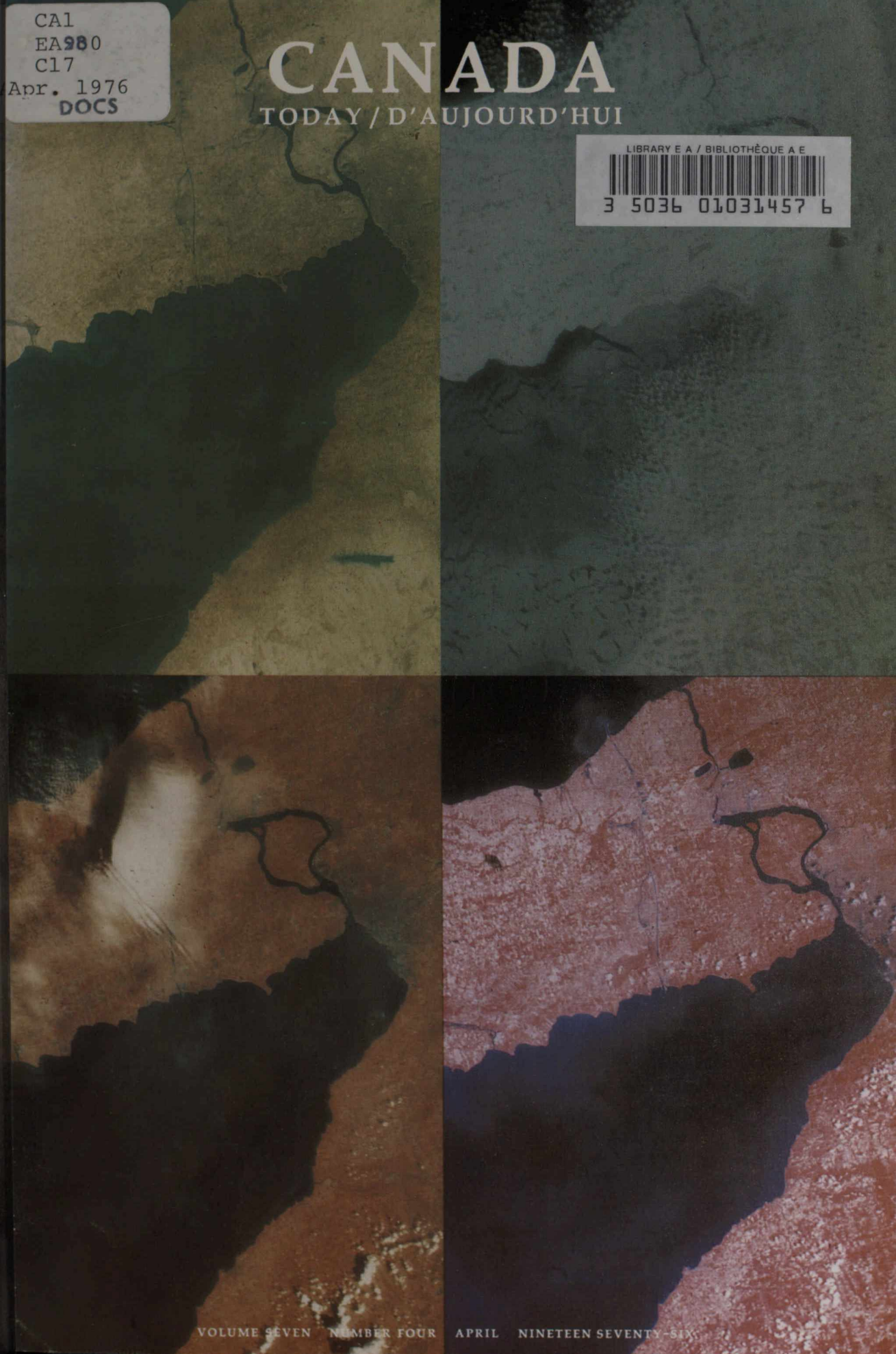
CANADA

TODAY / D'AUJOURD'HUI



VOLUME SEVEN NUMBER FOUR APRIL NINETEEN SEVENTY-SIX

The Great (Polluted) Lakes

The Great Lakes are accidents of time and temperature—melted ice in rock basins. If the weather stayed cold enough they would freeze completely again; if it grew hot enough they would boil away.

They are the most impressive grouping of big lakes on earth. Viewed from a whaleboat, the smallest, Ontario, seems an ocean. But viewed (as they are every thirty minutes) from a satellite 22,300 miles out, Superior is an inkblot, Ontario a drop of spilled tea.

They are owned by the United States and Canada. The future of the Lakes, like the depths of Erie, is hazy and dim. It depends on the continued and expensive efforts of two national, one provincial and eight state governments.

