Colleges of Canada has developed plans for university participation in the work of the centre.

Other important agencies include the Hydro-Electric Power Commission of Ontario, which is endowed with Broad Powers relating to the province's power supply, and the Ontario Water Resources Commission, which administers an extensive program on pollution control and water resource protection directed mainly toward the control of municipal and industrial wastes.

United States

More than half of the Great Lakes Basin, or about 176,000 square miles, lies within the United States. Although the U.S. portion of the lakes is owned by the states, the federal government has definite statutory responsibilities in the basin. Merely to catalogue all the federal departments, bureaus and agencies with some function involving the Great Lakes would present the reader with a mind-boggling array of impressive, but unmemorable, titles. The following listing includes only those federal organizations that are most involved in Great Lakes affairs.

Department of Agriculture. The USDA investigates agricultural, rural and upstream waters and related land resource problems. The water resource planning and development activities of the USDA are carried out principally through: the Soil Conservation Service, which is the technical, administrative arm for the USDA in the fields of soil and water conservation, watershed protection, flood protection and prevention, and resource development; the Forest Service, which is involved in flood prevention and river basin planning on state and private forest lands, as well as in the management of soil and water resources of the National Forest System lands; and the Economic Research Service, which participates in comprehensive river basin planning and research on the economics of natural resource use and development.

Environmental Protection Agency. The EPA was established in 1970, bringing together for the first time in a single agency the major environmental control programs of the federal government, among them the Federal Water Pollution Control Administration, formerly under the Department of Interior. The EPA is charged with mounting an integrated, coordinated attack on the environmental problems of air and water pollution, solid waste management, pesticides, radiation and noise — all of which are pertinent to the Great Lakes region. The EPA is first and foremost a regulatory agency with responsibilities for establishing and enforcing environmental standards within the limits of its various statutory authorities.

The agency has ten regional offices (the regional office that serves Wisconsin is located in Chicago). These offices are staffed by specialists in each area and are headed by regional administrators possessing broad authority to act for EPA in matters within their jurisdiction. EPA reviews environmental impact statements touching on any aspect of its responsibilities. In addition to reviewing statements filed by federal agencies, EPA frequently reviews statements filed by states and other jurisdictions as a technical service.

Environmental impact statements were instituted in 1970 by the National Environmental Policy Act (NEPA), which declared a national policy to encourage "productive and enjoyable harmony between man and his environment." NEPA established a Council on Environmental Quality in the Executive Office of the president and made it responsible for studying the condition of the nation's environment, for developing new environmental programs and policies, and for coordinating the wide array of existing federal environmental efforts. NEPA also requires each federal agency to prepare a statement of environmental impact in advance of any major action, recommendation or report on legislation that may significantly affect the quality of the human environment. Such actions include new highway construction, harbor dredging or filling, nuclear power plant construction, large-scale aerial pesticide spraying, river channeling, new airport runways, munitions disposal, bridge construction and others.

The impact statement procedure gives the public an opportunity to participate and respond to federal decisions that may affect the human environment. Each draft statement must be made public by the responsible agency at the time it is circulated for comment, not less than 90 days before the proposed action. A final statement, incorporating comments and objections on the draft, must be made public at least 30 days before the proposed action.

These statements are announced in the Federal Register, although many agencies have supplementary procedures to reach interested citizens.

Department of Defense. The most visible and controversial agency within the Department of Defense – as far as the Great Lakes are concerned – is the U.S. Army Corps of Engineers, which has been the federal government's principal water resources development agency since 1821. Through its civil works programs, the Corps carries out comprehensive water resources planning and construction operations with other interested agencies of government at all levels, and with a wide range of civic and private groups. In the Great Lakes area, the Corps, through its regional division and five district offices, plans and constructs flood control projects, maintains navigation channels and harbors, and builds or advises on structures to prevent beach and shore erosion.

Department of the Interior. The activities of the Department of the Interior are conducted through a number of semi-autonomous bureaus and agencies whose planning and related activities in the Great Lakes area are overseen by a regional coordinator. Some Interior agencies whose concern with the Great Lakes area is clear from their titles are the Bureau of Mines,

the Bureau of Outdoor Recreation, the U.S. Geological Survey, the National Park Service, and the Office of Water Resources Research.

