

University of Windsor

Scholarship at UWindsor

International Joint Commission (IJC) Digital
Archive

International Joint Commission

1991-08-01

Cleaning Up Our Great Lakes: A Report from the Water Quality Board to the International Joint Commission on Toxic Substances in the Great Lakes Basin Ecosystem

Great Lakes Water Quality Board

Follow this and additional works at: <https://scholar.uwindsor.ca/ijcarchive>

Recommended Citation

Great Lakes Water Quality Board (1991). Cleaning Up Our Great Lakes: A Report from the Water Quality Board to the International Joint Commission on Toxic Substances in the Great Lakes Basin Ecosystem. *International Joint Commission (IJC) Digital Archive*. <https://scholar.uwindsor.ca/ijcarchive/464>

This Report is brought to you for free and open access by the International Joint Commission at Scholarship at UWindsor. It has been accepted for inclusion in International Joint Commission (IJC) Digital Archive by an authorized administrator of Scholarship at UWindsor. For more information, please contact scholarship@uwindsor.ca.



International Joint Commission
Commission mixte internationale

00464

GLC ZZ... IJC-70 9143 ENG



Cleaning up **OUR GREAT LAKES**

A REPORT ON TOXIC SUBSTANCES IN THE GREAT LAKES BASIN ECOSYSTEM

CLEANING UP OUR GREAT LAKES
A REPORT FROM
THE WATER QUALITY BOARD TO
THE INTERNATIONAL JOINT COMMISSION
ON TOXIC SUBSTANCES IN
THE GREAT LAKES BASIN ECOSYSTEM

AUGUST, 1991



PRINTED IN CANADA
ON RECYCLED PAPER

ISBN 1-895085 - 26 - 8

WATER QUALITY BOARD REPORT COVER DESIGN

THE COVER CENTERS AROUND A CHILD-LIKE ILLUSTRATION USING A PRIMARY COLOUR SCHEME TO PORTRAY A POSITIVE VISION OF THE STATE OF THE GREAT LAKES. THE ILLUSTRATION SHOWS THE ELEMENTS IN OUR ENVIRONMENT-EARTH, AIR AND WATER. THE PLAY TOYS- THE PAIL, SHOVEL AND TRUCK LEFT ON THE BEACH WITHOUT THE CHILD - SIGNIFY A CHILD WHO WAS ONCE AT PLAY. THESE TOYS ARE SUBTLY EMPHASIZED AND ENLARGED ACROSS THE ENTIRE BACKGROUND OF THE COVER TO CREATE BALANCE AND ADDED INTEREST.

THE COVER'S MESSAGE IS THAT OUR CHILDREN HAVE BEEN LEFT WITH A LEGACY: AS CHILDREN, THEY PLAY AND ENJOY THE GREAT LAKES WITH A CHILD'S TOOLS, BUT LATER AS ADULTS THEY WILL BE FACED WITH A MAJOR TASK TO IMPROVE THE QUALITY AND CONDITION OF OUR GREAT LAKES. THE POSITIVE IMAGE OF THE COVER IS CONTRASTED BY PHOTOGRAPHS WITHIN THE REPORT, AS THEY DEPICT THE REALITIES AND EFFECTS OF PERSISTENT TOXIC SUBSTANCES ON THE GREAT LAKES.

1870
The first of the
series of the
series of the
series of the

1870

1870

1870

1870

1870



International Joint Commission
Commission mixte internationale

GREAT LAKES WATER QUALITY BOARD

September 1991

International Joint Commission
Canada and United States

Commissioners:

The Water Quality Board hereby submits its 1991 report to the International Joint Commission. The report responds to the priorities statement dated June 7, 1990 and is particularly oriented to the state of knowledge on toxic substances and persistent toxic substances.

Respectfully,

V. V. Adamkus
United States Chair

D. L. Egar
Canadian Chair



Faint text centered below the stamp, possibly a title or header.

GRAND LAKES WATER QUALITY BOARD

Faint text on the left side of the page.

Faint text on the right side of the page.

Faint text on the right side of the page.

Faint text on the right side of the page.

Main body of faint text, likely a letter or report content.

Faint signature or stamp on the bottom left.

Faint text below the signature on the bottom left.

Large, prominent signature in the center of the page.

Faint text below the large signature on the right.

THE INTERNATIONAL JOINT COMMISSION

THE INTERNATIONAL JOINT COMMISSION (IJC) IS A PERMANENT, SIX-MEMBER BODY THAT WAS CREATED BY THE UNITED STATES AND GREAT BRITAIN ON BEHALF OF CANADA UNDER THE BOUNDARY WATERS TREATY OF 1909. THREE OF ITS MEMBERS ARE APPOINTED BY THE PRESIDENT OF THE UNITED STATES AND THREE ARE APPOINTED BY THE PRIME MINISTER OF CANADA. THIS COMMISSION, WHICH HAS OFFICES IN WASHINGTON, D.C., OTTAWA AND WINDSOR, ONTARIO, HAS BEEN MEETING SINCE 1912 TO ADVISE THE TWO GOVERNMENTS ON BOUNDARY WATER ISSUES.

The Commission rules on applications for the use, obstruction or diversion of boundary waters between Canada and the United States. It also investigates and advises on boundary water issues jointly referred by the two governments.

Over the past two decades, one of the major tasks of the IJC has been to report regularly on progress in cleaning up the Great Lakes, under the 1972 and 1978 Great Lakes Water Quality Agreements and the 1987 Protocol to the 1978 Agreement.

The Water Quality Board is an 18-member advisory board to the IJC. The Board consists of an equal number of members from Canada and the United States; from the two Federal governments and from the governments of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin, and the provinces of Ontario and Quebec.

ACKNOWLEDGEMENTS

THE WATER QUALITY BOARD EXPRESSES ITS APPRECIATION TO MR. MICHAEL KEATING FOR PREPARING THIS REPORT. HE HAS DRAWN UPON THE WORK DONE BY A NUMBER OF OTHER IJC BOARDS AND EXPERT GROUPS. THESE INCLUDE THE SCIENCE ADVISORY BOARD, VIRTUAL ELIMINATION TASK FORCE, STATE OF GREAT LAKES ECOSYSTEM TASK FORCE AND THE WORK OF A NUMBER OF CONSULTANTS TO THE COMMISSION.

This report also draws on, "Toxic Chemicals in the Great Lakes and Associated Effects," a report by Environment Canada, the Department of Fisheries and Oceans and Health and Welfare Canada, and, "A Prescription for Healthy Great Lakes," by the National Wildlife Federation and the Canadian Institute for Law and Policy.

The International Joint Commission

The International Joint Commission (IJC) was established in 1888 to resolve disputes between the United States and Great Britain concerning the St. Lawrence River. The IJC was created by the International Great Lakes and St. Lawrence River Commission Act of 1888, which was signed by President Grover Cleveland and Queen Victoria. The IJC's mandate was to settle any disputes that might arise between the two countries concerning the river and its waters.

The Commission was given the authority to investigate and report on any disputes that might arise between the two countries concerning the river and its waters. It also has the authority to make recommendations to the governments of the two countries concerning the resolution of such disputes.

Over the years, the IJC has been instrumental in resolving numerous disputes between the two countries concerning the river and its waters. Some of the most notable disputes that the IJC has resolved include the 1912 and 1927 Great Lakes flooding, the 1957 St. Lawrence River flooding, and the 1977 St. Lawrence River flooding.

The IJC has also been instrumental in promoting cooperation between the two countries concerning the river and its waters. For example, the IJC has been instrumental in the development of the 1984 Great Lakes Water Quality Agreement, which is a landmark agreement that sets standards for the protection of the Great Lakes and their waters.

ACKNOWLEDGEMENTS

The IJC would like to thank the following individuals and organizations for their assistance and support in the preparation of this report: [List of names and organizations]

This report was prepared by the IJC staff in the Great Lakes and St. Lawrence River Division. The IJC staff would like to thank the following individuals for their assistance and support in the preparation of this report: [List of names]

PREFACE **CONTENTS**

THE WATER QUALITY BOARD BELIEVES THAT PERSISTENT TOXIC SUBSTANCES POSE THE GREATEST CURRENT THREAT TO THE GREAT LAKES ECOSYSTEM. THE INTENT OF THIS REPORT IS TO PROVIDE THE INTERNATIONAL JOINT COMMISSION, GOVERNMENTS, BUSINESS AND THE PUBLIC WITH A CONCISE REPORT ON THE STATE OF TOXIC CONTAMINATION OF THE GREAT LAKES. IT OUTLINES THE PROBLEMS THAT REMAIN, SOME OF THE SUCCESSES THAT HAVE BEEN ACHIEVED, AND SUGGESTS SOME OPTIONS FOR THE FUTURE.

Under the direction of the IJC, the Board itself is undergoing a transition and is taking on more of a policy advisory role to the Commission and is reducing its role as an evaluator of government programs. In the future, the IJC will receive assessments of the governments' Great Lakes programs from a variety of advisory groups. These include the Science Advisory Board, IJC staff, special task forces and round tables, and public meetings.

The role of the Board is to provide advice on broad policy questions and priorities for the cleanup and future protection of the Great Lakes. In response to its new mandate, the Board has identified 15 priority issues, which it hopes to address in the coming years. These priorities are spelled out in detail in the concluding pages of this report.

In synopsis, the top priorities are the provision of advise for the next Great Lakes Water Quality Agreement; assessing and managing risk and damage to the ecosystem and dealing with varying regulatory systems. The Board thinks that governments around the lakes need to develop better integrated methods of managing watersheds and shorelines. It also considers there is a need to study the management and preservation of underground water systems in the basin.

Further priorities include a stronger involvement of municipalities, industry, agriculture and forestry in protecting the lakes; evaluation of education and information programs; development of a working definition of sustainable development of the basin; public health; the control of pollution from faraway sources; tourism; fisheries and water diversions.

Members of the Water Quality Board think that we who live around the Great Lakes are at an historic point. After years of experience with pollution, we now have a very good understanding of what must be done to restore a healthy ecosystem. We have the know-how to clean up our lakes, but to do so we now have to make serious decisions. These decisions include the banning of some chemicals, the strengthening of some regulations and the changing of some business practices and lifestyles. Although governments must pass regulations, provide some funding and co-ordinate research, much of the work of cleaning up and protecting the lakes has to be done by businesses and citizens. This means that all of us have to understand the importance of pollution prevention and learn how to practice it in our daily lives.