A commitment, called formally the Great Lakes Water Quality Agreement, was made in 1972 when Canada and the US agreed to spend billions of dollars to restore Great Lakes waters for fish and man. The third annual report on the progress of the rehabilitation was issued by the International Joint Commission on March 11, 1976, and it is a sober though not an entirely pessimistic document.

In this issue of CANADA TODAY/D'AUJOURD'HUI, we look at the ability of the two countries to adjust together to the new world of instant communications and novel forms of pollution. Present problems sometimes seem almost beyond solution, but we have data and analytical tools, most particularly earth observation satellites, that give us new abilities, the extent of which we still cannot grasp.

These satellites were built and launched by the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) in the United States. They do not look alike and they move in different orbits at different altitudes, but they resemble each other in basics. They take pictures without cameras. They use sensors to measure reflected light and heat and then produce the results in the form of lists of numbers. The numbers, each one a measurement of heat or light intensity, are sent by radio to receiving stations throughout the world.

Canada's involvement is extensive. To receive data from the Landsat satellites, Canada has developed its own receiving equipment at Prince Albert, Saskatchewan and Shoe Cove, Newfoundland, which gives instant television and photographic read-outs as the satellites pass. The station now under construction at Shoe Cove will be semi-mobile—ideal for use in developing nations.

Satellite information means different things to different people. It assists in hunting mineral deposits, mapping unmapped country, planning highways, measuring agricultural productivity, predicting the weather and navigating Arctic waters. Our emphasis is on its role in monitoring polluted waters. Hopefully within two decades the clear satellite pictures will be of five clear lakes.

Cover: *Satellite pictures reflect the changing seasons. These four show the Niagara Peninsula in winter, spring, summer and fall. Summer vegetation is red, snow is white, and the bare ground of fall is pale tan.*

Right: *The varying shades of a Landsat picture can show the varying states of Lake waters. In this picture of Lakes Ontario and Erie, turbidity is white and biotic materials are light brown. The suggestive shades are primary pollution clues which are varified by close examination — the "ground truth." Scientists believe that satellite data will be an increasingly important tool in monitoring water quality.*

A Short History of the Causes of Our Joint Concern

The Lakes began about 14,000 years ago when the edges of the glaciers melted and left puddles behind. The ones we now call Michigan and Erie were the first. Erie, the larger, included parts of what are now Huron and Ontario. Superior appeared, Michigan grew, Erie shrank and Huron and Ontario were linked. Another lake, the one which would be called Champlain, covered an enormous expanse and then, as the eons passed, dwindled to a wet splinter.

Seventy-five hundred years before the birth of Christ the biggest lake of all took shape, a huge triangle of icy water north of Ontario and east of Superior. It would dry up completely long before the first European mapmaker arrived to give it a name.

In the last two hundred years the Lakes have changed more than in the previous five thousand, and in the last three decades the change has accelerated disastrously. They have been polluted by man's droppings—slags and chemicals from his plants, acids from his mills, sewage from his cities and most recently, algae nurtured by his laundry detergents.

As a result the Lakes have given the United States and Canada a bond as well as a boundary.

In 1912 the two governments asked the International Joint Commission (which had just begun operations) to consider the pollution which was causing an increasing number of typhoid fever cases. In 1918 the Commission reported that the pollution responsible was "very intense along the

What Pollutes the Lakes?

We are essentially concerned with man-made pollution from city sewage, industrial waste and farm run-off. Most comes out of a sewer pipe or a plant outlet, but some is carried by wind or rain. Each type requires its own solution. Listed below are the pollutants which significantly injure the Great Lakes:

Phosphorous Concentrations: Most phosphorus comes from laundry detergents. The suds from the family wash go down the drain and into the rivers and lakes. It also comes from farm fertilizers. Phosphorus feeds plants, including algae, and an increase in phosphorus means an increase in algae. Rotting algae falls to the lower depths, consumes the oxygen in the water and kills fish. When algae overwhelms the fish—as in Lake Erie—the water is in a state called eutrophication. Phosphorus may be controlled by treating sewage or (as it is in Canada, three states and several US municipalities) by limiting its quantity in detergents.

Bacterial Matter: The most frequent bacterial products of sewage are coliforms which do not cause diseases. Their presence however indicates the possible presence of dangerous organisms, more difficult to detect, such as those causing typhoid, dysentery and cholera. Bacteria can be removed or killed by chemical treatment or other methods, but they still pose serious problems in many Lake areas.

Industrial Discharges: These include phenols, asbestos, cyanide, oil, mercury, wood fibers and a rich variety of other wastes. In the US, government permits which limit effluents and set deadlines for compliance have been issued for 292 of the 312 major industrial dischargers.