Department of Commerce. One of the most important lake organizations under the aegis of the Commerce Department is the Maritime Administration, established by the Merchant Marine Act of 1936. The administration provides financial assistance for shipping, regulates maritime operations, promotes cargo and port development, conducts maritime training (including the U.S. Merchant Marine Academy), and conducts research and development projects.

Also in the Commerce Department is the **National Oceanic and Atmospheric Administration**, which has numerous agencies with functions relevant to the Great Lakes. Included under NOAA is the Office of Sea Grant Programs, with its pragmatically-oriented efforts in research, education and advisory sercices at various universities, patterned after the successful land grant effort to aid the nation's agricultural sector. Since the passage of the Coastal Zone Management Act of 1972, NOAA has had the responsibility for management of the nation's coastal zone on the oceans and the Great Lakes. The Office of Coastal Zone Management can issue grants to individual states for up to two-thirds of the cost of creating and administering coastal zone management programs and for up to half the cost of acquiring and developing estuarine sanctuaries.

The National Marine Fisheries Service, also in NOAA, conducts biological research on economically important species, analyzes economic aspects of fisheries operations, develops methods for improving catches, and, in cooperation with the U.S. Department of State, is active in international fisheries affairs. With the U.S. Coast Guard, the NMFS conducts enforcement and surveillance operations on the high seas and in territorial waters, including the Great Lakes.

Elements of the U.S. Lakes Survey (formerly of the Army Corps of Engineers) have also been incorporated into NOAA's National Ocean Survey. The survey prepares and publishes navigational charts and related materials for the Great Lakes and conducts investigations of the physical aspects of the lake waters.

U.S. Department of Transportation. The U.S. Coast Guard was incorporated into the Department of Transportation in 1967. This helped focus attention on the Coast Guard's role relative to the safety of shipping, life and property on the Great Lakes. For a number of years, the Coast Guard has also provided icebreaking services and contributed toward an interagency effort to improve ice fishing.

The St. Lawrence Seaway Development Corporation also reports to the Secretary of Transportation. One of the purposes of the corporation is to construct, operate and maintain

deep-water navigation works in the American sector of the seaway in coordination with the Seaway Authority of Canada. It also establishes operating agreements between the two countries and serves to stimulate the Great Lakes economy by fostering Great Lakes shipping.

Some other federal organizations with interests involving the Great Lakes include the Atomic Energy Commission, Federal Power Commission, the National Council on Marine Resources and Engineering Development, the National Science Foundation, Smithsonian Institution and the Water Resources Council. The latter consists of those departments and independent agencies in the federal government that have the major responsibility for water resources.

Regional

Great Lakes Basin Commission. The GLBC serves as the principal coordinating agency for federal, state, interstate, local and non-governmental plans for the development of water and related land resources in the Great Lakes Basin. The commission was created in 1967 by the president, pursuant to the Water Resources Planning Act. Commission members represent the eight states bordering the Great Lakes, nine federal agencies and the Great Lakes Commission (see below). The GLBC is a planning and research organization, and is an excellent source of information on the Great Lakes.

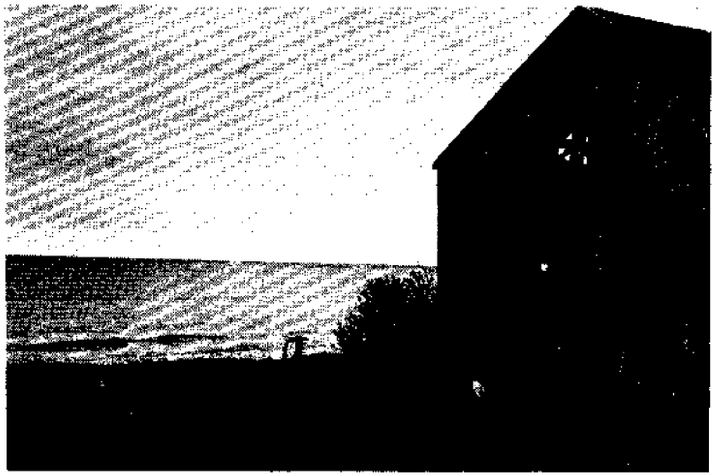
The **Great Lakes Commission** was formed in 1955 by the eight lake states as their common resource for Great Lakes information, for joint consideration of regional lakes problems, and for coordination of state views, plans and programs. In contrast to the GLBC, the Great Lakes Commission generally focuses on the commercial uses of the lakes.