*THIS IS OUR VISION
OF THE GREAT LAKES
OF THE FUTURE. THIS
IS WHAT WE ARE
STRIVING TO ACHIEVE.*

*THE GREAT LAKES WATERSHED IS
A CLEAN, SAFE ENVIRONMENT
WHERE LIFE FORMS EXIST IN
HARMONY. PEOPLE TAKE PRIDE IN
THE GREAT LAKES. WE SHARE
AND LIVE AN ETHIC WHICH
RECOGNIZES THAT ENVIRONMENTAL
INTEGRITY PROVIDES THE
FOUNDATION FOR A HEALTHY
ECONOMY.*

*WE ARE SECURE IN THE
KNOWLEDGE THAT THE FISH AND
WILDLIFE ARE HEALTHY AND THE
WATER CAN BE ENJOYED BY ALL.*

*WE UNDERSTAND OUR
RESPONSIBILITY FOR ENSURING A
SELF-SUSTAINING GREAT LAKES
ECOSYSTEM. THIS IS THE EXAMPLE
WE SET FOR THE REST OF THE
WORLD AND THE LEGACY WE LEAVE
OUR CHILDREN.*

PREFACE

The Water Quality Act of 1972 was a landmark piece of legislation that established the basic framework for the nation's water quality program. It set the stage for the development of the Clean Water Act of 1977, which further strengthened the program and provided for the establishment of the National Sanitation Foundation.

The National Sanitation Foundation was established in 1970 to provide leadership and technical assistance in the development of sanitary and health programs. The Foundation's primary concern is the improvement of the nation's sanitary and health conditions, and it works to achieve this through a variety of activities, including research, education, and technical assistance.

The Foundation's work is carried out through a network of regional offices and a staff of experts in the fields of sanitation and health. The Foundation also maintains a close working relationship with the Federal Government, and it has been instrumental in the development of many of the nation's sanitary and health programs.

In addition to its work in the field of sanitation and health, the Foundation is also active in the area of water quality. The Foundation's research and technical assistance programs have been instrumental in the development of many of the nation's water quality programs, and it continues to play a leading role in this area.

The Foundation's work is supported by a variety of sources, including the Federal Government, state and local governments, and the private sector. The Foundation's commitment to the improvement of the nation's sanitary and health conditions is unwavering, and it continues to work tirelessly to achieve this goal.

The National Sanitation Foundation is a non-profit organization that is dedicated to the improvement of the nation's sanitary and health conditions. The Foundation's work is carried out through a variety of activities, including research, education, and technical assistance. The Foundation's commitment to the improvement of the nation's sanitary and health conditions is unwavering, and it continues to work tirelessly to achieve this goal.

TABLE OF CONTENTS

PREFACE	7
INTRODUCTION	11
TOXIC SUBSTANCES IN THE GREAT LAKES	14
SOURCES OF POLLUTION	17
POLLUTED AREAS	21
EXPOSURE TO AND EFFECTS OF TOXIC SUBSTANCES	22
WHAT HAS BEEN DONE TO CLEAN UP THE LAKES	27
TRENDS IN POLLUTION DISCHARGES AND LEVELS	29
CURRENT APPROACHES TO CLEANING UP THE LAKES	31
<i>TRADITIONAL APPROACH</i>	31
<i>THE ECOSYSTEM APPROACH</i>	32
<i>VIRTUAL ELIMINATION AND ZERO DISCHARGE</i>	32
CLEANING UP IN THE FUTURE	34
<i>NATURAL PROCESSES</i>	34
<i>GOVERNMENT CLEANUP PROJECTS AND PLANS</i>	34
<i>INDUSTRY</i>	36
REMEDIAL ACTION PLANS	37
<i>COSTS OF CLEANING UP OUR LAKES</i>	37
THE CHALLENGE AHEAD	39
HOW CAN WE DO A BETTER JOB OF CLEANING UP?	40
RECOMMENDATIONS	42
PRIORITIES OF THE WATER QUALITY BOARD	44
LONG TERM GOALS	45
APPENDICES	46
<i>READING LIST</i>	46
<i>CONTACT LIST</i>	47
<i>ENVIRONMENT GROUPS</i>	47

TABLE OF CONTENTS

1	Preface
11	Introduction
12	Two Substances in the Same Mixture
15	Points of Interest
21	Points of View
25	Points of View in the History of the Subject
27	What We Know About the Subject
31	There is Nothing New Under the Sun
37	Points of View in the History of the Subject
41	Points of View
42	Points of View
43	Points of View
44	Points of View
45	Points of View
46	Points of View
47	Points of View
48	Points of View
49	Points of View
50	Points of View
51	Points of View
52	Points of View
53	Points of View
54	Points of View
55	Points of View
56	Points of View
57	Points of View
58	Points of View
59	Points of View
60	Points of View
61	Points of View
62	Points of View
63	Points of View
64	Points of View
65	Points of View
66	Points of View
67	Points of View
68	Points of View
69	Points of View
70	Points of View
71	Points of View
72	Points of View
73	Points of View
74	Points of View
75	Points of View
76	Points of View
77	Points of View
78	Points of View
79	Points of View
80	Points of View
81	Points of View
82	Points of View
83	Points of View
84	Points of View
85	Points of View
86	Points of View
87	Points of View
88	Points of View
89	Points of View
90	Points of View
91	Points of View
92	Points of View
93	Points of View
94	Points of View
95	Points of View
96	Points of View
97	Points of View
98	Points of View
99	Points of View
100	Points of View

INTRODUCTION

THE GREAT LAKES ARE SO BIG THAT ASTRONAUTS COULD SEE THEM FROM THE MOON. THEIR HEADWATERS BEGIN IN THE MIDDLE OF THE CONTINENT AND FLOW 3,800 KILOMETRES TO THE ATLANTIC OCEAN IN A VOYAGE THAT CAN TAKE TWO CENTURIES. ON THAT JOURNEY THEY SHAPE THE LIVES AND FUTURES OF MORE THAN 37 MILLION PEOPLE.

The five lakes form the largest reservoir of drinkable water on the planet. They contain one-fifth of the fresh water on the earth's surface and 80 per cent of that in North America. Early Jesuit missionaries called the lakes the Sweetwater Seas for in those days one could dip a cup into their waters anywhere and drink deeply and without fear of contamination. Since then, the Great Lakes - St. Lawrence River region has become a magnet for settlement and development. It is an industrial centre for two great nations. And it bears the scars of decades of pollution by everything from raw sewage to complex chemicals. Despite sewage treatment plants, towns and cities ringing the lakes still discharge so much bacteria-laden sewage that the lake water they draw is not safe for drinking without disinfection. Many municipal beaches are too polluted for swimming, mainly because rains overload sewage treatment plants, washing raw sewage into the lakes, and some people still discharge some untreated sewage directly into the waters.

Along the shores of the lakes and their tributary rivers, our society has built about 13,000 factories that refine petroleum and that make plastics, chemicals, paints, iron, steel, cars, pulp and paper and a host of other products. On the fertile plains surrounding the lakes, people have developed large and highly-productive farms, pastures and stockyards. These businesses all have an impact on the environment of our lakes.

Over the past century we have changed the lakes in many ways. By cutting forests, plowing land, introducing farm animals, damming tributary rivers and dredging or filling river mouths, bays and shoreline marshes, we have changed the shape and quality of many river shorelines. By digging canals we allowed the introduction of foreign organisms such as the sea lamprey and the zebra mussel into the lakes. They entered by swimming or by being carried by ships. We have overfished some native species and introduced others for fishing.

For generations we have used our lakes as a giant sewer, convinced that such vast waters had an infinite capacity to assimilate and neutralize our pollution. The operative phrase was "the solution to pollution is dilution." And we all continue to pollute: big industries, small factories, farms, stockyards and individuals.

*....TO RESTORE AND
MAINTAIN THE
CHEMICAL, PHYSICAL
AND BIOLOGICAL
INTEGRITY OF THE
WATERS OF THE
GREAT LAKES BASIN
ECOSYSTEM.*

*- STATEMENT OF PURPOSE FROM
THE 1978 CANADA-UNITED
STATES GREAT LAKES WATER
QUALITY AGREEMENT*



*THE GREAT LAKES AS VIEWED
FROM SPACE*

To some degree this principle of dilution worked when the quantity of pollution discharged was not too great for the ecosystem to assimilate without damage and the pollutants contained chemicals that nature could easily break down into harmless substances. Over the past three decades we have realized that many wastes do not simply disappear into the lakes. The discharge of thousands of tonnes of phosphorus a year from sewage and from detergents put too great a load on the lakes for them to rapidly assimilate. The phosphorus acted as a fertilizer, causing the development of algae, which drew oxygen out of the water as they decayed. This situation led to such results as dead fish and slimy beaches.

The discharge of persistent toxic chemicals has led to sickness and death among

wildlife and the risk of harm to humans. During this century we created chemicals that never existed before and that break down very slowly, if at all, in nature. And we have excavated large amounts of toxic metals from deep in the earth. Persistent toxic substances, including pesticides, transformer fluids, chemical wastes and a number of industrial metals, have penetrated the food chain, killing or injuring wildlife and threatening human health. Some of the chemicals are

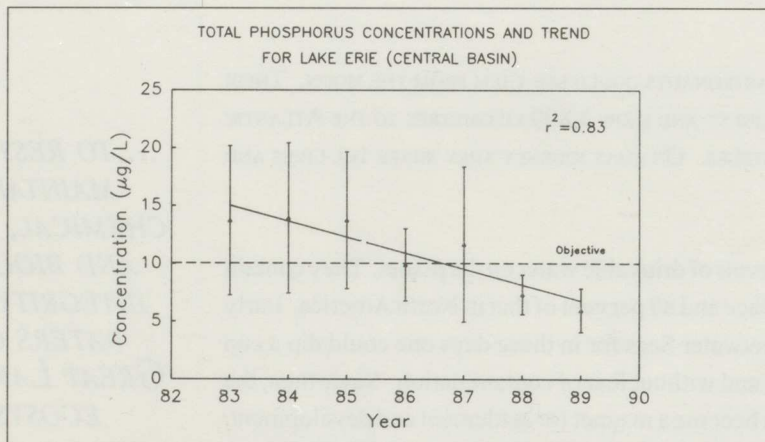
even passed from one generation to another through the placenta and in mothers' milk.

Tens of thousands of chemicals and metals are used around the lakes and hundreds of the more common and persistent ones have been detected in the lakes' ecosystem, including its water, sediments, fish, reptiles, mammals, waterfowl-- and humans. Fish in many areas are too contaminated for human consumption. A number of the birds and animals that feed on contaminated fish have suffered reproductive problems and produced young with birth defects. There is growing evidence that some children have been affected by exposure to toxic chemicals transferred through the placenta and in mothers' milk.

Since the 1960s, public concern about the condition of the lakes has created a political movement both in Canada and the United States that brought pressure for a cleanup of the lakes. This movement has resulted in laws banning or restricting a number of chemicals and in the spending of billions of dollars on sewage treatment. Since the 1970s, there has been a dramatic reduction in the discharges of gross pollution, such as raw sewage and oil. Phosphorus levels have dropped and the algal slime caused by this pollution is receding. The discharge of some hazardous chemicals has been cut significantly.