Toxic-Organic Contaminants: These come to the Lakes through aerial spraying, industrial discharge and farm run-off. They are ingested by fish and by people who eat the fish. Polychlorinated biphenyls (PCBs) have been monitored since 1970, and Lake Michigan fish show residues above the recognized safe level. Significant levels have also been reported in Lake Ontario. Occasional checks in other Lakes indicate Superior and Huron levels are low. Those in Erie are generally low too, though high levels have been found in some carp. DDT levels have dropped spectacularly in the last six years, since the restriction of its use both in Canada and the United States.

Thermal: This does not involve substances but temperatures. Water is used in many industries for cooling—cool water is removed and warm water returned. Many organisms are harmed by heat. Trout, for example, are cold-water fish and if warm water is added to their river they will depart or be killed. The eggs of whitefish will not hatch if the water is above 4°C (39°F).

shores of the Detroit and Niagara Rivers." In 1920 it was given authority to take corrective measures, but by then the advent of chlorination had provided an easy solution for the immediate problem.

In 1946 the two governments asked the Commission to study the causes and effects of pollution in the streams flowing in and out of the lower Lakes—the St. Marys, St. Clair, Detroit and Niagara Rivers—and in 1950 the Commission made specific remedial recommendations. The immediate situation improved, but the long-range problems remained and in October 1964 the Commission was asked to report on the state and prospects of Lake Erie and Lake Ontario. The result was the 1972 Great Lakes Water Quality Agreement. But the difficulties in implementation were underestimated. The recent annual report notes, "The Commission believes that the parties . . . could not have foreseen the magnitude of the problems of clean-up and the length of time that clean-up would take." It may take a decade or more to achieve the basic goals.

Status Reports

Without treatment, pollution could kill the Great Lakes. But now they are neither dead nor useless, and the damage done to Erie has been often exaggerated.

Cities along the Lakes' edges have improved their sewage plants. Canada began with a clear lead; the Province of Ontario has adequate sewage treatment for eighty-five per cent of its population. Major facilities for most of the untreated (or inadequately treated) areas will be completed this year. Thunder Bay's will be delayed until 1977. In the United States some sixty per cent of the population has adequate facilities and the remaining programs are under construction.

[LAKE ERIE]

Last summer Lake Erie swimmers noticed that the water seemed cleaner than it had the summer before.

They were right—from their limited point of view. Major sewage plant construction is well under way. Detroit and Buffalo will complete their projects by 1979. Cleveland will not complete its projects before 1981.

Chloride concentrations have decreased, but the Lake's overall condition has deteriorated, not from bacteria but from phosphorus. Erie, viewed from the shore, seems longer and wider than Ontario and as long as Huron, but it has far less water than either. The Lake is in effect three basins overlapping—a large central one, a deeper eastern one and a shallow one in the west. The deepest point is only 210 feet down. The big shallow central basin is in bad shape. In 1972 an area of 2,547 square miles there was anoxic—algae stimulated by the phosphorus (from detergents and other sources) had died and its decomposition had consumed the oxygen in the lower, cooler waters. In dying it also produced more phosphorus, stimulating the growth of more algae. Last summer 4,246 square miles were anoxic. Anoxia kills fish. The improved sewage treatment facilities have greatly reduced the flow of detergents but the run-off of phosphorus-based fertilizers from farm land has increased. Scientists now believe that only the total elimination of the flow of new phosphorus into Erie will reverse the anoxia.

The prospect is for slow but steady improvement, and the probability, that the goal of the US's Water Pollution Control Act amendments—a lake clean enough for swimmers and fish by 1983—will be met. The long-term prospects may be less pleasant. Increased population and industrial growth could send Erie back to its current state after the year 2020.

Ecologist Robert G. Rolan believes, "by that time we will have new technologies or will no longer be discharging into the Lake."