Upper Great Lakes Regional Commission. Through the Public Works and Economic Development Act of 1965 and in response to requests from the governors of Michigan, Minnesota and Wisconsin, the Secretary of Commerce designated the upper Great Lakes area an Economic Development Region in 1965. This paved the way for the formal organization of the Upper Great Lakes Regional Commission in 1967.

The federal-state commission was given the task of identifying the economic problems and potentials of the region and of recommending public investment programs to stimulate the lagging economy of the region. Recent federal cutbacks threaten to abolish the UGLRC but the states involved are fighting for an extension of the program.

Wisconsin

The eight Great Lakes states are Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin. Each



state has many agencies involved with water resources in some way. In Wisconsin a recent reorganization has centralized most water resource management into the **Department of Natural Resources**, with a few other water-related groups remaining in other agencies.

Most of the water management functions of the DNR are centered on three bureaus within the **Division of Environmental Protection.** The Bureau of Water Supply and Pollution Control administers regulations and programs and conducts surveys related to the protection of public health and welfare in the use of the state's water resources. It controls industrial and municipal waste treatment facilities, as well as municipal and other domestic water supplies. The Bureau of Standards and Surveys has the prime responsibility for evaluating the state's environment, which includes portions of Lakes Superior and Michigan. To do this, it conducts a stream survey program, operating 35 stream quality monitoring stations, supervises chemical treatment of water, and plans for the use, conservation, development and protection of the state's water resources. The Bureau of Water and Shoreland Management is concerned with the regulation of water use. Among its functions are floodplain and shoreland management and the regulation of well drilling.

To carry out the duties of the DNR's Division of Environmental Protection, district directors and district advisory boards have been set up within the state's five water resources districts. Other DNR bureaus with significant management functions relevant to the Great Lakes include the Bureau of Fish Management, the Bureau of Research and the Bureau of Parks and Recreation.

The water-related functions of Wisconsin's **Department of Health and Social Services** are confined to the Division of Health, Bureau of Evironmental Health. The bureau oversees public health and safety aspects of the state's water resource use. For

example, its responsibilities touch on: the operation of town sanitary districts; plot approval; the equipping of boats with toilets; radiation protection; sanitary supervision of county institutions, camps, hotels and restaurants; nuisance abatement; monitoring of public swimming facilities and private waste disposal systems; and the promotion of public water and sewerage systems.

The **Department of Local Affairs and Development** is primarily involved with water resource management through its program of community assistance planning, usually at the city, village or county level. And the **Public Service Commission** has the responsibility for setting municipal water rates. It also licenses power-generating plants and sets electric rates.

Under the Wisconsin Environmental Policy Act of 1972, each state agency is required to issue environmental impact reports on any major action it plans or legislation it proposes. This follows the pattern set by the National Environmental Policy Act (NEPA), which requires such statements of all federal agencies.

Under the state law, agencies have to study and list all adverse environmental effects of proposed actions and list alternatives. Proposals must be circulated for comment by other interested agencies, such as the Department of Natural Resources, and their comments become a part of the public record.

Citizens seeking redress for existing pollution problems of a public nature may notify the state **Department of Justice** for possible action. In addition to serving as the enforcement agency for the DNR, the Department of Justice has launched STOP (Students to Oppose Pollution), an environmental program utilizing law and environmental science students to process pollution complaints received by the department and to conduct investigations. The information obtained has been used in the preparation of public nuisance suits initiated by the Attorney General against some polluters. Justice Department attorneys also appear as "public intervenors" at DNR hearings on water pollution in behalf of the public interest.

