United States
Environmental Protection
Agency
Region 5

EPA

GREAT LAKES, AMERICA

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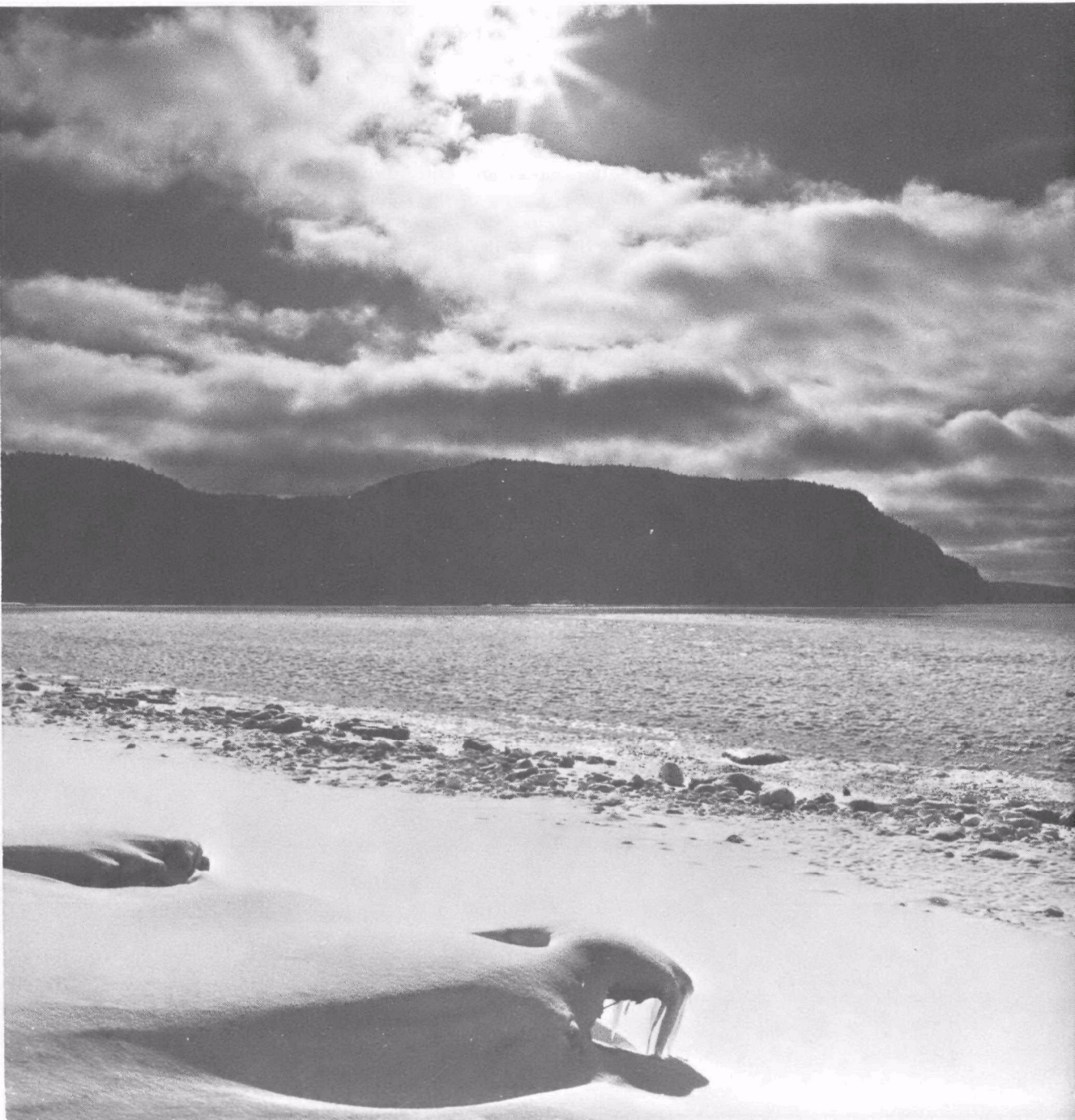
Superior, Michigan, Huron, Erie, Ontario. The largest system of fresh water on Earth, these Great Lakes are North America's glue, binding East to West, giving strength and vitality to the American way of life.

The United States and Canada have spent millions of dollars in recent years in an effort to keep these useful Lakes as clean and healthy as possible — for drinking water, recreation, sport and commercial fishing; for industry; and for shipping of the heartland's abundance. Despite their problems, the five Great Lakes retain a special beauty that is unique to our continent.

This exhibition of 62 photographic images, produced by the U. S. Environmental Protection Agency's Great Lakes National Program Office, is presented as a public testament to one of North America's premier treasures and resources. The images are those of photoessayist B. A. King, who grew up along Lake Ontario and spent parts of his summers along Lake Huron.

"Great Lakes, America" opens October 22, 1980 at the Museum of Science and Industry in Chicago and will tour for two years after that. Its purpose is to heighten appreciation of, and concern for, a vulnerable national treasure.



Introduction

In 1610 young French adventurer Étienne Brulé and a group of Huron Indians paddled their canoes down a northern wilderness river and arrived at what is now known as Georgian Bay in Lake Huron. Brulé thus became the first European to see any of the Great Lakes.

At the time, the Lakes were completely unspoiled. Although thousands of American Indians lived on their shores and fished in them and drank from them, the Lakes were not abused. They were respected, honored, even worshipped.

In the several hundred years since then, the area around the Lakes has gradually changed from that of a quiet wilderness to a region of enormous industrial, commercial, and agricultural development.

Although that development has helped to raise our standards of living, it has also resulted in a proliferation of pollutants in the Lakes' waters. Their presence has permanently altered the Lakes and now even threatens the health of living creatures who use the Lakes.

Slightly more than a decade ago, the public began to take a more active interest in the state of the Great Lakes. It was a timely concern: Many beaches and tributary rivers and sections of the Lakes had become polluted with everything from industrial chemicals to human waste.

Concern about the Great Lakes grew along with a general public interest in the state of our Nation's deteriorating environment. Laws were passed, and State and Federal agencies—most notably, the U.S. Environmental Protection Agency (EPA)—created programs to restore our water and air quality.

The momentum begun by that public interest resulted in a national commitment to clean up the Great Lakes. In the past decade, more than $5 billion has been spent on the Lakes by the Federal Government, and at least $1 billion more has come from local governing bodies and industries.

That attention and those expenditures have brought an improvement in water quality: The water in the Lakes is clearer, and there are fewer oil slicks and growths of algae and dead fish washing up on the beaches.

However, hundreds of toxic chemicals, pesticides, and metals are still fouling the fish and waters of the Great Lakes, and some areas of each Lake remain severely polluted. Much work remains to be done.

But as the United States moves into a new decade, its citizens are increasingly concerned about holding down Government expenditures. This and other problems, including energy shortages and rapid inflation, are coming into conflict with our environmental concerns, which require further spending by public agencies and private companies to continue the cleanup work started in the 1970s.

It is hoped that a balance may be reached between the needs of our society's industrial development and what we require of the Lakes for our own good health and the health of our children and grandchildren. We haven't reached that balance yet—but we're moving in that direction.

This brochure is intended to acquaint the reader with the crucial role of the Great Lakes as the key water system of mid-North America. It will also explain the different kinds of pollution problems that are still facing the Lakes, and what the EPA is doing about them.

Geology

The five adjoining Lakes—Superior, Michigan, Huron, Erie, and Ontario—were formed by a two-billion-year process that included volcanic emissions, shifts in the earth's crust, and movements by glaciers through several ice ages. The last glacial withdrawal was about 10,000 years ago.

The levels of the Lakes stabilized some 2,500 years ago, the geologists tell us. The Great Lakes now extend 850 miles from easternmost point to westernmost point and 700 miles from north to south, with a total water surface area of 94,710 square miles—one-fifth of all the fresh water on the planet Earth. Their total U.S.-Canadian shoreline measures 9,402 miles, including islands. Of that figure, 4,530 miles is the U.S. shoreline—longer than the Atlantic and Gulf of Mexico coastlines combined.