We still have to reduce toxic chemical discharges, because despite some significant reductions, they are still released by the tonne every day.

- *A number of major industries discharge wastes directly into the lakes.*
- *Some large and many smaller factories discharge their chemical wastes into municipal sewage treatment systems. Some wastes are collected in sewage sludge, while others continue through the sewage system to be discharged into the lakes or tributary rivers.*
- *Old chemical wastes seep into lakes and rivers from buried dumps near the shorelines.*
- *Wastes that have settled on the bottom sediments of industrial rivers and harbors get picked up by wildlife and become part of the food chain.*



MULTIYEAR PHOSPHORUS CONCENTRATION TREND; CENTRAL BASIN, LAKE ERIE

- *Oil and chemicals enter the Great Lakes and their tributaries in hundreds of spills a year.*
- *Chemicals from farm fields, lawns and gardens, and pollution from cars, including chemicals, gasoline and oily wastes, wash off the land and into the lakes.*
- *Tonnes of chemicals fall on the Great Lakes watershed every year. They come from industrial smokestacks and incinerators as well as drifting from pesticide sprays. Fallout comes both from local sources and from hundreds, even thousands of kilometres away, before landing.*

Some of the toxic pollution breaks down into less harmful substances and some is buried in the natural process of sedimentation, where it becomes less exposed to the food chain. Part of the chemical load is absorbed by living organisms and gets into the food chain. It is this process that is of greatest concern to people.

ELEVEN CRITICAL POLLUTANTS IN THE GREAT LAKES

FROM THE LIST OF THE GREAT
LAKES WATER QUALITY BOARD
OF THE INTERNATIONAL JOINT
COMMISSION

PCBs

(INDUSTRIAL CHEMICALS)

DDT

AND ITS

BREAKDOWN PRODUCTS

(PESTICIDE)

DIELDRIN

(PESTICIDE)

TOXAPHENE

(PESTICIDE)

DIOXIN

(2,3,7,8-TCDD)

(WASTE BY PRODUCT)

FURAN

(2,3,7,8-TCDF)

(WASTE BY PRODUCT)

MIREX

(PESTICIDE, INDUSTRIAL
CHEMICAL)

MERCURY

(INDUSTRIAL METAL)

BENZO(A)PYRENE

(B[A]P)

(WASTE BY PRODUCT)

HEXACHLOROBENZENE

(PESTICIDE, BY PRODUCT)

ALKYLATED LEAD

(INDUSTRIAL COMPOUND USED AS
GASOLINE ADDITIVE, BEING
PHASED OUT)

TOXIC SUBSTANCES IN THE GREAT LAKES

PEOPLE ARE CONCERNED ABOUT POLLUTANTS IN THE ENVIRONMENT THAT CAN INCREASE THE RISK OF CANCER, BIRTH DEFECTS, STERILITY, MUTATIONS AND NERVE DAMAGE, AND THAT ATTACK THE NERVOUS SYSTEM OR VARIOUS ORGANS OR CAN CHANGE BODY CHEMISTRY. ONCE RELEASED, CERTAIN CHEMICALS BUILD UP TO EVER-HIGHER LEVELS IN THE FOOD CHAIN, MAKING THEM MORE AND MORE DANGEROUS TO WILDLIFE AND HUMANS.

Scientists have confirmed the finding of 362 contaminants in the Great Lakes ecosystem, including the water, sediments, fish, animals, waterfowl and humans. There are 32 metals, 68 pesticides and 262 other organic chemicals, mainly industrial substances and waste by-products. The list includes 126 substances that can have acute or chronic toxic effects on life.

Eleven of the 362 have been singled out by the Water Quality Board as critical or priority pollutants that have been found to accumulate in fish, harm fish and wildlife, or possibly threaten human health. There is a number of reasons for highlighting these 11 for special attention. They have been confirmed as serious problem substances, that have caused or are very likely to cause harm. There is also a feeling among some researchers that if these 11 can be successfully controlled, then many other, related chemicals could be controlled by the same measures. In other words, the work done to reduce discharges of one chemical will likely also affect related pollutants in the same waste stream.

The toxic substances cover a wide array of materials. Some of the worst problems are caused by a class of chemicals known as organochlorines. They are often toxic and they resist natural bacterial and chemical breakdown processes in the environment. The organochlorine chemicals include insect and weed killers, industrial materials used in the manufacture of other chemicals, and waste by-products of industry or combustion. Heavy metals, such as mercury and lead, are also toxic and persistent in the environment.

• **PCBs (polychlorinated biphenyls)** - This is a family of chemicals with up to 209 possible variations. Some members of this family have chemical structures and biochemical characteristics similar to dioxins and others are neurotoxins. Since the 1930s, PCBs have been used widely in electrical, hydraulic and other equipment. Until the 1970s, they were used in such consumer products as domestic fluorescent lights and carbonless copy paper. PCBs are no longer made or sold in North America, but they are still used in a large amount of older electrical equipment. PCBs periodically escape in spills or when old equipment is junked. They are widely dispersed in the environment, are very persistent and accumulate dramatically in the food chain. They have been linked to health problems, such as embryo mortality and deformities in

wildlife, and are suspected of causing developmental problems in human infants.

• **DDT and its breakdown products, particularly DDE** - The insecticide DDT was first widely used after the Second World War, but has been highly restricted in Canada and the United States for two decades, and is now banned. DDT disrupts the body's chemical system of hormones and enzymes. It causes eggshell thinning in a number of fish-eating birds and is associated with the mortality of embryos and sterility in wildlife, especially in birds. In recent years it has been associated with the feminization of embryos. DDT still enters the Great Lakes, probably from a combination of sources. These include long-range airborne transport from countries where it is used, leakage from dumps and may include the illegal use of old stocks.

• **Dieldrin and the related pesticide, aldrin** - These persistent chemicals were used mainly as insecticides, starting in 1948. Both are manufactured chemicals, but aldrin is also naturally degraded to dieldrin in the environment. Dieldrin has been linked to the death of adult bald eagles in the Great Lakes basin. Dieldrin levels in herring gull eggs and fish in several areas sampled in the Great Lakes have not declined since the mid-1970s. Dieldrin is still used for termite control.

• **Toxaphene** - This chemical, once the most heavily-used insecticide in the United States, was applied extensively to cotton crops in the southeastern United States. Large amounts of it blew north to land on the Great Lakes, building up to substantial levels in fish in Lake Superior. The chemical has been detected in wildlife as far north as the Arctic. The use of toxaphene is now restricted in the United States and there are minimal registrations in Canada.

• **Dioxin** - This is a family of 75 chlorinated chemicals, which vary greatly in toxicity. The 2,3,7,8-TCDD variant is considered the most toxic synthetic chemical known. Dioxins are unwanted by-products of combustion and of some industrial processes that use chlorine. The most important source of dioxins in the Great Lakes is the chlorine bleaching of pulp and paper and the production of some herbicides. Dioxins also come from a wide variety of other sources, including incinerators. Dioxins, especially 2,3,7,8-TCDD, are highly toxic to many animals in low doses and are believed responsible for the fatal chick edema disease in Lake Ontario herring gulls in the 1970s. The effects on humans are not well understood, but dioxins are considered very hazardous chemicals.

• **Furan** - This family of chlorinated chemicals has 135 variations. Furans are waste by-products both of the manufacture of chlorophenol chemicals and of the same processes that produce dioxin. The 2,3,7,8-TCDF variant is similar to TCDD dioxin, but about one-quarter as toxic. Furans are often found as contaminants in PCBs.

• **Polynuclear Aromatic Hydrocarbons, (PAHs)**, especially the variant, benzo(a)pyrene (B[a]P) - The PAHs are a waste by-product of the incomplete combustion of fossil fuels and wood, incineration, steel and coke production, and coal liquification and gasification. B[a]P is linked with cancer in wildlife and humans. In the case of humans, this link has been through inhalation at workplaces. PAHs have also been associated with cancers in fish in highly contaminated areas around steel works.

• **Hexachlorobenzene** - This chemical was used as a fungicide for cereal crops and it is also a contaminant or by-product of the making of some other pesticides. HCB is persistent and is found in the tissues of fish, animals and humans

from the Great Lakes basin. It interferes with enzymes that control the production of hemoglobin, a constituent of blood. In tests, HCB affects the nerves and causes liver damage, reproductive effects and cancer in laboratory animals. Excessive hexachlorobenzene doses have caused death among infants. Limited uses of HCB are still permitted.

- **Mirex** - An extremely persistent chemical that was used as an insecticide and a fire retardant. It has been used extensively as a fire ant killer in the southern United States. It was once packaged along the Niagara River and the shore of Lake Ontario and is found almost exclusively in that lake and downstream into the St. Lawrence River. In laboratory animals, mirex causes reproductive problems and cancer.

- **Mercury** - An industrial metal that was used to prevent slime from forming in industrial equipment, and was used in the manufacture of chlorine and caustic soda. Mercury is still used in consumer products, including some street lamps, paints, batteries and light switches. It is also released as a vapor by the burning of fuels containing traces of mercury, particularly in coal-fired power plants. Mercury can build up in the brain, kidney and liver and it harms the nervous system. A number of fishery closures around the lakes were caused by mercury pollution. Mercury residues in fish are still a problem in parts of the Great Lakes, particularly the Lake St. Clair area.

- **Lead** - Alkyl lead, particularly tetraethyl lead, was used for decades to increase the performance of gasoline. Alkylated lead is now being phased out of this use in the United States and Canada, but ordinary lead is still used in other applications, such as automotive batteries. Like mercury, lead is a neurotoxin. Studies indicate that the ingestion of lead can reduce intelligence in children and this evidence has been influential in leading to stronger control measures on uses of the metal. The highest alkyl lead concentrations in the Great Lakes are found near where it was processed: at Sarnia on the St. Clair River and at Maitland on the St. Lawrence River. Lead has also been found in atmospheric fallout across the lakes.

SOURCES OF POLLUTION

DIRECT INDUSTRIAL DISCHARGES

LARGE INDUSTRIES HAVE MADE IMPORTANT REDUCTIONS IN THEIR DISCHARGES OF TOXIC SUBSTANCES, PARTICULARLY OVER THE PAST 20 YEARS, BUT THEY STILL RELEASE SIGNIFICANT AMOUNTS OF HAZARDOUS POLLUTANTS. THERE IS NO COMPREHENSIVE ESTIMATE OF THE AMOUNT OF PERSISTENT TOXIC MATERIAL THAT IS DISCHARGED INTO THE GREAT LAKES EVERY YEAR.

MAJOR SECTORS THAT DISCHARGE PERSISTENT TOXIC SUBSTANCES INCLUDE:

- **Pulp and paper mills**, which release tonnes of toxic chemicals into the lakes every day. They have been identified as a major source of dioxins, furans and other toxic organochlorine chemicals. There are 73 mills on the shorelines of the Great Lakes, the upper St. Lawrence and a number of tributary rivers. An Ontario report indicated that, in that province alone, nine mills discharge 200 tonnes a day of chlorinated organic materials. A U.S. report identified nine mills in that country that discharge large amounts of similar materials.