Through the welter of bureaucracies outlined above, the United States and Canada "regulate" the 95,000 square miles of the Great Lakes. Governments from the highest echelons to the town council are all involved in trying to construct a rational framework to guide man's relationship with the Great Lakes.

As both an aid and counterbalance to the public agencies, a raft of private groups — like Save Lake Superior, the Lake Michigan Federation and the League of Women Voters — are also growing in competence and influence. The stability and success of our heavy governmental structures may ultimately depend on such grass roots organizations in the sands of the Great Lakes Basin.

Organizations Related to Great Lakes Management

UNITED STATES – CANADA

International Joint Commission
United States and Canada
1717 H Street NW, Room 203
Washington, D.C. 20440

Great Lakes Fishery Commission
1451 Green Road
Post Office Box 640
Ann Arbor, Michigan 48107

STATE

Department of Local Affairs and Development
123 West Washington Avenue
Madison, Wisconsin 53703

Public Service Commission
4802 Sheboygan Avenue
Madison, Wisconsin 53705

Department of Justice
123 West Washington Avenue
Madison, Wisconsin 53703

Eastern Region Office
U.S. Forest Service
710 North Sixth Street
Milwaukee, Wisconsin 53203

Soil Conservation Service
4601 Hammersley Road
Post Office Box 4248
Madison, Wisconsin 53711

Department of Natural Resources
Box 450
Madison, Wisconsin 53701

Division of Health
Department of Health and Social Services
1 West Wilson Street
Madison, Wisconsin 53703

Sea Grant College Program
University of Wisconsin System
1225 West Dayton Street
Madison, Wisconsin 53706

PRIVATE GROUPS

League of Women Voters
443 West Washington Avenue
Madison, Wisconsin 53703

Lake Michigan Federation
53 West Jackson Blvd.
Chicago, Illinois 60604

Save Lake Superior Association
1707 North Avenue
Two Harbors, Minnesota 55616

Environment Wisconsin Inc.
114 North Carroll Street
Madison, Wisconsin 53703

REGIONAL

Great Lakes Basin Commission
Post Office Box 999
3475 Plymouth Road
Ann Arbor, Michigan 48106

Great Lakes Commission
2200 North Campus Boulevard
Ann Arbor, Michigan 48105

Upper Great Lakes Regional Commission
215 North Brooks Street
Madison, Wisconsin 53715

UNITED STATES

Environmental Protection Agency

Environmental Protection Agency
1626 K Street, NW
Washington, D.C. 20460

Regional Coordinator
Region V, EPA
33 East Congress Parkway
Chicago, Illinois 60605

Council on Environmental Quality

Council on Environmental Quality
722 Jackson Place, NW
Washington, D.C. 20006

Department of the Interior

Department of the Interior
18th and C Streets NW
Washington, D.C. 20242

Field Representative
North Central Region
U.S. Department of the Interior
2510 Dempster Street
Des Plaines, Illinois 60016

Department of Transportation

St. Lawrence Seaway Development Corporation
800 Independence Avenue, SW
Washington, D.C. 20590

Ninth Coast Guard District
1240 East Ninth Street
Cleveland, Ohio 44199

Department of Commerce

Eastern Region Director
Maritime Administration
26 Federal Plaza
New York, New York 10007

Northeast Regional Director
National Marine Fisheries Service
U.S. Department of Commerce
Federal Building
14 Elm Street
Gloucester, Massachusetts 01930

Office of Sea Grant
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Rockville, Maryland 20852

Lake Survey Center
National Ocean Survey
630 Federal Building and U.S. Court House
Detroit, Michigan 48226

Department of Defense

Office of Chief of Engineers
James Forrestal Building
Washington, D.C. 20314

District Engineer
U.S. Army Engineer District, Chicago
219 South Dearborn Street
Chicago, Illinois 60604

Department of Agriculture

14th Street and Independence Avenue SW
Washington, D.C. 20250

Great Lakes Bookshelf

HISTORY

The Great Lakes Reader, Walter Havighurst, New York, Macmillan Co., 1966

Lore of the Lakes, Dana Thomas Bowen, Daytona Beach, Florida, 1940

Great Stories of the Great Lakes, Dwight Boyer, New York, Dodd, Mead, 1966

True Tales of the Great Lakes, Dwight Boyer, New York, Dodd, Mead, 1971

The Great Lakes Frontier; an Epic of the Old Northwest, John Anthony Caruso, Indianapolis, Bobbs-Merrill, 1961