Superior, the largest of the Great Lakes, is 350 miles by 160 miles. It is 1,333 feet deep at its deepest point, with an average depth of 489 feet, and contains 2,935 cubic miles of water.

Lake Michigan, with a deepest point of 923 feet, has an average depth of 279 feet and holds 1,180 cubic miles of water. Huron is 750 feet deep at its deepest point, has an average depth of 195 feet, and has 849 cubic miles of water. Ontario, with a deepest point of 802 feet and an average depth of 283 feet, has 393 cubic miles of water. Erie, which looks larger than Ontario on a map, is actually smaller: It has a maximum depth of 210 feet, an average depth of only 62 feet, and 116 cubic miles of water.

Although each of the Great Lakes has its own separate characteristics, it's important to understand how they all fit together into one massive, integrated water system.

The Lakes all act as drainage for their tributary rivers, of which there are hundreds throughout the Great Lakes Basin, and each Lake's water moves through the Lakes' system to the Atlantic Ocean. Of the five Lakes, Lake Superior is the highest above sea level. Its water flows through the St. Marys River into Lake Huron. Lake Michigan's water moves slowly into Huron, too, through the Straits of Mackinac. Huron's water passes through the St. Clair River, Lake St. Clair, and the

Detroit River into Lake Erie, and Erie's water flows into the Niagara River and then over Niagara Falls into Lake Ontario. Ontario, now with the water from the four other Lakes and its own tributary rivers, rushes into the St. Lawrence River. And from the St. Lawrence River, all that water moves into the Gulf of St. Lawrence and finally enters the Atlantic Ocean between Nova Scotia and Newfoundland.

"All that water" means just that: The Great Lakes system moves nearly 6½ billion gallons of water *every hour* into the St. Lawrence River. Yet, despite their awesome capacity, the Lakes are fragile.

Lakes are different from rivers. If you dump garbage into a river, the flowing water will eventually wash it away. Flowing water, compared with standing water, is easier to clean up.

It doesn't work that simply with lakes. If you stood on the western shore of Lake Superior and threw in something nonbiodegradable—say, an unopened aluminum soft-drink can—it would take about 200 years before that can slowly drifted through Lake Superior and into Lake Huron. Your great-great-great-great-great-great grandchildren, more environmentallly conscious than you were, could pick it out of that Lake for you.

But if they didn't, and assuming that the can kept drifting, it would take another 50 to 75 years before it found its way through Lakes Erie and Ontario into the St. Lawrence River. If the can found its way into Lake Michigan and floated down to Chicago and back again to the Straits of Mackinac, that would add another 100 years to the journey.

Once in the St. Lawrence River, your soda-pop can would no longer be a Great Lakes pollution problem. After a relatively short ride in the river, it would then become an Atlantic Ocean pollution problem.

What this demonstrates is that the Lakes have a long "flushing" period. It would be as if you filled a bathtub with water and then punched a tiny pinhole in the bathtub drain stopper.

The Great Lakes are a very, very big water system. But it's a finite system. There's only so much room in it for fish, people, boats, ships, and wastes, and the problems don't go away by being ignored. This means that the Lakes are what we make them: clean or dirty.

History

The first humans to see the Great Lakes were American Indians. Dozens of tribes lived along the Lakes hundreds and perhaps even thousands of years before Western exploration and development pushed them away. There were the Ojibway (also known as Chippewa), Ottawa, Potawatomi, Menominee, Sauk, Fox, Kickapoo, Miami, and Winnebagoes to the south and west of the Lakes; the Erie, Seneca, Onondaga, Mohawk, Oneida, and Cayuga to the east; and the Hurons and Neutrals to the north of the Lakes.

All five of the Lakes were "discovered," in the Western sense of exploration, by the French. The stage for this was set when Jacques Cartier sailed a ship from the Atlantic Ocean up the St. Lawrence River in 1535 to the site of the future city of Montreal, which at the time was an Indian village called Hochelaga. As with many other explorers of the era, Cartier was searching for a route to the Far East.

He got no farther than Hochelaga, but Cartier set an important precedent.

During the period of the late 1500s and early 1600s, the normal route in further exploration of the region was to follow the St. Lawrence River to the Montreal site; then, instead of continuing up the St. Lawrence, to turn and journey up the Ottawa River, which feeds the St. Lawrence from what is now Canada. That was Huron Indian territory, and the Hurons were generally friendly to white explorers. Looking at a map you will see that the Ottawa is pointed roughly at Lake Huron, by way of Lake Nipissing and the French River. It's not surprising, then, that Lake Huron was the first of the Lakes to be explored by white men.

In 1610 famed explorer Samuel de Champlain sent one of his young aides, Étienne Brulé, to live and travel with the Huron Indians. Following the above-described route on a lengthy canoe trip, Brulé eventually arrived on the shore of what is now Georgian Bay in Lake Huron.

Five years later Champlain decided to see the Lake for himself and took an expedition of men there. He returned by way of Lake Ontario, accompanied by Brulé, who acted as his interpreter with the Indians. Champlain is often credited with the first sighting of Ontario, although it's likely that Brulé, who had by then

spent years living with the Huron Indians, had scouted ahead of Champlain and seen the water first.

Brulé was also the first European to see Lake Superior, which he did around 1629, and in his wanderings with the Hurons he may have run across Lake Erie as well, although it's not recorded. For all his accomplishments, the busy Brulé came to an ignominious end: He was killed in a drunken brawl in Huron territory in 1632, and eaten by the Indians.

Lake Michigan was discovered in 1634 by explorer Jean Nicolet, who was sent by Champlain. After passing through the Straits of Mackinac and crossing Lake Michigan before landing on Green Bay Peninsula, Nicolet is recorded as being disappointed that he hadn't landed in China when he was met by Winnebago Indians instead of by Chinese.

Lake Erie was the last of the Great Lakes whose discovery was officially recorded, by Louis Joliet in 1669. Little earlier exploring had been done around this Lake because the land near it was controlled by various tribes of the Iroquois Nation. The Iroquois were angry at the French because of an earlier alliance by Champlain with the Hurons in a Huron-Iroquois war. The Iroquois

had the courage and fierceness to back up their hostility, too, so the white settlers kept away from them.

All of the Lake names except for Superior are Indian names or words. Huron and Erie were named for nearby Indian tribes, and Michigan and Ontario mean "great water" and "beautiful lake," respectively. Superior was named "Superieur" by the French and simply meant "upper lake," although the Indian name—Gitchi Gummi, meaning "great water"— is more appropriate for this largest of the Great Lakes.

Throughout the 1600s the French continued trading and exploring with the Indians. Detroit was founded in 1701 as Fort Pontchartrain, and Fort Toronto was constructed in 1749. But the French ceded all their North American territory to the British as a result of defeats in the 1754-1763 French and Indian Wars. The British did not treat the Indians as well as the French had, and a great chief named Pontiac led a massive revolt against the British in 1763. This further discouraged white settlement in the southern portions of the Great Lakes system. It was not until Revolutionary War hero Anthony Wayne defeated the Iroquois, in the 1794 Battle of Fallen Timbers near Lake Erie, that whites were able to settle safely in the lower Lakes region.