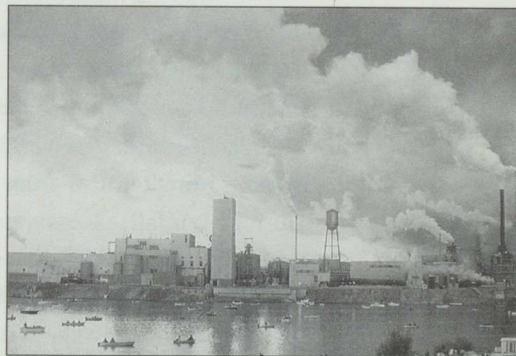
- **Chemical plants**, which add large amounts of toxic chemicals as a result of leakage and spills from factories, waste discharges through sewer pipes and leakage from old waste dumps. Major chemical industry centres are at Sarnia, Ont. and Niagara Falls, N.Y.

- **Petroleum refineries**, that discharge oil, grease, phenols, metals and other toxic substances. There is leakage of old oil spills in some cases. There are 14 refineries discharging into the Great Lakes. Many are concentrated at Sarnia, the Oakville-Mississauga area, Whiting, Indiana and northern Ohio.

- **Iron and steel mills**, that release heavy metals, arsenic, phenols, ammonia, other chemicals and PAHs. Major mills are located in Welland, Hamilton, Nanticoke and Sault Ste. Marie, in Ontario, in Detroit, Michigan and in East Chicago, Gary and Burns Harbor, Indiana.

OTHER SIGNIFICANT INDUSTRIAL DISCHARGERS OF PERSISTENT TOXIC SUBSTANCES INCLUDE:

- **Automotive plants**, that release metals and organic chemicals from current manufacturing processes and that introduce leakage from old dumps. They also release volatile organic compounds into the air, many as a result of degreasing and painting.



**GM CORP., BAY CITY PLANT
SITE CONTAMINATED BY TONNES
OF PCBs, ADJACENT TO
SAGINAW RIVER, MICHIGAN.**

- *Wood preserving factories*, that release toxic chemicals and metals used to stop rot in wood.

- *Metal processing and finishing plants*, that release acids and toxic metals into the lakes or into municipal sewer systems, that later discharge materials into the lakes.

MUNICIPAL SEWERS WITH HOUSEHOLD AND INDUSTRIAL DISCHARGES

Municipal sewage systems release a significant amount of toxic wastes. The IJC Water Quality Board estimated in 1989 that more than 2,900 tonnes of selected toxic metals and chemicals were released annually by the 1,199 sewage treatment plants around the lakes. This figure included 1,880 tonnes discharged into the water, with the rest going into the atmosphere or into sludge, which is then put in dumps or spread on land. Chemicals in the sludge can reach the lakes through surface runoff or leaching through underground water. If contaminated sludge is used on crops, some of the pollution can enter the food chain. The pollutants listed in the IJC report include arsenic, cyanide, lead, mercury, chloroform, PCBs and phenol. An estimated 300 kilograms a year of PCBs come out of Great Lakes' sewage systems; 73 kilograms of that amount comes from the huge Detroit sewage treatment plant alone.

Pollution comes from thousands of small industries which discharge hazardous chemicals into municipal sewer systems, and from homes. For example, many people use toxic household cleaners and empty chemical containers or rinse paint down the drain.

Many sewage systems are vulnerable to rainstorms. Rain can send a huge amount of water down the storm sewers, which collect street runoff. In cases where storm sewers are combined with the sanitary sewer system that takes waste from buildings, rain can contribute large amounts of water to the relatively smaller normal flows of sanitary sewage wastes. Rain also reaches sanitary sewers by illegal cross connections between the storm and sanitary sewage systems, direct inflow from gutters and yard or factory drains, and infiltration from the soil. During a rainfall, excess water, which is sometimes mixed with raw sewage, will be discharged untreated if the sewage system cannot handle the increased flow, or it will be bypassed to avoid flooding the sewage treatment plants. Around the Great Lakes, there are tens of thousands of pipes where raw sewage is discharged untreated, either during wet weather or even during dry weather in some cases, where the capacity of the sewer pipes is too small for even regular loads.

LEAKING MUNICIPAL AND INDUSTRIAL DUMPS

Millions of tonnes of hazardous wastes have been dumped into pits around the shores of the Great Lakes over the past century. Some of that material has been leaking into the lakes for years and is predicted to continue leaking for decades, even centuries, unless it is stopped. The wastes find their way into underground waters and from there are carried into the lakes. Chemical wastes have been seen running down the face of the Niagara Gorge, near one leaking dump.

One of the best-documented areas for toxic landfills is the Niagara River. An estimated one million tonnes of contaminated material has been dumped in 66 large sites near the river. It is estimated that more than 300 kilograms a day, or about 109 tonnes a year of toxic chemicals seep into the Niagara River from the largest hazardous waste dumps located within five kilometres (three miles) of the shoreline.

Even ordinary municipal dumps contain toxic chemicals that come from small industries and from household wastes, such as old paint, paint removers, oven cleaners, disinfectants, batteries, waste oil, garden sprays and drain cleaners.

CONTAMINATED SEDIMENTS

The bottoms of many industrialized Great Lakes harbors and the industrialized parts of rivers contain pollution that has drained into those waterways over decades. The worst cases are, in effect, underwater chemical dumps. Contaminated sediments in harbor bottoms are a problem in 42 of the 43 Areas of Concern around the lakes, listed by the IJC.

Pollution from contaminated sediments is absorbed by bottom-dwelling creatures, such as worms, larvae, molluscs and crayfish. From these organisms, contaminants are passed up the food chain into fish, turtles, ducks, eagles, mink, otter and humans. In shallow waters, contaminated sediments are periodically stirred up by wave action, making pollutants more available to fish. Because bottom pollutants can be easily stirred into the water, we are faced with a difficult and costly job. If the pollution is to be safely removed, it must be done in ways that will not release large amounts of it into the water.

ATMOSPHERIC FALLOUT

Air pollution is another serious problem for the Great Lakes. It includes chemicals from industries, incinerators and pesticide sprays, that are picked up by the winds and carried across countries to fall on the ground and water. Air pollutants can travel huge distances. Scientists have found that pollution in the Arctic comes from as far away as Europe. One of the most dramatic examples of the long-range transport of pollution came in 1986, when radionuclides from an explosion at the Chernobyl nuclear power plant in the Ukraine circled the earth in 11 days. In North America, researchers found that toxaphene, an insecticide that was widely used on cotton crops in the southeastern United States, had accumulated in fish as far away as Lake Superior. Chemicals, such as DDT, that fall on the Great Lakes are thought to come from at least as far away as Mexico and the Caribbean, where they are still used extensively. These chemicals are sometimes manufactured and exported by companies in the United States. Research also indicates that chemicals may be coming from as far away as Eurasia.

Scientists are trying to calculate the amount of toxic fallout on the lakes. A 1988 study by the IJC estimated that more than four tonnes of PCBs, DDT, Benzo[a]pyrene and lead fall on the Great Lakes basin each year. In the case of Lake Superior, fallout accounted for 90 to 97 per cent of the inputs of these four substances from all sources.

A 1990 IJC study of air pollution around Detroit, Windsor, Sarnia and Port Huron, lists 125 air pollutants, including arsenic, chloroform, formaldehyde and benzene. They include substances that can cause cancer and reproductive problems and can affect the immune, endocrine and nervous systems. The report raised the concern that they could enter the food chain and bioaccumulate. Sources of air pollution in those regions include thousands of large and small businesses, hundreds of thousands of cars and 1,688 incinerators. These incinerators range from small, apartment incinerators to large municipal garbage burners. There is also concern that open burning at landfills is a source of toxic fallout.

Scientists have long felt that a number of persistent, volatile chemicals migrate long distances in a kind of hopscotch from one body of water to another. They evaporate off the surface of the water in sunlight, fall in the rain or snow and are evaporated again. Some chemicals are deposited on land, where they may become part of crops and animal fodder.



***AIR QUALITY MONITORING
STATION, ISLE ROYALE, LAKE
SUPERIOR***

RUNOFF FROM TOWNS AND CITIES

Pollution, including toxic chemicals from towns, cities and farms, runs off the land and into the lakes, carried along by rainwater and melting snow. It comes from deliberate dumping and accidental spills. A considerable amount comes from cars, including oil, gasoline, antifreeze, windshield washer fluids and by-products of combustion. Some of the chemicals that we spread and spray onto our lawns and gardens are carried by rain water and garden watering into underground water, sewers or creeks that drain into the lakes.

RUNOFF FROM FARMS

Pesticide runoff from farm fields adds weed and insect-killing chemicals to the water. A preliminary study in 1986 found that 30,000 tonnes of pesticides were used in Ontario, Ohio and Wisconsin alone. A significant amount of chemicals sprayed on fields is washed into the lakes in runoff from rain and the spring snow melt. Chemicals also percolate down into the ground water and can slowly work their way into the lakes. Agricultural runoff also includes fertilizers, animal wastes and wastes from processing plants.

SPILLS FROM LAND AND SHIPS

Another pollution source is spills, which put many tonnes of harmful materials into the lakes. In 1988, the Canadian Coast Guard verified 195 spills into the lakes, and there were emergency cleanups for two of the oil spills in that list. The same year, the U.S. Coast Guard reported 262 verified spills, 13 of them involving hazardous materials and most of the rest involving oil. There were 17 cleanups for the 262 spills.

The spills vary greatly in size, but chemical spills have been serious enough to cause a number of temporary closings of downstream drinking water intakes, particularly along the St. Clair River. A report to the IJC in 1987 stated that one spill put 80 tonnes of the industrial chemical, styrene, into the St. Clair River. That spill put as much styrene into the St. Clair River as would be allowed in the normal industrial discharge over 1,428 years. Another spill put the equivalent of 58 years of permitted discharges into the river. In May, 1991, a tanker ran aground in Georgian Bay, spilling about 162,000 litres (42,800 U.S. gallons) of gasoline and diesel fuel.

ILLEGAL DUMPING

A number of businesses still discharge their wastes without treatment and without getting caught. People who illegally pour wastes down sewers or into ditches are sometimes known as "midnight dumpers" because of the time when they engage in such activities. Because of its secretive nature, this means of discharge is impossible to quantify. Governments are using waste tracking reports, called manifests, in an effort to limit the illegal transport and dumping of toxic wastes.