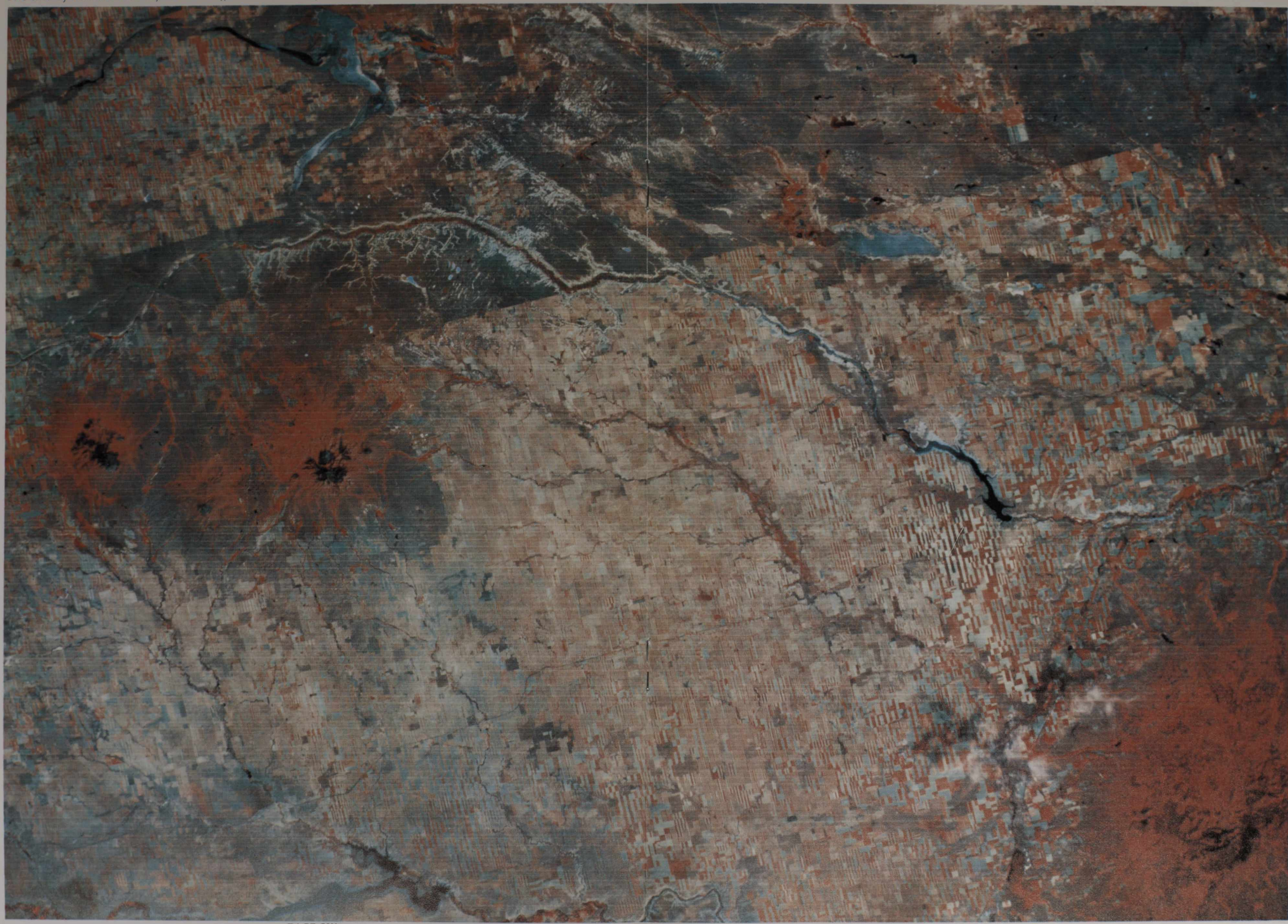
[LAKE MICHIGAN]

The waters of Lake Michigan, 923 feet deep, are generally of high quality. Three areas have problems—Green Bay, Milwaukee Harbor and the Indiana Harbor Ship Canal. The last major treatment plant in the Fox River Valley area near Green Bay will be in operation at Fond du Lac by July 1977. Steel and chemical plants in Calumet in the Indiana Harbor Ship Canal area have resisted compliance with regulations and their cases are now before the courts.

[LAKE ONTARIO]

Ontario, the second most threatened Lake, has shown early signs of oxygen deficiency. It is polluted not only by its own industries and municipalities but also by the waters from the other Lakes, most particularly Erie. The consolidation of thirty-three small treatment plants in the

The US-Canadian border is often termed invisible, but in a satellite view it is easily discerned for long stretches. The border here, between the Canadian prairies and the US plains, is as distinct as the edge of a rug on a floor. The line of demarcation reflects the different land use patterns. The intense red is vegetation on mountains.



When Can We All Go Swimming? Is It OK to Drink Erie Water? Is It Wise to Eat a Lake Michigan Fish?

PEOPLE can now swim, boat and fish in each of the Great Lakes. Two—Superior and Huron—are totally available for all kinds of recreation. The others have problem areas where some types of recreation may be unsafe or undesirable.

Ontario and Erie have recovered from the worst effects of intense pollution and now open their beaches for longer periods in the summer.

Michigan still has unsafe and undesirable areas, and it will take longer to respond to treatment than the others because it is a dead-end body of water.

The overall municipal sewage treatment program for the Lakes will be complete within five to ten years. It should be safe to swim at all beaches by then, though rotting algae may still make swimming unpleasant. The algae problem should be eliminated by 1986.

ALL THE LAKES are now desirable sources of raw drinking water. Away from the shoreline and local pollution sources, the water, even in Erie, is normally potable without treatment—though drinking it is not recommended. Great Lake water used for municipal drinking supplies requires only minimal treatment.