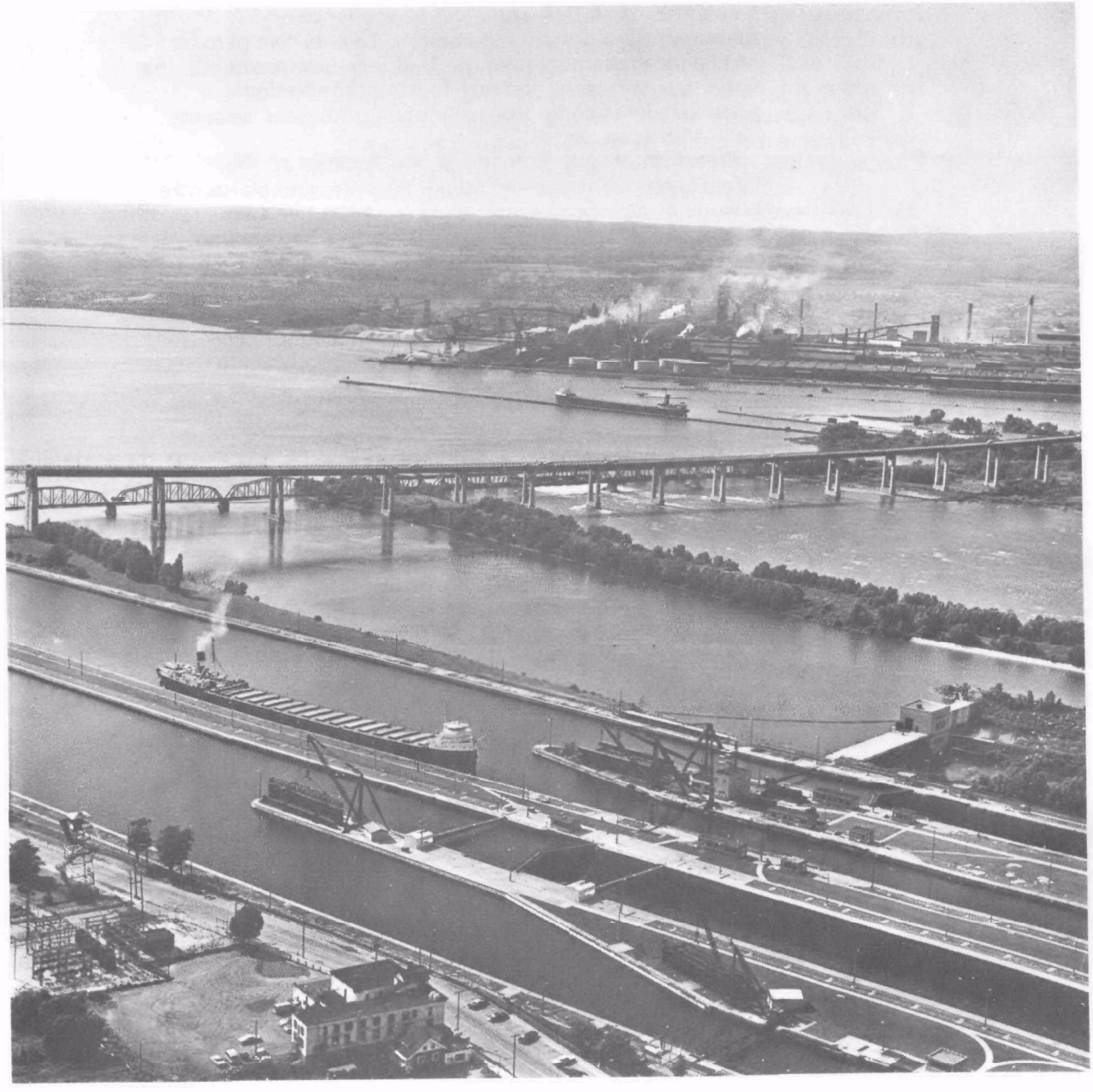
Although the American colonists had acquired Detroit and Niagara during the Revolutionary War, the British isolated those cities from the growing development of the region with their superior naval power on the Lakes. That contributed to the start of the War of 1812, during which naval battles were fought on Lakes Erie, Huron, and Ontario, as well as land battles on the Lake shores and on the Atlantic Seaboard. After several inconsequential skirmishes, the Americans finally made some significant land gains in the Great Lakes region after a major defeat of a fleet of British warships by Commodore Oliver Hazard Perry in the Battle of Lake Erie, on Sept. 10, 1813. Perry's victory came despite the near-sinking of his own flagship. "We have met the enemy and they are ours," read his concise dispatch—scribbled on the back of an envelope—to Gen. William Henry Harrison.

Commercial Development

Commercial development along the Lakes began in earnest during the 1800s, as the white settlers' population increased. Millions of acres of land were cleared for farming. The lumber industry had thousands of square miles of raw material in the forests of the upper Lakes. Commercial fishing began, with a plentiful supply of lake whitefish, trout, perch, and other species. In 1839 Fort Dearborn on Lake Michigan was incorporated as the city of Chicago, and it became a major jumping-off point for further western exploration. The Erie Canal, constructed to take shipping from New York to Ohio, increased immigration and development. The Illinois-Michigan Canal (later replaced by the Illinois Waterway), linking Lake Michigan to the Illinois and Mississippi Rivers, did the same for the Chicago area.

All of this development continued unchecked into the 20th century. The Lakes, already a tremendously important means of transportation within North America, took on greater significance in 1959 with the completion of the St. Lawrence Seaway. The Seaway made it possible for ships to travel from Lake Ontario—until then the easternmost end of the Great Lakes system—into the St. Lawrence River and the Atlantic Ocean. Chicago, Detroit, and other cities that started hundreds of years ago as wilderness outposts are now world ports. The Seaway made it possible for ocean-going vessels from around the world to enter the Great Lakes system,and for ships from Great Lakes ports to carry their goods into the open sea and to nations everywhere. And in a fuel-conscious economy, Great Lakes-rail combination shipping within the United States is increasing.

Thousands of cargo ships now travel through the Lakes, carrying hundreds of millions of tons of freight a year. Besides the nickel, copper, aluminum, bauxite, and magnesium that are mined in the Great Lakes region, 80 percent of the Nation's iron ore comes just from the Lake Superior area. It's sent to steel mills in Chicago and Gary and Cleveland, which produce more than one-third of all U.S. steel; to Toronto, whose mills make a majority of Canadian steel; and to mills elsewhere in the region. Steel from U. S. mills is then shipped to Detroit automakers, who in turn make



two-thirds of all U.S. cars, and to appliance manufacturers around the country. Twenty-five percent of chemical companies in the U. S. are now located in the Great Lakes region, and one-fourth of the Nation's paper products come from manufacturers near western Lake Michigan alone.

One-fifth of U. S. industry is now located on the Great Lakes. Hundreds of industries and power plants take billions of gallons of water daily from the five Lakes for such uses as recycling waste discharges and cooling their equipment and products.

All these facts and figures may be surprising to those who think of the Lakes mainly as recreational playgrounds—although recreation is indeed a major use of the Lakes. In Chicago alone, 20 million visits each summer are paid to the city's beaches on Lake Michigan. The Great Lakes shorelines collectively have 370 miles of public beaches and 1,220 miles of private recreational areas. More than one million privately owned small boats use the Lakes. Recreational uses of the Lakes are constantly increasing: More people are swimming, playing, water-skiing, and sport fishing in them and camping and hiking alongside them.

Sport fishing alone is a major component of recreation on the Lakes—it generates hundreds of millions of dollars a year in the form of licenses sold, sale of equipment, and related recreational expenses. Just in Michigan—and only in its 18 counties that border the Great Lakes—380,000 sport fishermen are licensed. But sport fishing has been particularly hurt by pollution in recent years, because pollution of the Lakes directly affects the health of the fish in them. Individual States have established warning systems on the dangers of eating fish contaminated with toxic chemicals.

Besides shipping, industry, and recreation, commercial fishing remains a fourth significant use of the Great Lakes. Although negatively affected in recent years, along with sport fishing, by polluted water and contaminated fish, enough commercial fishing firms remain in existence to bring in $25 million a year in revenues.

Agriculture is another major use of the Great Lakes. Of the 201,000 square miles in the Great Lakes Basin, 67,000 square miles is agricultural land, and 151 million gallons of water a day are taken out of the five Lakes to irrigate that land. The end product of that irrigation—millions of tons of wheat, corn, soybeans, barley, and oats—is shipped from U.S. and Canadian Great Lakes ports to nations overseas.