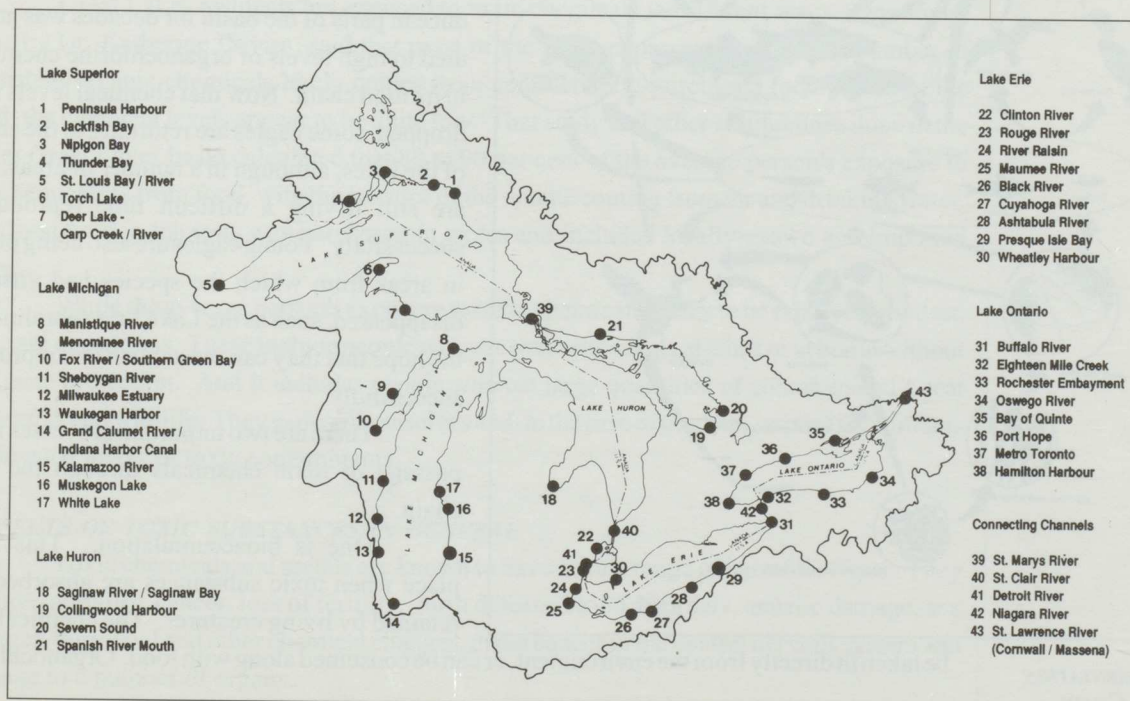
POLLUTED AREAS

THE MOST FREQUENTLY-CITED LIST OF POLLUTION HOTSPOTS IN THE GREAT LAKES IS THE ONE PRODUCED BY THE INTERNATIONAL JOINT COMMISSION. IT LISTS 43 SERIOUSLY-POLLUTED AREAS FOR SPECIAL ATTENTION AND CLEANUP. OFFICIALLY THESE ARE KNOWN AS AREAS OF CONCERN AND THEY HAVE BEEN IDENTIFIED BY GOVERNMENTS. THEY ARE MAINLY INDUSTRIAL HARBORS AND BAYS OR INDUSTRIALIZED STRETCHES OF RIVERS. THEY INCLUDE ALL FOUR RIVERS CONNECTING THE GREAT LAKES: THE ST. MARYS, ST. CLAIR, DETROIT AND NIAGARA, AS WELL AS PART OF THE UPPER ST. LAWRENCE RIVER.

Of these 43 areas, there are 42 which are contaminated by toxic chemicals, and 38 have restrictions on the human consumption of fish. These hotspots include areas on all five Great Lakes, the four connecting rivers and part of the St. Lawrence River. Fish tumours have been identified in 17 of the areas. Only one Area of Concern, Severn Sound in Georgian Bay, does not have toxic chemical pollution. It suffers from phosphate pollution, which degrades water quality to the point that aquatic life can be harmed. In addition to the 43 Areas of Concern, there are many other areas of contamination. Several years ago, an independent analysis listed several hundred sources of contamination. These included industries and municipal sewage treatment plants that discharged high levels of pollution, and hazardous waste sites that could leach chemicals into the lakes and tributary rivers.

THE OFFICIAL LIST OF POLLUTED AREAS WILL KEEP CHANGING.

*UNDER RULES APPROVED IN THE
1987 PROTOCOL TO THE
CANADA-UNITED STATES GREAT
LAKES WATER QUALITY
AGREEMENT, THERE IS A PROCESS
TO ADD OR DELETE AREAS OF
CONCERN.*



*THE 43 AREAS
OF CONCERN
IN THE GREAT
LAKES BASIN*

EXPOSURE TO AND EFFECTS OF TOXIC SUBSTANCES

HOW WILDLIFE AND HUMANS ARE EXPOSED TO TOXIC SUBSTANCES

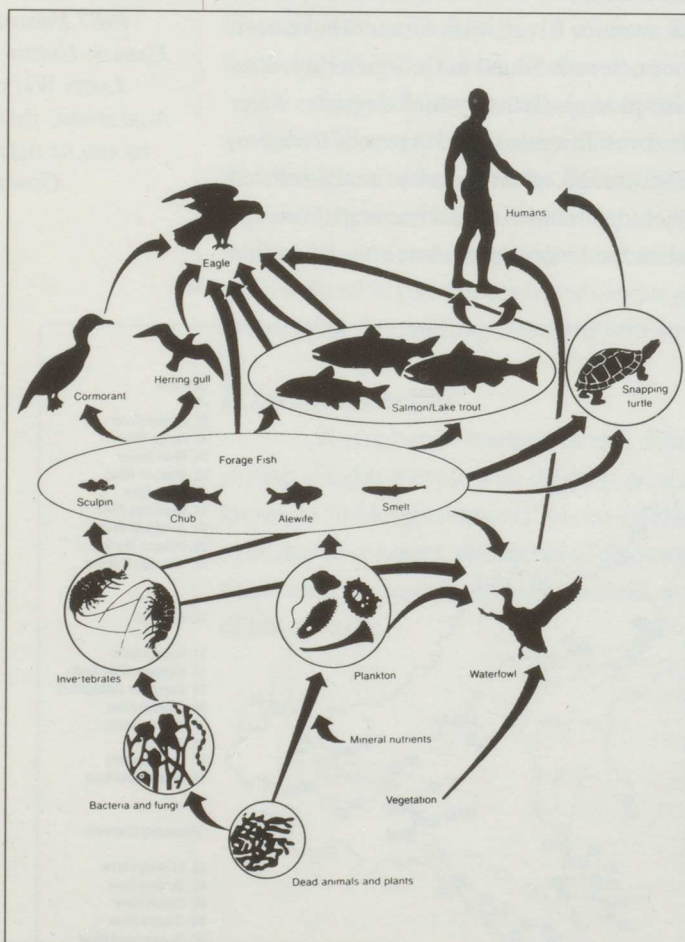
WE ARE ALL PART OF THE FOOD CHAIN-- MICROSCOPIC PLANKTON, TINY CRUSTACEANS, BIG FISH, GULLS, EAGLES, MINK, TURTLES AND HUMANS. THUS, WE ARE ALL EXPOSED TO SUBSTANCES THAT COLLECT IN OUR FOOD, PARTICULARLY THE CHEMICALS THAT ARE RETAINED IN FATTY CELLS AND ARE PASSED FROM ONE CREATURE TO ANOTHER.

In the Great Lakes food web, chemicals typically enter the base of the food chain at the level of the plankton, where the pollution begins to be concentrated at a low level. As the

plankton are eaten by small fish, that are in turn eaten by ever-larger fish, the packages of chemicals in each body are added together. At the top of the food chain, in the bodies of lake trout and fish-eating birds, such as gulls, cormorants and eagles, the levels of contamination get very high. The top predator in the lakes is the bald eagle, which eats fish-eating birds, such as gulls and cormorants. Failure of the bald eagle to reproduce in parts of the basin for decades was attributed to high levels of organochlorine chemicals in its food chain. Now that chemical levels have dropped, some eagles are returning to the shores of the lakes, although in a number of areas, they are still having a difficult time reproducing successfully. Young eagles are also being placed in areas from which the species had virtually disappeared, such as the Lake Erie shorelines, in the hope that they can reestablish and reproduce successfully.

There are two important processes in the passage of toxic chemicals through the food chain.

One is bioaccumulation. This takes place when toxic substances are absorbed and retained by living creatures. The chemicals can be taken in directly from the environment, or can be consumed along with food. Organochlorine



SIMPLIFIED REPRESENTATION
OF THE FOOD CHAIN

chemicals are highly soluble in fat so they accumulate in fatty cells and remain in living organisms.

The second process is biomagnification. This is the process of passing chemicals up the food chain. Each predator on the chain accumulates the chemical load of all the creatures it has eaten. A dramatic example of biomagnification is found in some Great Lakes bird eggs. The level of PCBs in the eggs of bald eagles nesting along the shores of Lake Erie has been measured at up to 25 million times higher than the level in the surrounding lake water.

The movement of toxic chemicals through the food chain can also cover long distances. Researchers have found mirex, a contaminant peculiar to Lake Ontario, in eels that migrate several hundred kilometres down the St. Lawrence River. The eels are eaten by beluga whales in the St. Lawrence estuary and the belugas are contaminated with mirex.

HUMAN EXPOSURE

After the discovery of toxic contaminants in the Great Lakes, particularly during the 1980s, there were concerns about their effects on humans. A major study on toxic contaminants in the Great Lakes, released by the Canadian government in March, 1991, said the levels of contaminants in Great Lakes residents in general do not appear to be different from those in people living in other industrialized parts of the continent. However, further studies of chemicals in Great Lakes residents are being undertaken.

Studies of treated tap water from municipalities around the lakes have found that contaminant levels are usually within acceptable guidelines set by federal, state or provincial governments. The most frequent contaminants in the average glass of tap water come from the water treatment and delivery systems, not the lakes. One common pollutant is a family of chemicals called trihalomethanes, which are created during the purification of drinking water with chlorine. Another pollutant found in some water systems is lead, which leaches from lead pipes or lead solder that holds copper pipes together. Trihalomethane levels can be reduced by modifying the way water is treated. Lead exposure can be reduced by running taps for at least a minute if water has been standing in pipes overnight.

Great Lakes residents are exposed to toxic chemicals in different ways. One study, done by Dr. Katherine Davies, said that most of the average person's intake of a number of persistent organic chemicals likely comes from commercially-purchased food. Even in the food, the chemical levels appear to be quite low. That study and other similar ones done in the lower Great Lakes basin calculated that 80 to 90 per cent of the average person's exposure to the chemicals is from food, with the balance of the uptake coming from air and drinking water. The food used in the tests was purchased in stores and included locally-grown and imported items.

While the average person's exposure to toxic chemicals seems to be relatively modest, there are exceptions. These include people who use toxic chemicals at work or at home without adequate protection. And it includes people who eat large quantities of contaminated Great Lakes fish and wildlife. They expose themselves and, in the case of mothers, expose their infants to elevated levels of toxic contaminants.