SOME LAKE FISH contain pollutants in their bodies in a concentrated form. There is no immediate solution to the problem and it may take twenty years to reduce it. However, in all cases, the occasional angler who catches and eats fish only a few times a year has nothing to worry about. It is only a problem in communities (such as several Indian ones) where fish from the Lakes form a major part of one's diet.

Rochester Embayment area into four regional ones has had a positive effect.

The Toronto Harbour and waterfront areas have had high sewage pollution, but the completion of a mid-city sewer interceptor program last year contributed significantly to the solution of the problem. Waste treatment projects at steel companies in Hamilton and improved sewage treatment facilities have also helped matters.

[LAKE SUPERIOR]

Superior is a liquid wedge driven 1,333 feet into the earth. It will almost surely remain the healthiest of the Great Lakes because its volume is so huge—2,858 cubic miles of water. The major problem areas are in Duluth-Superior Harbor, Silver Bay, Thunder Bay and some locations along the southern shore. By mid-1977 the nine sewage treatment plants in the Duluth area will be replaced by a single plant and the inflow of phosphorus will be significantly lowered. The city of Thunder Bay has scheduled two new sewage treatment plants, and waste loadings from that area's mills are being reduced.

[LAKE HURON]

Huron is smaller than Superior, but it is big enough and deep enough to generally cleanse itself. On the US side Bay City, Saginaw, Midland and Flint all discharge sewage into Saginaw Bay, and the Dow Chemical and Monitor Sugar Companies discharge industrial waste. All have remedial programs under way and the Bay water quality is expected to improve. On the Canadian side sewage and waste from Eddy Forest Products Ltd. has had an apparent effect on the taste of fish taken near the mouth of the Spanish River. Remedial programs are under study.

The Difficulties of Putting New Fish in Old Waters

A "fish-at-your-doorstep" program in two of the Great Lakes has run into difficulties. The Ontario Natural Resources Ministry and similar agencies in the United States planted Coho salmon in Lakes Ontario and Michigan, and by the early 70's they were abundant in both. Fishermen stood elbow to elbow at the Credit River and other Lake Ontario tributaries and caught salmon ten pounds

and over. Last year high levels of polychlorinated biphenyls were found in the salmon in both Lakes. The Michigan State Government suggested that no one eat such fish more than once a week and that women of child-bearing age eat none at all. New York State warned its Lake Ontario fishermen that salmon near the US shore carried five to nine parts of PCBs per million—any level above five parts is considered alarming. Salmon caught in the Toronto Harbour area have shown ten parts per million and the Ontario Health Ministry has said that about one-half of the fish tested from the Credit River exceed the five ppm guideline.

A Merry Note from England

Pollution can be conquered. The River Thames had been polluted for hundreds of years. In 1957 there were no fish in a forty-mile stretch around London and the river smelled so strongly that Members of Parliament, catching a breath of air on the terrace of the House of Commons, were taken ill.

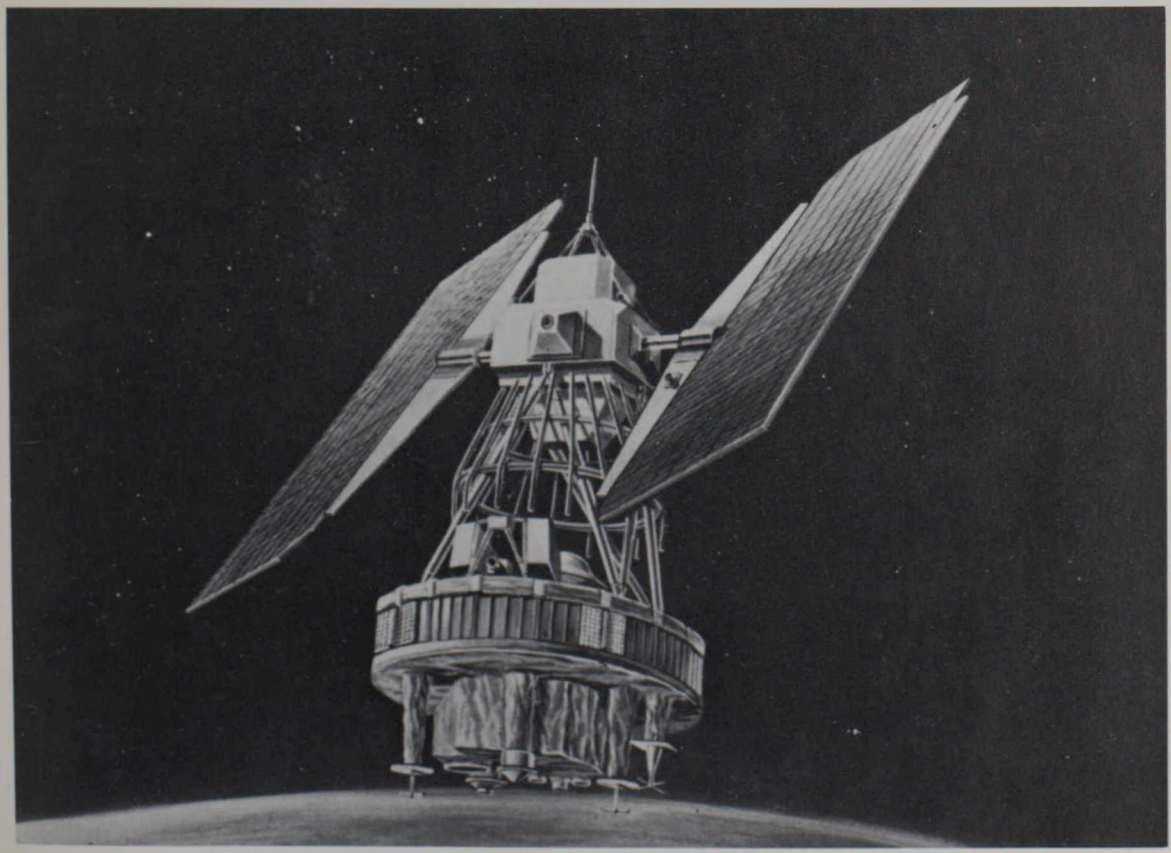
Stringent controls on the release of effluents has produced dramatic improvements. By 1967-68 there were forty-two species of fish, including sea-run trout, in the forty-mile stretch. By 1974 there were sixty-seven species, including the first Atlantic salmon to be caught in the Thames for 141 years.