The final and perhaps most critical major use of the Great Lakes is as a supply of drinking and washing water. Nearly 24 million Americans, out of 44 million in the Lakes' Basin, take billions of gallons of water a day from the Lakes for their personal use.

The Price We've Paid

There has been a price to pay for this ascension to national prominence in commerce and industry. The original environment of the Great Lakes system has been permanently changed; the Lakes have become polluted.

The first pollution of the Great Lakes isn't recorded, although the United States and Canada were sufficiently concerned about it in 1909 to sign the Boundary Waters Treaty, in which each pledged not to do anything to harm the Lakes. The agreement established the International Joint Commission, with members from both countries, to identify Great Lakes pollution problems.

Despite the existence of the Treaty, industries and municipalities in both countries contributed to the deteriorating environmental conditions that existed in the Lakes by the 1960s.

In response to the environmental movement, which began around then, the Canadian and U.S. Governments each held a number of local conferences before jointly reaffirming their good intentions about the five Great Lakes in the 1972 Great Lakes Water Quality Agreement, which was amended and again signed in 1978. This agreement set water quality objectives that range from acidity of the Lakes' waters to levels of mercury, pesticides, and other toxic substances.

Canada's federal agency, Environment Canada, and the Ministry of the Environment of Ontario Province, which borders all the Lakes except Lake Michigan, handle Canada's responsibilities under the Agreement. The U.S. EPA and its Great Lakes National Program Office (GLNPO), as well as the pollution-control agencies of the eight States on the Great Lakes, have the job of carrying out the U.S. end of the Agreement.

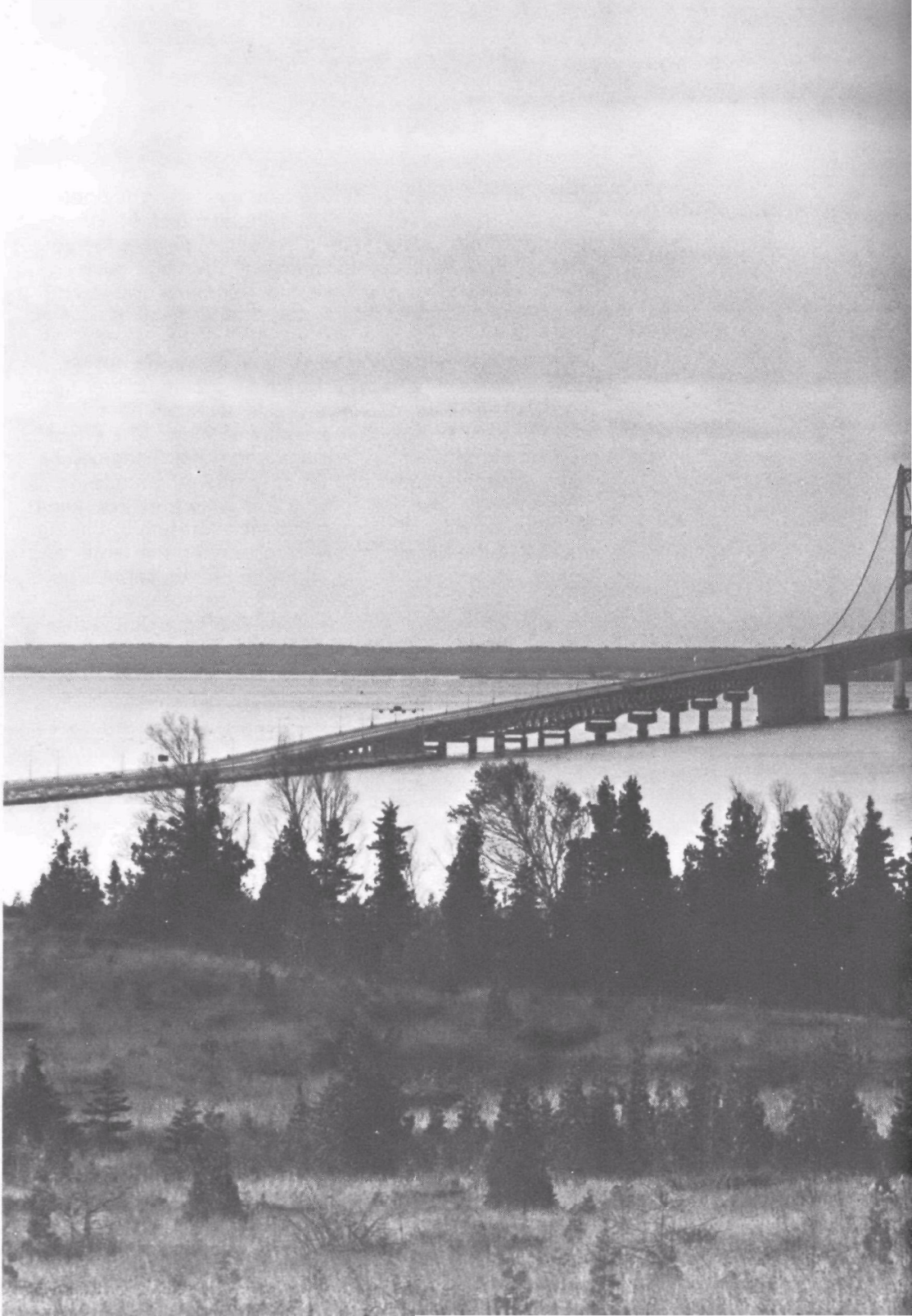
The Agreement includes studying and carrying out new pollution-control methods, awarding grant money to State and local agencies to help pay for pollution-control efforts, and taking legal action against persistent polluters. On a more basic level, it also includes monitoring the Lakes.

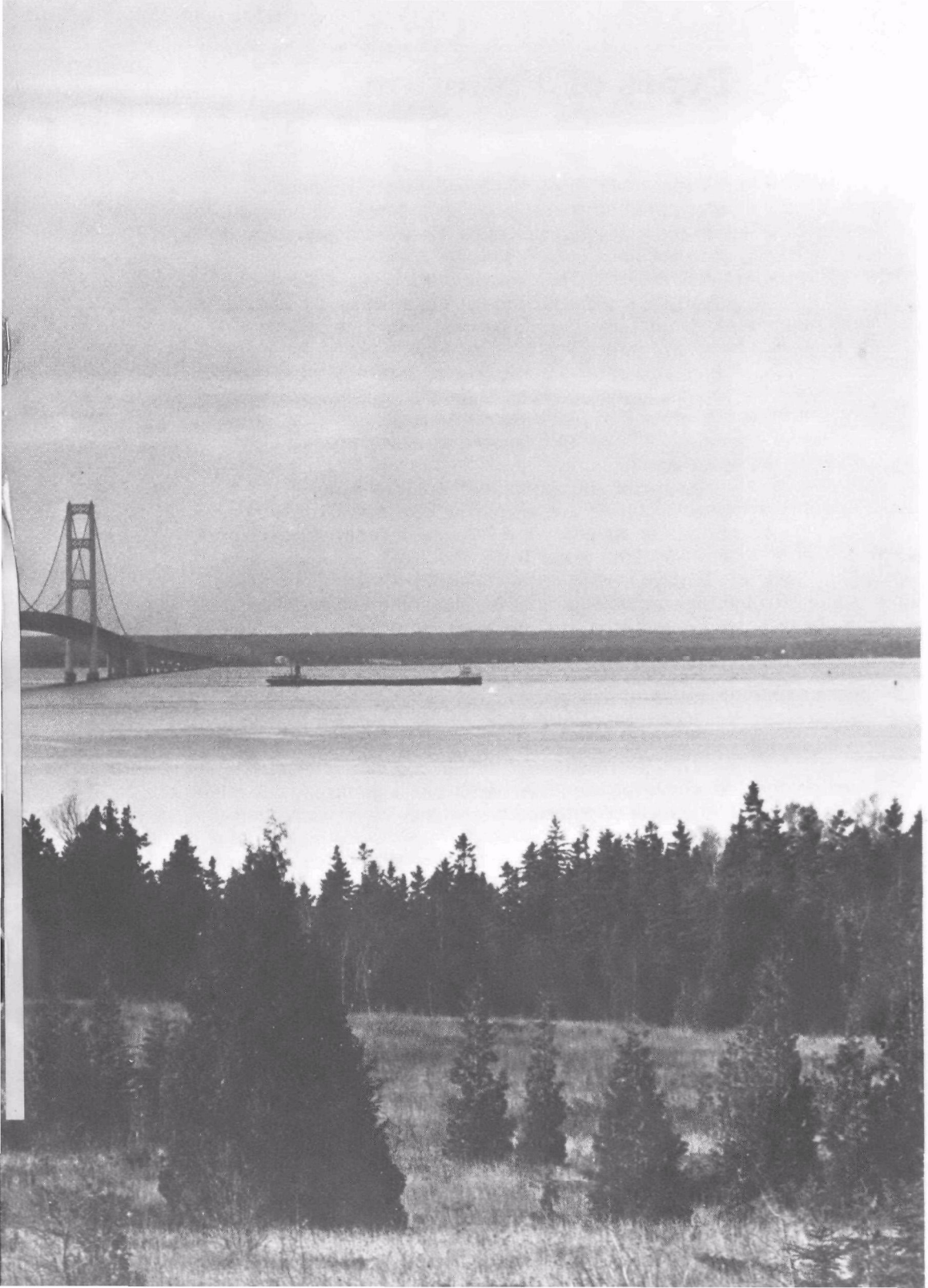
With its own researchers and subcontractors such as State environmental agencies and universities with Great Lakes research facilities, GLNPO studies water