EFFECTS OF TOXIC SUBSTANCES IN GENERAL

Toxic chemicals and metals are known to have a wide range of harmful effects. They include mortality, cancer, loss of fertility, birth defects, blood disorders, genetic damage, sex changes, hormonal and other chemical changes, disturbances in the central nervous system and damage to a number of organs.

EFFECTS ON WILDLIFE

Toxic chemical effects on Great Lakes wildlife include: cancer, death, eggshell thinning, population declines, reduced hatching success, abnormal behavior such as abandonment of nests, infertility, birth defects such as crossed beaks and club feet, and illnesses such as chick edema. They also include less visible effects on body chemistry, including abnormalities in the thyroid, liver and endocrine systems. According to researchers, there is strong evidence that a variety of diseases in some Great Lakes fish and wildlife is linked to such persistent toxic substances as DDT, dieldrin, PCBs and dioxins.

Since the 1950s, 14 Great Lakes wildlife species near the top of the food chain have suffered reproductive problems, population declines or other physiological problems. They include: mink, otter, double-crested cormorant, black-crowned night heron, bald eagle,

herring gull, ring-billed gull, Caspian tern, common tern, Forster's tern, snapping turtle, lake trout, brown bullhead and white sucker. There is research that suggests osprey, great blue heron and Virginia rail have also been affected.

One of the most dramatic effects of toxic chemical pollution has been massive reproductive failures in a number of species of fish-eating birds, such as eagles, gulls and cormorants. The evidence started to appear decades ago, but it took modern chemical testing equipment and a lot of ecological detective work for the scope of the damage to become clear in recent years.

Records show that there was no known successful breeding of double-crested cormorants on Lake Ontario between 1954 and 1977. By the early 1960s and 1970s, this breeding failure had spread to Lakes Michigan and Superior. This was traced to eggshell thinning caused when DDT inhibited the enzymes birds used to form the shells. The eggs would break when the parents tried to incubate them. By the 1960s, most bald eagles on the lower Great Lakes were having trouble breeding successfully. DDT was causing eggshell thinning and adults were being killed by dieldrin.

During the same period, herring gulls were starting to suffer reproductive failure in parts of the Great Lakes. In the late 1960s, some fish-eating birds in Lakes Ontario and Michigan were found to be among the most contaminated birds in the world.

Researchers have also found that contaminants in the Great Lakes may be changing the sexual development of some wildlife. They say that when DDT has been injected into gull eggs, it caused the feminization of male embryos. They note that herring gull embryos and newly-hatched chicks collected from Lake Ontario in 1975 and 1976 showed that five of seven males were significantly feminized. This was a period of high pollution by DDT and other organochlorine chemicals, and a period when there was poor reproduction of the gulls.

Other species of Great Lakes wildlife have been affected. Wildlife researchers say there is evidence that mink and otter living along the shorelines of Lake Ontario, and lake trout from Lakes Ontario and Michigan appear to have difficulty reproducing in the wild. Studies suggest this is linked to PCBs in their environment. It is known that ranch mink fed fish contaminated with PCBs and other organochlorine chemicals are unable to produce live kits.

Turtles from parts of the lower Great Lakes, such as Hamilton Harbor and the St. Lawrence River, have high levels of PCBs and related chemicals, and they have high numbers of dead or deformed embryos. There are tumours in some fish from contaminated parts of the lakes, and studies have associated a number of these tumours with pollution in the local



*CORMORANTS: A SPECIES
DAMAGED BY PERSISTENT TOXIC
SUBSTANCES*

environment. Tests have shown that fish painted with PAHs from a contaminated river bottom developed skin tumours. Fish tumours are more frequent than normal in a number of industrialized areas of the Great Lakes. These include Saginaw Bay in Lake Huron, Green Bay in Lake Michigan, the North Channel of Lake Huron, near Manitoulin Island, Hamilton Harbor, and the Black River in Ohio.

CURRENT SITUATION

As a result of more stringent pollution controls, the levels of toxic substances in the Great Lakes ecosystem have dropped in recent years and the populations of a number of fish-eating bird species are rebounding. In the case of the cormorant, the population is higher than at any time in this century, a condition which shows that the ecosystem has been altered in a way that is advan-

tageous to this species. However, levels of persistent toxic substances, such as DDT, dieldrin and PCBs, are still high enough that it is difficult for top predators, such as the bald eagle, to re-establish healthy populations in many parts of the shorelines of the Great Lakes.

Species	Population decrease	Effects on reproduction	Eggshell thinning	Congenital malformations ¹	Behavioural changes	Biochemical changes	Mortality	Alterations in recruitment
Mink	X	X	NA	NE	NE	NE	X	?
Otter	X		NA	NE	NE	NE	?	?
Double-crested Cormorant	X	X	X	(X)		X	?	?
Black-crowned Night-Heron	X	X	X	X		X	?	?
Bald Eagle	X	X	X	NE		NE	NE	?
Herring Gull		X	X	X	X	X	X	
Ring-billed Gull				X		NE	X	
Caspian Tern		X		X	NE	NE		X
Common Tern		X	X	X		X		
Forster's Tern		X		X	X	X		
Snapping Turtle	NE	X	NA	X	NE	NE	NE	NE
Lake Trout		X	NA			X		
Brown Bullhead			NA			X		
White Sucker			NA	X		X		

X = effects documented NE = not examined
 NA = not applicable ? = suspected since population declined

1. Unpublished records of congenital malformations (gross birth defects) exist for the double-crested cormorant, great blue heron and the Virginia rail.

CONTINUING WILDLIFE HEALTH EFFECTS

Caspian terns - crossed bills and other deformities and embryo mortality

Cormorants - club feet and crossed bills

Bald eagles - still unable to reproduce normally along shorelines of Great Lakes

Herring gull - deformities and abnormal function of thyroid and liver

Common tern - deformities and embryo mortality

Turtles - deformities and embryo mortality

Mink - indications of failure to reproduce normally along Lake Ontario shoreline

EFFECTS ON HUMANS

Since the discovery of high mercury levels in many fish from Lake St. Clair and western Lake Erie in 1970, people have been worried about the effects on humans of toxic chemicals in the Great Lakes food chain. Contamination by mercury and hazardous chemicals, such as PCBs, mirex and dioxins, has caused the closure of several commercial fisheries and warnings against eating sport fish in parts of all the Great Lakes, Lake St. Clair and the connecting rivers.

In news reports, the possibility of cancer is the risk most frequently associated with toxic chemicals. But there is growing evidence that some of the toxic chemicals identified in

SPECIES OF FISH AND WILDLIFE SUFFERING KNOWN EFFECTS FROM CONTAMINATION IN THE GREAT LAKES

the Great Lakes ecosystem are likely to affect the nervous system, fertility, the development of young and immunity to disease.

The most detailed investigation into the effects of Great Lakes pollutants on human health suggests that children may be affected. The study compared 242 children of mothers who regularly ate contaminated fish from Lake Michigan with 71 children of mothers who did not eat such fish. The fish-eating mothers had higher than average levels of several chemicals, especially PCBs, in their blood and umbilical cord serum.

The children of mothers who ate an average of 6.7 kilograms (15 pounds) of contaminated fish a year from Lake Michigan were born earlier, weighed less and had smaller head sizes than the children of non fish eaters. The children of fish eaters were also more easily startled, had abnormally weak reflexes and were less able to detect differences in visual images in front of them. At age four, these children had poorer verbal skills and poorer short-term memories than normal youngsters, based on psychological testing. Researchers think the adverse effects were most likely caused by chemicals passed from the mother to the fetus through the placenta.

In their 1990 report to governments, the International Joint Commission stated that there is: *"Abundant evidence of health effects, particularly in the early developmental stages in wildlife populations."*

The report went on to say that: *"When available data on fish, birds, reptiles and small mammals are considered along with this human research, the Commission must conclude that there is a threat to the health of our children emanating from our exposure to persistent toxic substances, even at very low ambient levels."*

It called for *"every available action"* to eliminate the flow of persistent toxic substances into the Great Lakes.

In the meantime, a number of people still eat large amounts of contaminated fish, waterfowl and other Great Lakes wildlife. These high consumers of wild food include sport fishermen and their families and native people. Health experts say the best way to minimize one's risk is to find out what foods have high levels of contamination and avoid eating them. The larger, older, fatter and higher up the food chain a creature is, the more likely that it will be contaminated. If one eats food that might be contaminated, one should discard the fatty flesh, such as the belly on a fish, and avoid eating the fat that comes from the cooked flesh, because organochlorine chemicals concentrate in fat. This technique does not protect against mercury, which distributes more evenly through meat.

In recent years, the number of restrictions on eating Great Lakes fish has declined, but health experts say that people should continue to adhere to guidelines for sports fish consumption, published by governments. One survey found that only about half of the sport anglers surveyed had seen the guidelines. Commercial fish must meet government safety standards before being sold.

WHAT HAS BEEN DONE TO CLEAN UP THE LAKES

THE UNITED STATES AND CANADA HAVE BEEN WRESTLING WITH THE PROBLEM OF GREAT LAKES POLLUTION FOR MOST OF THIS CENTURY. AT FIRST, THE CONCERN WAS OVER HUMAN SEWAGE THAT WAS POLLUTING SOME BOUNDARY RIVERS, BUT OVER THE YEARS THAT CONCERN HAS SPREAD TO COVER PHOSPHORUS DISCHARGES, ESPECIALLY IN LAKES ERIE AND ONTARIO, AND FINALLY TO TOXIC CHEMICALS IN ALL THE LAKES.

In 1909, the United States and Great Britain, on behalf of Canada, signed the Boundary Waters Treaty, an historic agreement to manage shared waters. Under that treaty, the United States and Canada created the International Joint Commission, a permanent panel appointed by the President and Prime Minister to advise the nations on boundary water issues. The six-member body, based in Washington and Ottawa with a Great Lakes office in Windsor, Ont. keeps a close watch on the Great Lakes. It began operations in 1912 and has reported on the state of the waters since 1918.

In recent decades, pollution reached such high levels that the two nations developed a series of pollution control pacts. They signed the first Great Lakes Water Quality Agreement in 1972, mainly to control phosphorus and sewage discharges. The phosphorus pollution was causing serious eutrophication and a buildup of algae in Lake Erie.

Serious efforts to reduce pollution of the Great Lakes began in the 1960s and accelerated around the time of the signing of the 1972 Agreement. These efforts mainly involved controls on pollutants, such as raw sewage, detergents that were causing rivers to foam, and oil so thick that it could burn on the water's surface. The cleanup at that time mainly involved building industrial waste and municipal sewage collection and treatment systems and passing laws to restrict the use and discharge of several harmful substances.