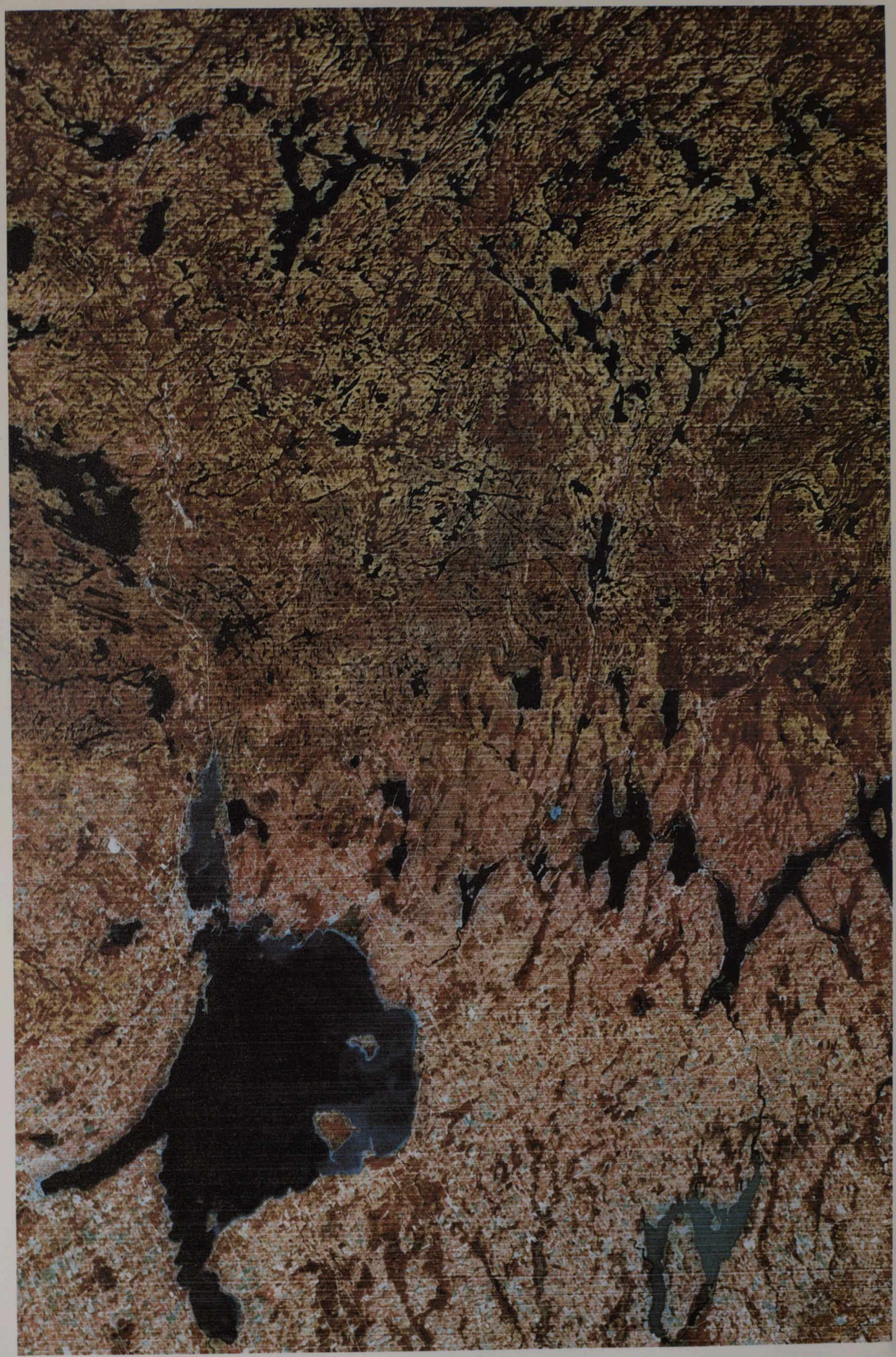
Sensors in the Sky

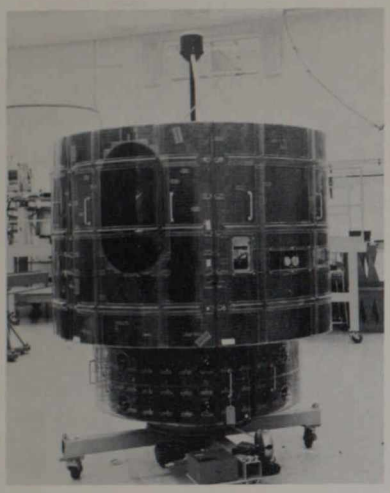
[LANDSAT]

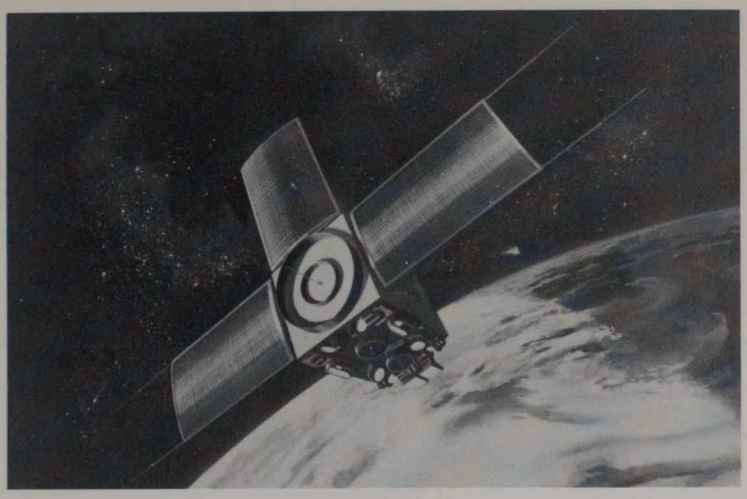
Two NASA Landsat satellites are studying the whole world.Landsat 1 (first called ERTS for Earth Resources Technology Satellite) was launched in July 1972 in a polar orbit 569 miles high. The second, Landsat 2, followed in January 1975.

A Landsat looks like a buoy—broad and round at the base, narrowing to an octagonal cap. Solar paddles extend from two sides. A multi-









spectral scanner (MSS) on the bottom scans the earth's surface with an oscillating flat mirror, which reflects light from below to glass fibers and then through filters. The filters separate it into four bands on the colour spectrum—two in the visible range and two in infrared, which is not visible to the human eye. The bands can be analyzed separately or in combinations. One band of infrared light, coming from the sun, is strongly absorbed by clean water and little or none of it is reflected. A picture from this infrared band shows clear, deep water as black, in sharp contrast to vegetation on the shore, which reflects the infrared light strongly.

By using colour filters in various combinations, maps (such as those in this issue of CANADA TODAY/D'AUJOURD'HUI) can be contrived which emphasize particular conditions. Clear water can be easily distinguished from turbid water, and (since the satellite pictures are used in many scientific disciplines) sick corn can be distinguished from healthy and limestone beds from glaciated areas.

Pictures taken of the Great Lakes show, in contrasting shades, clear areas, natural turbidity and sources of municipal and industrial effluents. They show, in the form of long straight lines, areas where surface water is sinking to mix with water in the deeper layers.

This is a wide view of Ontario rocks and waters as they were on October 9, 1973, with Lake Simcoe at the lower left. The enhanced colour shows the value of the satellites to mineral hunters. Mineral deposits are often indicated by the juxtaposition of different rock formations. The Laurentian uplands—old primeval rock—show yellow; the limestone beds in the middle, reddish brown; the glaciated area to the south is a mixture of red, blue and green.

All colour photographs and the NASA Landsat photograph are courtesy of the US Geological Survey, EROS Program. All other photographs are from the US Department of Commerce, National Oceanic and Atmospheric Administration.