quality in five ways: by taking samples from the open waters of the Great Lakes, studying samples of fish taken from the Lakes, testing water from rivers to see what's being dumped into them and thus into the Lakes, testing river and Lake sediment, and taking air samples to measure the pollutants settling into the Lakes from the atmosphere.

The task of monitoring water quality should not be lightly regarded; the Lakes' pollution problems are highly complex. Approximately 400 toxic chemicals have been found in the Lakes, and there may be more. The effect of these substances on humans and other living beings requires sophisticated and lengthy scientific study.

Essentially, however, all of these pollutants are doing one of two things: They're either accelerating the aging process of the Lakes, or they're poisoning the water and the fish. In both cases the end result is the same. The various forms of life in the Great Lakes ecosystem—humans, birds, and other animals—can get sick with a variety of illnesses ranging from minor disorders to cancer, either by using contaminated water or eating contaminated fish.





Types of Pollution

The remainder of this brochure will present information on three general categories of substances that are polluting the Lakes. Here's a description of each problem.

NUTRIENTS. The excessive dumping of nutrients, mainly phosphorus, into the Lakes causes a speeding up of the Lakes' aging process, which is called *eutrophication.* The nutrients act like a fertilizer for algae and other aquatic plants, and they grow rapidly, especially a blue-green algae called *Cladophora.* Such overgrowth of plant life in the water reduces the amount of oxygen available for fish and other living organisms.

Advanced eutrophication causes a general deterioration in water quality, and that directly affects the water supply of the 24 million Americans who get their drinking water from the Lakes.

Eutrophication is controlled by reducing phosphorus in treated sewage that is released into the Lakes (human waste and household detergents are major sources of phosphorus). Most Great Lakes States have banned the use of high-phosphate detergents and have installed special phosphorus-removal equipment at sewage treatment plants in order to reach the U.S.-Canada Water Quality Agreement allowable level of one part of phosphorus per million parts of sewage effluent. At this level, the three upper Lakes generally can tolerate the effects of pollutants they receive in wastewater. It is less certain whether the 1 part-per-million level will adequately protect the lower Lakes, Erie and Ontario. Control of phosphorus from land runoff is receiving increasing attention, particularly in the lower Lakes.

Except for localized problems in Lake Michigan's Green Bay and Lake Huron's Saginaw Bay, the three largest of the Great Lakes—Superior, Michigan, and Huron—are able to assimilate thousands of tons of phosphorus each year without reductions in overall water quality.

Ontario has some eutrophication and water deterioration because of the inability of cities such as Buffalo, N.Y., and Hamilton, Ont. to reach the international standard in their sewage treatment. Lake Erie has the worst eutrophication problem among the five Lakes. In

1978 Erie received more than 36,000 pounds of phosphorus *a day* from all sources, with a good chunk of that coming from the City of Detroit, whose massive sewage treatment plant has had extreme difficulty in meeting the international phosphorus standard. Cleveland is another major problem source.

TOXIC ORGANICS. There are two main sources of toxic organic pollutants: pesticides and industrial wastes.

Pesticides have been used in the Great Lakes Basin for more than 50 years. The earliest pesticides, no longer in use, were arsenic-based. These early compounds have become bound to soil particles in abandoned orchards and may contribute to potential contamination of the Great Lakes' waters if there is soil runoff.

The chemical industry developed increasingly complex pesticides after World War II. Some of these organochlorine-type chemicals included DDT, aldrin, dieldrin, chlordane, mirex, and heptachlor. Later investigations showed that all of these are suspected of causing cancer; some have been shown to cause reproductive disorders if ingested, as through contaminated food.

After a process of EPA investigation and research, many organochlorine-type pesticides were either banned or their use was severely restricted. The public's rising concern about pesticides, which had begun with the publication of Rachel Carson's *Silent Spring*—a book about the effects of pesticides in nature—helped encourage this research.

But, because they don't break down easily in the environment, DDT, aldrin, dieldrin, chlordane, and heptachlor are still found in all five of the Great Lakes. Mirex is a problem localized in Lake Ontario and the Niagara River. (Unlike the other compounds, mirex was released directly into the water from a chemical company's wastes. The other pesticides were washed into the Lakes from agricultural lands.)

One of EPA's main tasks now is to sample sediments and fish throughout the Great Lakes and test for the presence of pesticides. Levels of DDT—which were so high in the early 1970s that a ban on commercial fishing in Lake Michigan was imposed—have since fallen and now are

within safe levels. Dieldrin and mirex are still found at levels that are of concern in the Lakes.

Among industrial chemical wastes, much of the EPA's concern is currently directed to one compound in particular: PCBs.

PCBs stands for *polychlorinated biphenyls,* which are chemical substances—usually liquids in oil form—that are used in electrical equipment, heat transfer fluids, lubricants, plastics, and many other products. PCBs are resistant to fire and water and can withstand temperatures of up to 800 degrees Fahrenheit. That means they are hard to get rid of; you can't get rid of them permanently just by throwing them in the garbage, flushing them down a sewer, or even burning them at customary temperatures.

But until the late 1960s many companies had done just that. And, because PCBs are a stable compound, they weren't disintegrating (as some chemicals do). Instead, they were being carried through sewage systems or through the air from incinerator chimneys to that ever-handy end of the line for waste disposal: the waters of the Great Lakes.

Once in the Lake water, PCBs bioaccumulate, which means they store up in the systems of living organisms. As fish pass water over their gills or eat PCB-contaminated phytoplankton and zooplankton, the PCBs enter their fatty tissues and stay there. When bigger fish eat smaller fish, they add new PCBs to the ones already in their own tissues. The PCBs thus move up through the food chain in increasing proportions until they wind up in the creatures who created PCBs in the first place: humans. In large enough quantities, PCBs can cause various illnesses: eye disorders, skin lesions, gastrointestinal problems, jaundice, edema, and birth abnormalities.

After scientific testing had established the danger of PCBs to humans, the 1976 Toxic Substances Control Act called for a phaseout of the compound. In 1977 Monsanto Corp., the sole U.S. manufacturer of PCBs, stopped all production. An EPA ban on the production and new use of the compound went into effect in 1979. However, many of the earlier-manufacturered PCB compounds are still around.