A Pictorial History of the Great Lakes, Harlan Henthorne Hatcher, New York, Crown Publishers, 1963

Great Lakes Saga, Anna G. Young, Toronto, Richardson, Bond & Wright, 1965

Great Lakes Shipwrecks and Survivals, William Ratigan, Grand Rapids, Eerdmans, 1960

Memories of the Lakes, Told in Story and Picture, Dana Thomas Bowen, Daytona Beach, Florida, 1946

We Explore the Great Lakes, Webb Waldron, New York, The Century Co., 1923*

Off Watch; Today and Yesterday on the Great Lakes, Anna G. Young, Toronto, Ryerson Press, 1957*

The Story of the Great Lakes, Edward Channing, New York, Macmillan Co., 1909*

Freshwater; a History and a Narrative of the Great Lakes, George A. Cuthbertson, New York, Macmillan Co., 1931*

COMMERCE

Transportation Economics of the Great Lakes – St. Lawrence Ship Channel, A.H. Ritter, Washington, D.C., Great Lakes – St. Lawrence Tidewater Assoc., 1925

Long Ships Passing; The Story of the Great Lakes, Walter Havighurst, New York, Macmillan Co., 1942

Blut-Water Boundary; Epic Highway of the Great Lakes and the St. Lawrence, Alida Malkus, New York, Hastings House, 1960

Great Lakes Foreign Commerce, Great Lakes Commission, Ann Arbor, Michigan, 1955

Shipways to the Sea, Ernest Seabury Clowes, Baltimore, The Williams & Williams Co., 1929

Our Inland Seas; Their Shipping and Commerce for Three Centuries, James Cooke Mills, Chicago, A.C. McClurg & Co., 1910

The Great Lakes; The Vessels that Plough Them, James Oliver Curwood, New York, G.P. Putnam's Sons, 1909*

The Great Lakes in Relation to the Railroad Development of Northern Wisconsin, J.S. Griffin, Wisconsin Historical Society Proceedings, 1898

GENERAL

The Great Lakes, Harlan Henthorne Hatcher, New York, Oxford University Press, 1944

Great Lakes Country, Russell McKee, New York, Crowell, 1966

The Great Lakes, Robert Thomas Allen, Toronto, Natural Science of Canada Ltd., 1970

The International Law of the Great Lakes, Don Courtney Piper, Durham, Duke University Press, 1967

The Heartland: Illinois, Indiana, Michigan, Ohio, Wisconsin, Robert McLaughlin and Ed. of Time-Life books, New York, Time, Inc., 1967*

Keys to a Continent: The Great Lakes, Canada Department of Energy, Mines and Resources, Ottawa, Queen's Printer, 1969*

The Great Lakes – St. Lawrence Deep Waterway to the Sea, Tom Ireland, G.P. Putnam's Sons, 1934*

The Great Lakes, Inland Seas of America, John Disturnell, New York, C. Scribner, 1865*

The Way to the Sea, Great Lakes – St. Lawrence Tidewater Assoc., Duluth, 1922

MAGAZINES

Great Lakes News Letter, Great Lakes Commission, 5104 Institute of Science and Technology Building, 2200 Bonisteel Blvd., Ann Arbor, Michigan, 48105

Great Lakes Living, Tribune Tower, Suite 3200, 435 North Michigan Ave., Chicago, Illinois, 60611

Limnos, The Great Lakes Foundation, 3750 Nixon Road, Ann Arbor, Michigan, 48105

Telescope, Great Lakes Maritime Institute, Dossin Great Lakes Museum, Bell Isle, Detroit, Michigan, 48207

Wisconsin Trails, 6120 University Ave., Madison, Wisconsin, 53705

Wisconsin Weekend, Inc., Spring Green, Wisconsin, 53588

*State Historical Society Library, 816 State Street, Madison, Wisconsin, 53703

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