[NOAA]

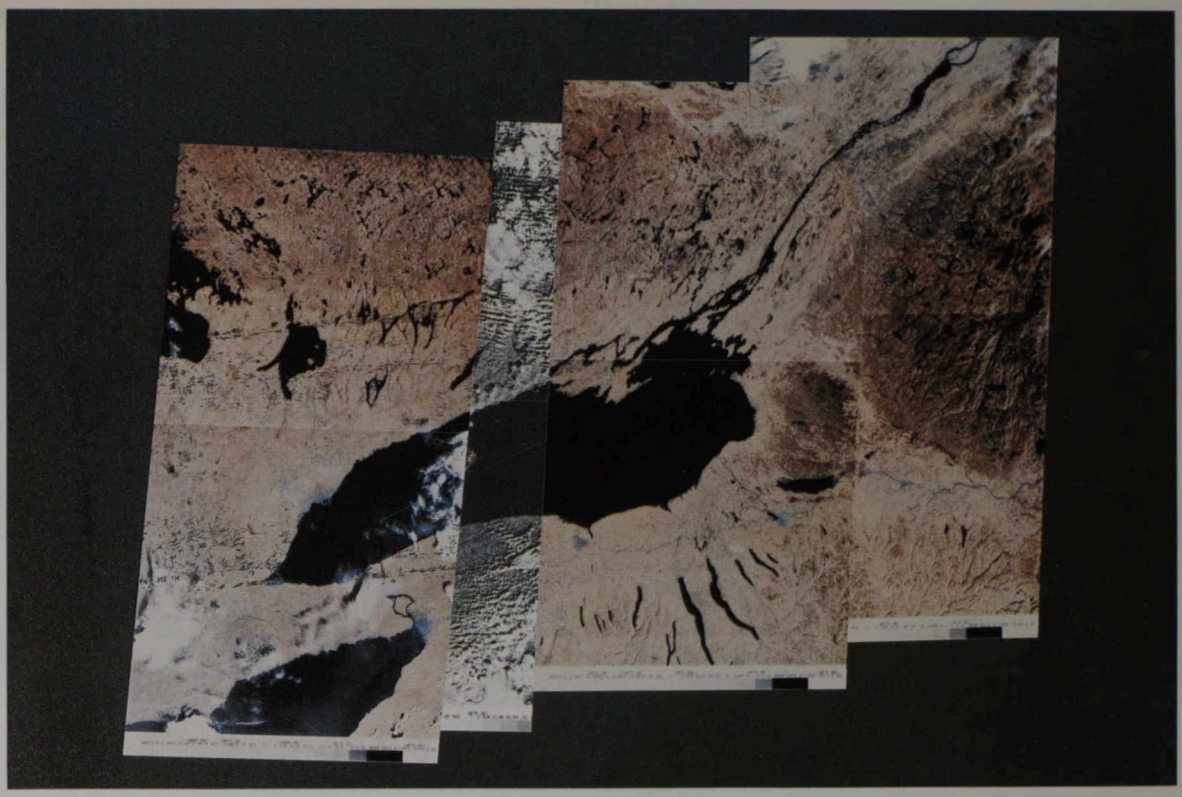
NOAA-4 which looks like a flying air conditioner with three fixed, unflappable wings, circles the earth at an altitude of 902 miles once every 114 minutes. It passes over the polar regions and —since the earth is rotating beneath it—moves always to the west.

Each NOAA-type satellite carries a basic scanning radiometer (SR), a scanner which measures radiation precisely over a limited area (the very high resolution radiometer or VHRR) and one which gives a vertical temperature profile (VTPR).

The VHRR can be used to measure the area of snow cover in critical areas, such as the St. John River Basin of New Brunswick, to prepare for spring flooding. VTPR data helps in the prediction of rainfall.

[GOES]

NOAA's GOES satellites (Geostationary Operational Environmental Satellite) are way out. Two are positioned 22,300 miles above the equator (one above the western Atlantic, one the eastern Pacific), and since their orbital movements are synchronized with the earth's rotation, they seem to stay still. Each is shaped like two drums, a bass on top of a snare. Sensors are lined around the big drum's circumference—earth sensor, x-ray sensor, energetic particle sensor and infrared spin-scan radiometer. A magnetometer sensor, shaped like a bass drumstick, is perpendicular to the top drum's flat surface. GOES take the big picture—they provide visible and infrared pictures of all of North and South America every thirty minutes and are particularly useful in monitoring the weather and warning of hurricanes and other dangerous storms.



Landsat moves north to south over the continent, and as the earth turns, the successive pictures move west. Those taken on sequential passages can be joined to form a wide map mosaic. This one is of the Lake Ontario basin. The strip in the center was covered by clouds during that overflight. A similar section from another passage was inserted to give the map context. Each strip was collected in about fifty seconds. The dark brown to the east is the Adirondack Mountains, and to the north, the Laurentians.

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