The EPA ban on PCBs and the resulting decline of PCB use in industry has been reflected in fish samples in the Great Lakes: PCB levels are coming down. However, PCBs are still found in all five of the Great Lakes and will be for many years, because of the persistence of those millions of pounds of the compound that were previously discharged into wastewater or from smokestacks, and because of all the PCB-containing products that remain in use. Lake Michigan faces the biggest PCB cleanup, due to a combination of heavy industry on its shorelines and its slow flushing period. EPA scientists are now developing techniques to dredge or remove existing PCBs from the Lakes and from Lake sediment without releasing the PCBs into open water or into the environment.

Besides PCBs, a variety of other industrial chemical wastes is polluting some or all of the Great Lakes. Additional EPA testing has shown that phenols, a steel mill and petroleum and paper processing by-product, hexachlorobenzene (HCBs), and polybrominated biphenyls (PBBs)—more industrial by-products—can cause

illnesses including nervous disorders. Phenols are found in all five Great Lakes, HCBs are most noticeable in Lakes Erie and Michigan, and PBBs have been found in tributaries of Lake Huron and at the Canadian port of Cobourg, on Lake Ontario.

But that only scratches the surface of the problem. There are currently at least 40,000 chemicals used by U. S. industry, with another 1,000 introduced every year. EPA's research facilities, including its national water quality laboratories in Duluth, Minn., and Grosse Ile, Mich., have been testing suspected toxic substances. But just as the chemicals of industry are increasingly complex, the testing is even more complicated. For example, one mixture of chemicals known as the pesticide toxaphene changes its characteristics after it has been in the environment for a short time. The interactive effects of combinations of chemical wastes are also just being explored.

In fact, there are so many compounds whose toxicity isn't yet known that it will require an indefinite amount of time for EPA to test them all. Thus, EPA must rely on special reports from chemical firms—as required by the 1976 Toxic Substances Control Act (TSCA)—that explain the potential harmful effects of new chemical compounds. By requiring testing and analysis prior to commercial use, TSCA is EPA's main tool for regulating the production of new chemicals.

TOXIC METALS. The use of heavy metals by industries has resulted in the release of mercury, lead, cadmium, and other toxic metals into industrial wastewater. Mercury is the most worrisome in terms of threatening human health, since a natural process in water called *methylation* can transform inorganic mercury in Lake sediment into a very potent human nerve poison known as methyl mercury. Fifteen years ago, after the families of some Japanese fishermen had inadvertently eaten mercury-contaminated fish, grave neurological illnesses including brain damage and paralysis were reported, and mothers gave birth to retarded children.

High levels of mercury have been found in the sediment and fish of Lakes Erie, Ontario, and St. Clair, which flows from Lake Huron into Lake Erie. A ban on fishing in Lakes St. Clair and Erie was

required in the early 1970s because of the high proportion of mercury in fish there. Although the plant discharging mercury into Lake St. Clair was closed at that time, mercury is still being washed from Lake St. Clair sediment into Lake Erie.

Lead, which can cause brain damage, is not found in the Great Lakes to the degree that mercury is—but less is known about its exact levels of toxicity in humans, or its ability to be converted to more toxic forms in the environment. Cadmium, which can cause kidney damage and metabolic disturbances, is also being studied for its toxicity levels.

Other elements have also been identified in the Lakes and are being studied for possible adverse health and environmental effects: arsenic, iron, selenium, copper, zinc, chromium, and vanadium.

Working on Solutions

Nutrients, toxic organics, and toxic metals—these are the three categories of pollutants that are affecting the Great Lakes.

These pollutants can get into the Lakes two ways: from specific factory wastewater discharges or municipal sewage plants, which are called *point sources;* or from unspecified areas, such as the runoff from agricultural land or urban streets, or from the rain or air, all of which are called *nonpoint sources.* Nonpoint-source pollution is considered one of the toughest environmental problems remaining for the United States and the world.

An example of nonpoint-source pollution is the lead that is entering the Great Lakes at the rate of several hundred tons a year. Almost all of this lead originates in automobile exhausts and then enters the air as tiny lead particles and vapors—where it remains until it falls or is washed down by rain. Urban streets, where auto use is concentrated, also contribute substantial amounts of auto-generated lead through storm runoff.

Acid rain is a well-known nonpoint-source pollutant, although it doesn't particularly affect the Great Lakes because of their large volume and chemical nature. In smaller lakes, however, it can kill off aquatic life by making water too acidic for fish and their food sources. Acid rain results from the combination of sulfur oxides, mainly from coal-burning factories and power plants, and nitrogen oxides from automobiles, with rain, snow, or sleet.

Another example of nonpoint-source pollution is the air deposition of PCBs into the Great Lakes. The sources of this pollution are thought to be combustion in private or municipal incinerators, as well as PCB vapor from transformers and old disposal areas. The PCBs enter the air as vapor and microscopic particles from smokestacks. It's estimated that more than half of all PCBs in the Great Lakes originate from such nonpoint sources.

One more example is agricultural runoff. Rain can wash farm soil containing fertilizers or pesticides into a creek or river, which then flows into one of the Great Lakes. This is also considered a major method by which phosphorus and heavy metals enter the Lakes.

CONTROLLING POINT-SOURCE POLLUTION. Controlling point-source wastes has been more successful than controlling nonpoint-source wastes, partly because the sources are more easily identifiable and partly because a major effort has been under way for years.

Under the National Pollutant Discharge Elimination System (NPDES), called for in the Federal Clean Water Act, every industry or municipality that uses the Lakes or their tributary rivers as an outlet for sewage or wastewater must first obtain a permit from either the EPA or the appropriate State agency. The permit is issued contingent on the city's or company's ability to meet clean-water standards and industrial-effluent guidelines. The permit also requires periodic reports by the discharger on just what it is releasing into the river or Lake or public sewage system.

As called for in amendments to the Clean Water Act, EPA is currently conducting a revision of industrial permits, placing further specific limitations on the amounts of organic chemicals and metals that can be released into the Lakes. For those companies that release their wastes into public sewage systems, a pretreatment program is being implemented in all States. It will also require reductions in chemical and metal wastes generated by individual companies.

If the cost of installing new pollution-control equipment is a problem, companies may be eligible for various types of financial assistance that include State bonds, Federal tax incentives, or loans from the Federal Government. Cities are eligible for grants under a special Clean Water Act program.

For example, EPA has helped to fund the cost of constructing new sewage treatment facilities to help cities meet the U.S.-Canada phosphorus standard. In Detroit alone this has amounted to more than $300 million in grants at the city's giant sewage treatment plant. Nationally, such EPA grants number in the thousands and have cost billions of dollars. They've become a crucial part of the process of reducing phosphorus loads, because most cities are unable to pay for new treatment plants on their own.