Controls on toxic chemicals began in the late 1960s and, a decade later, some of the worst excesses in the use and disposal of hazardous chemicals were being curtailed. Since then, a number of major discharges of pollution into the waterways have been cut and there has been a reduction in the dumping of raw chemical wastes into leaky pits beside lakes and rivers. There have also been bans and restrictions on the use of a number of toxic substances, such as PCBs, DDT, dieldrin, aldrin, mirex, hexachlorobenzene and mercury.

Some industrial processes that create dioxins, furans and PAHs have also been controlled and others face new restrictions. In fact, these restrictions were not aimed only at protecting the Great Lakes, but were nation-wide. A number of controls that were sometimes referred to as bans are not total because, in some cases, limited uses are allowed. New uses of PCBs were stopped in the late 1970s, but old PCBs are still in use in thousands of pieces of electrical equipment. There are hundreds of PCB spills each year, as well as volatilization into the atmosphere. The sale of old DDT stocks was allowed in Canada until the end of 1990.

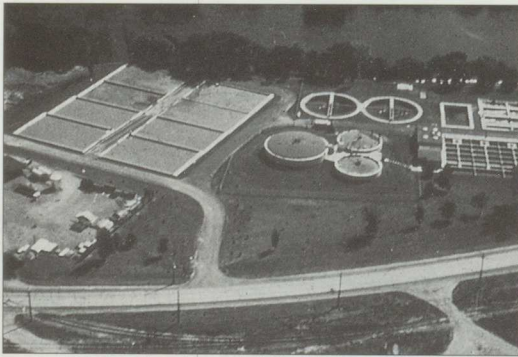
*"BOUNDARY WATERS
AND WATER FLOWING
ACROSS THE
BOUNDARY SHALL NOT
BE POLLUTED ON
EITHER SIDE TO THE
INJURY OF HEALTH OR
PROPERTY ON THE
OTHER SIDE."*

*- FROM THE 1909 BOUNDARY
WATERS TREATY BETWEEN
CANADA AND THE UNITED STATES*

The attack on toxic substances was written into a binational pact, the 1978 Great Lakes Water Quality Agreement. The pact marked a breakthrough in governments' stated goals for pollution control by calling for the virtual elimination of inputs of persistent toxic substances. This Agreement pledged Canada and the United States to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem.

A 1987 Protocol, updating the Agreement, promised that the countries would deal more strictly with such diverse pollution sources as toxic chemical fallout from the air, leaking chemical waste dumps and polluted runoff from farm fields, industry and city streets. And the two nations agreed to develop Remedial Action Plans to bring business people and citizens into the process of helping to clean up the Areas of Concern.

In 1987, Canada, the United States, Ontario and New York also signed a Declaration of Intent on Pollution of the Niagara River. This document committed the four governments to reduce specific chemical discharges to that river by at least half by 1996. This agreement covers a number of persistent toxic chemicals that have been coming from industries that discharge waste water directly into the Niagara and those that send their wastes into municipal sewer systems, which later discharge into the river. Some municipal systems have carbon filtration systems to trap organic chemicals. The Niagara agreement also covers wastes seeping into the river from leaking dumps.



*LARGE MUNICIPAL WASTEWATER
TREATMENT PLANT*

Pollution control has not been cheap. Federal, state, provincial and municipal governments in the United States and Canada have spent tens of billions of dollars on sewage treatment systems alone during the past 20 years. This sum has been mainly on "conventional" sewage treatment, that deals with human wastes and phosphorus from detergents. Sewage treatment plants are not capable of completely removing and disposing of the toxic chemicals that flow through them. They trap some of the chemicals but these pollute the sewage

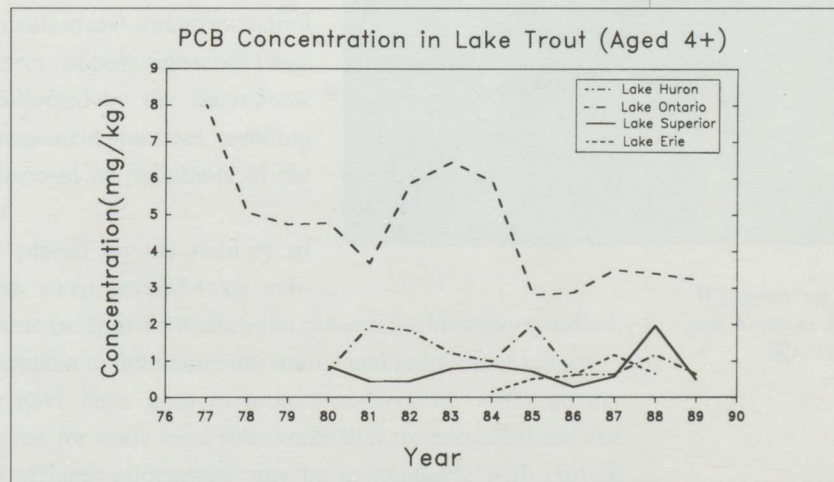
sludges or are released into the air.

Controls on toxic chemical pollution are harder to price. In a number of cases, they involved orders to stop producing certain products. In other cases, they required many millions of dollars of spending by industries to change processes or to build pollution control devices. In the future, they will require very large sums to clean up chemical wastes in leaking dumps, leakage on current and former industrial sites, and contaminated sediments on harbor and river bottoms. Cost estimates are not complete, but the indications are that the cleanup of toxic dumps and polluted harbor and river bottoms will likely cost billions of dollars. As they begin to understand the true costs of pollution, industries are now making greater attempts to catch pollutants before they escape beyond the plant gate. And there are signs that industries are looking at new processes that will create fewer hazardous substances in the first place.

TRENDS IN POLLUTION DISCHARGES AND LEVELS

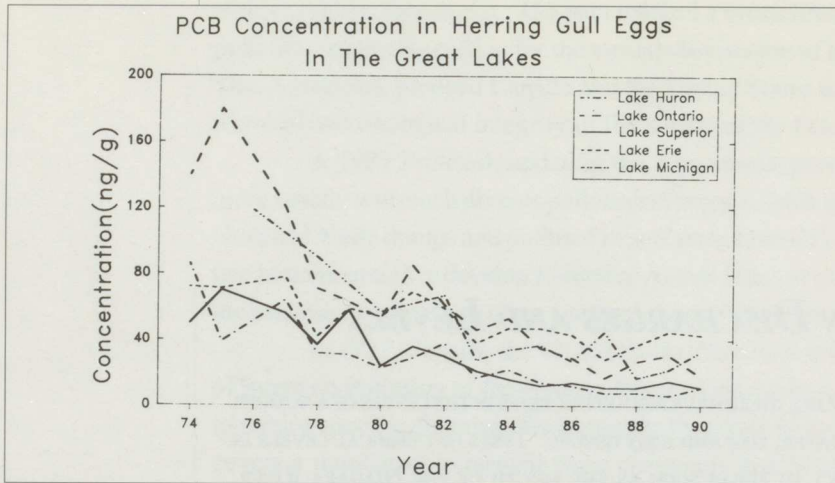
AS A RESULT OF CONTROL PROGRAMS, THERE HAVE BEEN REDUCTIONS IN THE LEVELS OF A NUMBER OF TOXIC CHEMICALS IN GREAT LAKES WATER, FISH AND BIRD TISSUES. TESTS OF CHEMICAL LEVELS IN GREAT LAKES SEDIMENTS, PARTICULARLY IN AREAS SUCH AS THE MOUTH OF THE NIAGARA RIVER, INDICATE THAT TOXIC CHEMICAL POLLUTION ROSE AS INDUSTRY GREW AFTER ABOUT 1940. THE GREATEST INPUTS OF ARSENIC, CADMIUM, LEAD, MERCURY, DDT, DIOXINS, FURANS AND OTHER INDUSTRIAL CHEMICALS AND PESTICIDES TOOK PLACE IN THE 1960S AND 1970S. SINCE THEN, THERE HAVE BEEN MAJOR DECLINES IN SOME KEY POLLUTANT LEVELS.

One example of the amount of reduction that can be achieved is in the Niagara River, which has long been identified as one of the most contaminated areas of the Great Lakes. The New York Department of Environmental Conservation reported that the daily discharge of priority pollutants from 29 U.S. municipal and industrial sources was reduced by 80 per cent during the period 1981-82 to 1985-86. Consequently, the load was reduced from 2,745 pounds (1,245 kilograms) to 544 pounds (247 kilograms) per day.



The trends for most contaminants in the Great Lakes ecosystem were steadily downward for a number of years following the peak of the early 1970s. In recent years the levels of certain chemicals in wildlife have levelled off and pollution still remains above acceptable ambient levels in a number of cases. The levelling off indicates both that toxic

**POLLUTION TRENDS:
PCB CONCENTRATIONS
IN LAKE TROUT.**



**POLLUTION TRENDS:
PCB CONCENTRATIONS IN
HERRING GULLS**

chemicals are still being added to the lakes and that old chemicals are remaining in the ecosystem. This situation offers us a great challenge. Many of the easy and relatively cheap steps have been taken. If we want to further reduce the risk to the ecosystem, we will have to make much greater efforts.

CURRENT APPROACH TO CLEANING UP THE LAKES

TRADITIONAL APPROACH

CONTROL OF TOXIC SUBSTANCES IS NOT NECESSARILY UNDERTAKEN IN THE SAME WAY IN THE TWO COUNTRIES OR IN ANY OF THE INDIVIDUAL JURISDICTIONS. IN THE UNITED STATES, TOXIC SUBSTANCES ARE CONTROLLED THROUGH THE AUTHORITY OF THE 1972 CLEAN WATER ACT. DIRECT DISCHARGES OF TOXIC SUBSTANCES ARE PERMITTED SO LONG AS THEY ARE IN NON TOXIC AMOUNTS. THESE AMOUNTS ARE CALCULATED IN TWO WAYS. THE FIRST IS BASED ON AN APPLICATION OF THE BEST TECHNOLOGY THAT IS PRACTICABLE OR AVAILABLE FOR THE TREATMENT OF EACH POLLUTANT FROM OVER 250 CATEGORIES OF INDUSTRIES. THE SECOND IS BASED ON APPLICATION OF THE CAPACITY OF A RECEIVING WATER TO ASSIMILATE A SUBSTANCE.

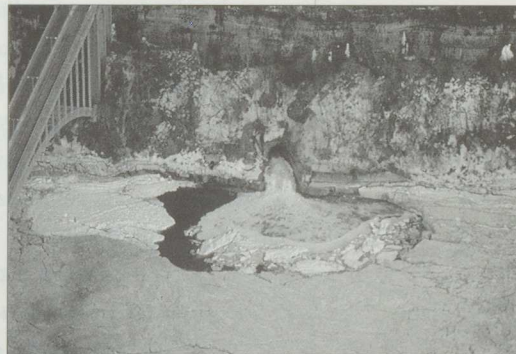
The assumptions and methods for calculating wasteload allocations vary from state to state. Some states may consider all sources of a substance in an entire basin, while others may allocate loadings on the basis of individual discharges. Restrictions on effluent discharges can be expressed in concentrations and/or in mass limits.