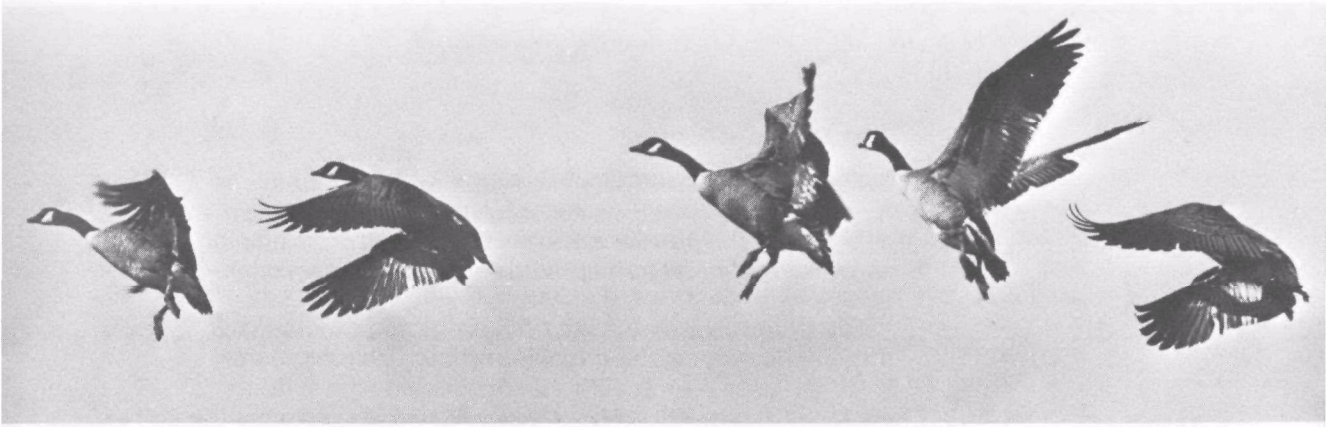
The Great Lakes National Program Office monitors the Lakes to determine how effective these efforts are in controlling phosphorus and other pollutants, and whether more controls are needed.

The NPDES permits provide the basis for legal action against those users of the Lakes who have refused to clean up their wastes. If monitoring of water samples by EPA determines that a permit holder is releasing more pollutants into its wastewater than is allowed, a series of actions begins that could eventually lead to a lawsuit: notification of the appropriate State agency by EPA, with a request that the State resolve the problem; a Notice of Violation issued by EPA to the violator if the first step doesn't work; and, finally, turning the matter over to the U.S. Department of Justice for prosecution.

The vast majority of pollution cases never get this far. In fact, more than three-fourths of all U.S. industries and three-fifths of all U.S. cities are now completely meeting their NPDES permits for discharging minimal pollution into the Great Lakes. In Canada, half of all industries and nearly all municipalities are meeting their abatement requirements. Most of those not in compliance are installing special equipment to bring wastewater and discharges to within acceptable limits.

Of cases that have resulted in lawsuits, some significant victories have been won in the last few years:

- United States Steel Corp. was fined $4 million for its failure to clean up the wastewater at its Gary, Ind., plant and later was fined $25,000 when it fell behind schedule in finishing a treatment facility there.
- Scott Paper Co. of Oconto Falls, Wisc., was fined $1 million for noncompliance with its NPDES permit.
- The City of Detroit was sued and put under court supervision for its failure to construct treatment facilities in a timely fashion for its sewage effluent.
- American Can of Canada Ltd. in Marathon, Ont., was fined more than $100,000 for a series of violations in its wastewater treatment.
- Three former officers of Olin Corporation in Niagara Falls, N.Y., were tried and convicted of falsifying an



NPDES report on the content of the firm's discharges. All three received $2,000 fines and suspended jail sentences. The company was fined $70,000.

●A $3 million penalty was levied against United States Steel Corp. for air and water pollution violations at its Lorain, Ohio, plant. The company was allowed to credit the fine to pollution-control equipment purchases.

●EPA, the States of Minnesota, Wisconsin, and Michigan, and several citizens' groups joined in a lawsuit against Reserve Mining Company of Silver Bay, Minn., which was dumping taconite filings containing asbestos particles into western Lake Superior—the worst pollution yet known in this cleanest and largest of the Great Lakes. The asbestos-like particles in the taconite, suspected of causing cancer, were getting into local water supplies. After 10 years and millions of dollars spent by both sides on litigation, a court ruled that Reserve Mining must dump its taconite wastes in a landfill, which it is now doing.

●Other significant lawsuits include an ongoing suit against outboard Marine Corp. of Waukegan, Ill., to clean up the PCBs it had previously released into the sediment of Waukegan Harbor on Lake Michigan, and a suit against the city of Gary, Ind., for incomplete treatment of its sewage.

CONTROLLING NONPOINT-SOURCE POLLUTION. You can't put a scrubber on a cornfield, or on the wind. But progress has begun in the treatment of nonpoint-source pollution.

A $1.8 million grant from the Great Lakes National Program Office funded the first agricultural nonpoint-source control project, at Black Creek in eastern Indiana. Pollutant-laden sedimet from the Black Creek Basin was

being eroded heavily into the Maumee River, which in turn flows into Lake Erie. Although the work was done in the mid-1970s, the project is still one of the best of its kind for showing the impact of agricultural practices on water quality.

The project's purpose was to test farming methods that would reduce soil erosion and then communicate test results to farmers. The tests showed that erosion could be minimized with techniques such as reducing the frequency of tilling soil, plowing with implements that only break the soil for seeding and don't turn it over, and leaving crop residue on the ground.

The Great Lakes National Program Office has used much of its demonstration grant money to fund nonpoint-source pollution-control projects. More than $3 million went to the Red Clay Project in a five-county area of the western Lake Superior Basin. That area was suffering heavy erosion and deteriorating water quality from the red clay that is characteristic of the region. Federal and local officials established special programs that included increased livestock control, so that animal waste wouldn't get into streams, and construction of earthen dams that slowed stream velocity, reduced erosion, and captured sediment. There, too, educational programs on soil tillage techniques were presented to local farmers.

A $1.5 million grant from GLNPO paid for an urban drainage study in the city of Rochester, N.Y. In order to prevent sewer overflows, officials developed a special, porous pavement that allows water to filter into the ground rather than run into sewers and carry pollutants to the river. Other techniques tried in this study included the increase of street sweeping and alteration of sewer construction so that fewer pollutants were washed into the sewers and more water was held in the system.

Although Federal grant money has helped to start the research, nonpoint-source pollution control is still in its infancy. Major problems yet to be resolved include controlling leaking chemical wastes from hazardous dump sites, better control of sources of airborne chemicals such as PCBs and elements such as lead, and more thorough techniques in farmland erosion control. And all of these studies will cost money.

Summary

The environmental movement has changed since it first began so earnestly in the late 1960s—it has become institutionalized. Government agencies at the local, State, and Federal levels have been created and charged with the function of enforcing new laws that protect the environment. Environmental agencies in the eight States and one Canadian province bordering the Lakes, hundreds of municipalities in those States, and a dozen Federal agencies in addition to EPA—all have at least some responsibilities in helping clean up the Lakes.

The Lakes are huge, and their problems are huge as well. To divide those problems into workable responsibilities for all those different agencies requires energy and time. And money.

More money. There have been several references to money in this brochure: money for water sampling, money for research, money for grants for municipal sewage treatment, money for nonpoint-source pollution-control projects, and money for industrial bonds and loans.

The bottom line, of course, is that the taxpayers have to pay that bill. Even cleanup projects funded totally by private industry simply come back to individual citizens in the form of higher prices for products from that industry.

But, as it was suggested at the beginning of this brochure, citizens of the United States are increasingly concerned about holding down Government expenditures, not to mention their own expenses. As individuals and as a Nation, we may have to make choices about how much more environmental cleaning up we can afford, or how much more development our environment can tolerate.

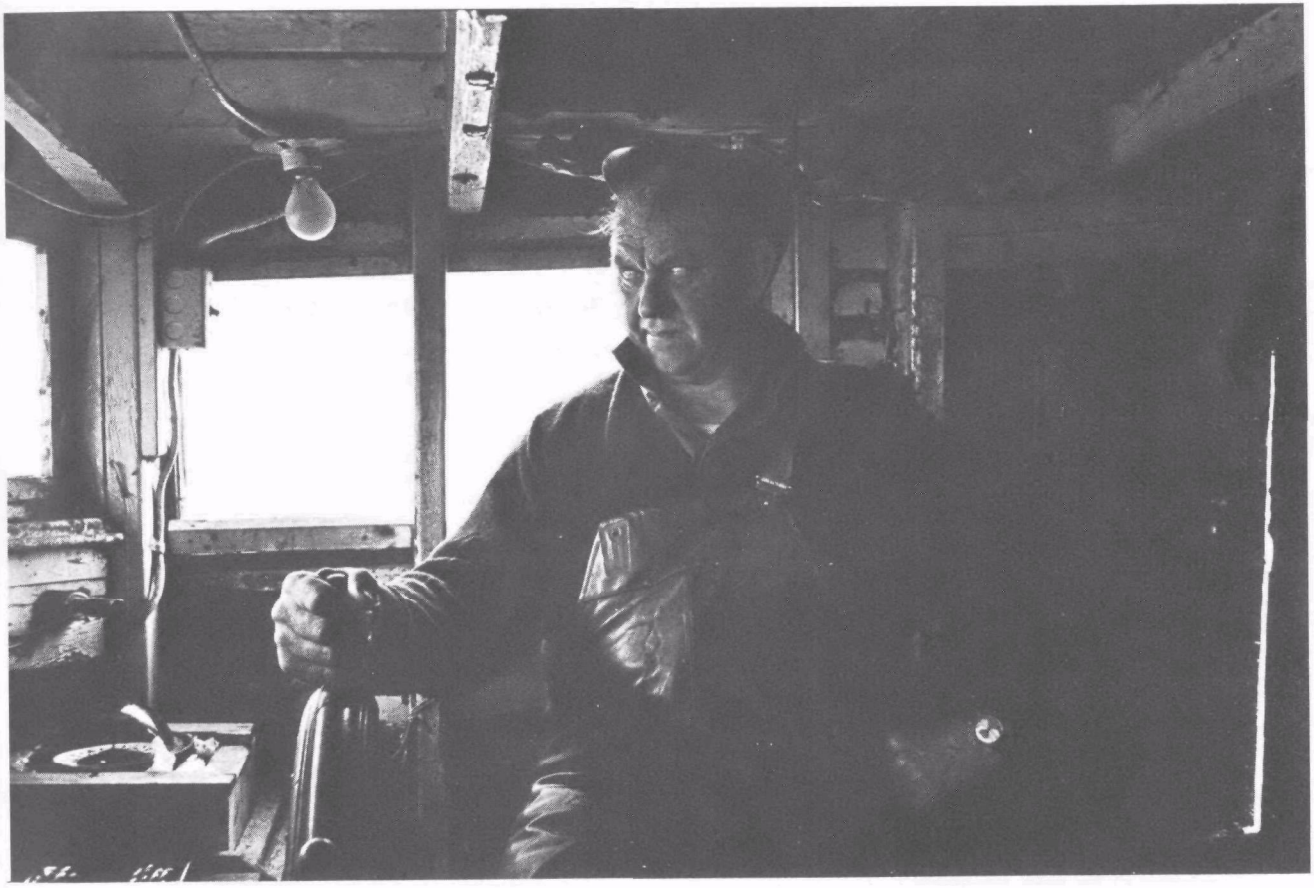
Our environment has changed. Just as the Indians were a part of the Great Lakes ecosystem in the days of Étienne Brulé, modern human development along the Lakes and the Lakes themselves are part of the same ecosystem, too. And the health of the whole ecosystem is affected by each of its parts.

The Great Lakes ecosystem is still being studied. After the considerable Lakes cleanup effort of the 1970s—the permit program, the grants programs, Lake

monitoring—a major EPA emphasis in the 1980s is toward more investigations: into the increasingly complicated toxic chemicals of private industry, into the discovery and cataloguing of new pollutants, into the design of new control mechanisms. EPA must examine and understand the responses of living creatures to toxic materials, the sources of toxics and just how harmful they are, at what levels they exist in nature, how they accumulate, and the effect of multiple toxics. This is increasingly esoteric work.

And, as scientific investigations become more sophisticated and complex, they move away from the public's understanding of pollution and pollution control. Fifteen years ago, nearly everyone was sympathetic to and involved with the issue of banning DDT—but since then we have been plagued with PCBs, PBBs, HCBs. How many alphabet-soup problems can people be expected to decipher before turning off the whole subject?

While technology is becoming more complex, the pollutants harder to see, and their names harder to pronounce, the central issue remains the same. We must balance our use of the Lakes and their tributaries with the need to protect their quality. To do this, we need organizations to identify new contaminants, monitor quality, and control Lake uses, especially for waste disposal. But above all, protection of the Lakes requires public support from informed and concerned citizens.



1. Sun passes daily over the world's greatest freshwater resource, the Great Lakes.
2. Text.
3. A snow-fed capillary of Lake Superior.
4. Swift rivers deepen gorges originally dug by ice-age glaciers in the Great Lakes Basin.
5. Winter rapids near Hancock, Michigan.
6. The Genesee River falls, suddenly, on its way to Lake Ontario through New York.
7. Icy surf has pounded White Fish Point, Michigan since the Lakes were formed.
8. Prevailing winds forced these pines to grow stooped on a Georgian Bay island, Lake Huron.
9. Water erosion sculpted the rocky formations giving name to Flower Pot Island near Tobermory, Ontario.
10. Constant winds send sands creeping over trees at the Indiana Dunes.
11. Visitors climb Sleeping Bear Dunes on the Leelanau Peninsula, Michigan.
12. Sun-pierced calm on Old Woman Bay near Wawa, Ontario.
13. Text.
14. Cutting a wake on Lake Erie.
15. Basking on a Lake Michigan shore.
16. Riding in the surf of Lake Huron.
17. Looking over Lake Superior from Grand Sable Dunes.
18. Sporting canoeists on Lake Ontario.
19. Playing on the shore of Lake Ontario near Oswego, New York.
20. Gaming on a winter pond near Toronto, Ontario.
21. Landing geese on their way through New York.
22. Visiting Point Pelee Bird Sanctuary, Lake Erie.
23. Pondering a tourist scene near Pointe Au Baril, Lake Huron.
24. Bathing on the Georgian Bay, Lake Huron.
25. Ascending Scarborough Bluffs on Lake Ontario.
26. Mackinac Bridge arches over the juncture of of Lakes Huron and Michigan.
27. On the St. Lawrence River, connecting America's inland seas with worldwide ocean commerce.
28. Breaking free of ice in the St. Marys River near Sault Sainte Marie.
29. A familiar cityscape at the center of the Great Lakes megalopolis: Chicago.
30. A country church in Michigan, near Lake Superior.
31. Once-grand boathouse at Thousand Islands, New York.
32. Real estate promotion in Great Lakes vacationland.
33. King Island, a private domain in Georgian Bay.
34. A lighthouse perches on a point of Lake Huron.
35. Scarborough Bluffs shield Toronto from Lake Ontario.
36. The industrial belt south of Lake Michigan.
37. Over Gary, Indiana's refineries.
38. Cargo transits the Soo Locks daily, at Sault Sainte Marie.
39. Portrait of a woman near Erie, Pennsylvania.
40. An oil pump on the lower peninsula of Michigan.
41. One of the plants bringing power to the Lakes.
42. Text.
43. A fisherman guides his boat through the Straits of Mackinac.
44. Portrait of a Manitolian Island fisherman, Lake Huron.
45. A Lake Ontario waterman makes his point.
46. Fishing boat returning to Door Peninsula, Wisconsin.
47. Part of the catch.
48. Near Gary, Indiana.
49. Near Rochester, New York.
50. Near Lake Huron.
51. Near Cleveland, Ohio.
52. The bare essentials, along Lake Michigan.
53. Conference on the shore of Lake Erie.
54. Text.
55. A landscape near Lake Huron.
56. Northern Illinois farmlands.
57. A farm near Kingston on Lake Ontario.
58. A Door County farmer with his corn.
59. A rural scene off Lake Ontario.
60. A farmer waits for help.
61. Portrait of Rodney Monague, an Ojibway chief, Christian Island, Lake Huron.
62. In the home of an Ojibway elder.
63. An Ojibway Indian girl.
64. An Ojibway mother and son.
65. A milkweed sheds its seed to sprout again along the Great Lakes.
66. Credit text.