Spills and dumping of chemicals in and around industrial plant sites may result in nonpoint sources of pollution since these sources would not normally be collected by the wastewater system. The application of best management practices, resulting in the collection, treatment and disposal of pollutants in the wastewater system may be required.

Restrictions may also be placed on the toxicity of municipal or industrial wastewaters when several toxic substances are present. In cases where the toxicity of the wastewater exceeds the bioassay standard, detailed investigations may be undertaken to determine the source and reduce its toxicity.

These various techniques have been used to protect and restore water quality throughout the United States. However, for some toxic substances that are persistent and can be bioconcentrated, the calculated effluent allocations may be unattainable with current wastewater treatment technology. For these persistent and bioconcentrated toxic substances, their use and release must be prohibited in order to eliminate the effects they have caused.

In the Canadian system, the focus is on the provincial program. The Province of Ontario, through its legislation and provincial Water Quality Objectives, issues approval certificates with conditions to dischargers. These conditions have traditionally addressed the more common contaminants, but through the new Municipal Industrial Strategy for Abatement (MISA) will contain requirements for the more exotic contaminants present in the discharge.



*WASTEWATER DISCHARGE TO
THE NIAGARA RIVER, NIAGARA
FALLS, N.Y.*

In addition, the province, through the Ministry of the Environment, issues orders under its legislation requiring municipalities, industries and individuals to take steps to control emissions to air, water or land. These orders may be appealed by their recipients, but are enforceable once issued or following a favourable appeal board ruling.

THE ECOSYSTEM APPROACH

For years there have been calls for a new approach to pollution control, particularly to the control of persistent substances that remain toxic in the environment for months or years. One way of viewing the Great Lakes basin is to think of it as an ecosystem, in which political boundaries mean nothing to the movement of pollutants once they are released. The ecosystem is defined in the 1978 Great Lakes Water Quality Agreement as the interacting components of air, land, water and living organisms, including humans. The ecosystem approach recognizes that all components of the environment are interconnected and that pollution released in one area can cause problems in another. This concept requires everyone who can have an impact on the environment to recognize and reduce impacts. In practice, it requires people to avoid actions that can even indirectly lead to contamination of the lakes.

VIRTUAL ELIMINATION AND ZERO DISCHARGE

The 1978 Water Quality Agreement brought important commitments from the United States and Canada for the control of toxic pollutants.

- *It said that the two nations, "agree to make a maximum effort to develop programs, practices and technology necessary for a better understanding of the Great Lakes Basin Ecosystem and to eliminate or reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes System."*
- *It said that it is the policy of the two nations that: "The discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated."*

The Agreement said that "regulatory strategies for controlling or preventing the input of persistent toxic substances to the Great Lakes System shall be adopted in accordance with the following principles:"

- *"The intent of programs specified in this annex is to virtually eliminate the input of persistent toxic substances..."*
- *"The philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge."*

There have been many discussions about exactly what those phrases mean. A number of people interpret them to mean that there should be no use of persistent toxic substances, because experience has shown some will almost always leak or be spilled in the environment. An example of applying the principle of zero discharge to its fullest would be to impose a ban on the manufacture and use of a hazardous substance. The bans could even be applied to chemicals which are made in the United States or Canada and exported to other nations, if those chemicals could blow into the Great Lakes basin on air currents.

The Virtual Elimination Task Force of the IJC, said that: "Zero discharge means elimination of all inputs, whether from direct discharges into waterways or the air, indirect discharges such as agricultural and urban runoff, or inadvertent discharges, such as leaking landfills or reactivation of contaminated sediment." It went on to say that: "The guiding assumption is that all sources of persistent toxic substances must be eliminated so there will be no opportunity or availability for the chemicals to enter the ecosystem. Zero discharge,

therefore, implies zero availability."

In practice, governments in both nations have banned the manufacture or use of very few chemicals, but they try to restrict the use and discharge of hazardous substances. This policy means that chemicals can be produced and used, but under very tight controls. However, it leaves the possibility that chemicals will escape from factories during their manufacture or storage, will be released into the environment by a user, or will be disposed of in a way that lets them escape.

There is another important aspect to the interpretation of zero discharge. Because pollution is now present in the water, it will be taken in by industries that draw from the Great Lakes, and discharged later. The term zero discharge should be interpreted to mean zero pollution added to the discharge as it goes through a system.

BOTH THE
CANADA AND
ONTARIO
GOVERNMENTS
ANNOUNCED
MEASURES TO
FURTHER REDUCE
POLLUTION
DISCHARGES

Municipal-Industrial Strategy for Abatement (MISA) is to regulate about 200 major industries that discharge directly into the Great Lakes or tributaries. MISA will also cover 12,000 industries that discharge into 400 municipal sewage treatment plants by setting limits on what the sewage treatment plants can release to waterways. Industries are to reduce discharges, using the best available pollution control technology that is economically achievable.

In 1990, the Canadian government released draft national regulations for pulp and paper mills, including those on the Great Lakes. These regulations are aimed at reducing discharges of a wide range of harmful chemicals and are to virtually eliminate dioxin and furan discharges from pulp and paper mills.

The United States government, particularly the Environmental Protection Agency (EPA), and the eight Great Lakes state governments, have spent large amounts of money on Great Lakes cleanups. The EPA Regions II, III and V offices, which are responsible for the U.S. side of the Great Lakes, and the EPA Great Lakes National Program Office have spent \$11 billion since 1972. Most of this money has gone into building sewage treatment plants.

Under the U.S. Clean Water Act, states have been implementing control programs, based on best available technology. Such programs treat chemical wastes before they are discharged into municipal sewers and they reduce pollution levels in water released directly into lakes and rivers. The Clean Water Act uses National Pollutant Discharge Elimination System permits, which set specific limits for discharges of various pollutants.

The EPA has identified the Great Lakes as one of the agency's top priorities and wants them to be a laboratory to demonstrate ways of reducing and preventing pollution, and protecting both ecological integrity and human health.

In the spring of 1991, William Reilly, the Administrator of EPA, announced the U.S. Pollution Prevention Action Plan for the Great Lakes. The plan includes four initiatives to accelerate restoration and protection of the Great Lakes. The program will assist auto makers in reducing pollution, launch a pilot program on reducing urban runoff, host an international pollution prevention symposium in Traverse City, Michigan in September 1991, and develop a program to protect Lake Superior from toxic pollutants. The action plan sets targets for pollution reductions, including a 50 percent drop in the release of 17 contaminants, between 1988 and 1995. The budget request for EPA resources to be devoted to the Great Lakes basin is approximately \$44 million for fiscal year 1992, an increase of \$18.5 million from fiscal year 1991.

Two new laws adopted by Congress in 1990 could reinforce federal and state authority for achieving virtual elimination of toxic pollution of the lakes. Part of the U.S. Clean Air Act allows the regulation of pollutants that fall on the lakes. The Great Lakes Critical Programs Act adds a specific requirement that Environmental Protection Agency programs conform to provisions of the Great Lakes Water Quality Agreement.

Governors of the eight Great Lakes states have made a number of commitments as a group to Great Lakes protection. In 1986, the governors signed the Great Lakes Toxic Substances Control Agreement. Since then, Ontario and Quebec have signed a memorandum of understanding, which joins them to the Agreement with its six principles. Those principles include a statement promising to reduce toxic discharges to the maximum extent possible. By mid-1991, the governors had put \$50 million into a \$100 million endowment to fund Great Lakes protection programs. Interest from the fund is providing grants for a number of projects, including citizens' participation in Remedial Action Plans, studies on the health effects of contaminants, public information programs on the risk from eating contaminated fish and

research into sources of air pollution affecting the lakes.

In April, 1991, the governors released a Pollution Prevention Challenge. It is aimed at getting government, business and citizens to co-operate on pollution control programs. The governors have promised a number of actions that are to make pollution prevention easier and more rewarding for business.

Pollution reduction plans are having an effect in a number of highly contaminated areas. The case of the Niagara River shows the kind of reductions that can be achieved. Four-fifths of the cuts in the early 1980s came from regulations under New York State's Pollutant Discharge Elimination System permits, better pretreatment of waste discharges into the municipal sewer system and better industrial practices to reduce leaks and spills. The rest of the cleanup resulted from plant closings and process shutdowns.

INDUSTRY

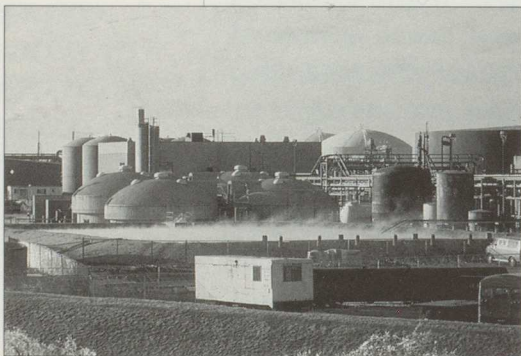
Our waters will never be cleaned up without a major effort by industries. Until a few years ago most business leaders gave few public signs that they felt a pressing need to alter the long-standing practice of simply diluting waste discharges in water. The approach of a growing number of industrialists is changing, and corporate leaders are now talking about major reductions or the elimination of toxic discharges.

Industries have spent hundreds of millions of dollars on pollution controls around the Great Lakes. Much of this expenditure has been on what is often called end-of-pipe technology - equipment added to try to capture toxic chemicals before they escape into the water and air. Money is also being spent on building physical barriers and containment systems to reduce leakage and spills into the lakes.

Some of the most promising efforts directed at pollution reduction are going into new

products and processes. This approach means changing the way old products are made and creating new products, to use and produce less hazardous materials. A number of the new manufacturing processes are called closed-loop systems because they are designed not to release any harmful substances into the environment. The chemicals are literally kept in a closed system in the factories.

One example of a company that has made significant changes is located along the St. Clair River, an Area of Concern. Since 1985, Dow Chemical Canada Inc. has cut the amount of 43 priority pollutants escaping from its Sarnia complex into the St. Clair River from 350 kilograms to about eight



**WASTEWATER TREATMENT
PLANT - DOW CHEMICAL,
SARNIA, ONTARIO**

kilograms a day.

In 1989, Dennis Lauzon, a Dow vice-president, said: "Our goal is to virtually eliminate spills and discharges from our plant site to the St. Clair River. To make this happen we are committed to separate our site from direct contact with the river." This goal will require 100 projects on the site, which has 13 manufacturing plants, and much of the work will involve capturing and treating pollution before it reaches storm sewers on the property. The plan is to virtually eliminate spills of harmful discharges by or before the year 2000. In May, 1990, Dow separated the chemical cycle of its plant at Varennes, just east of Montreal, from the St. Lawrence River and is recycling the water that is used in the factory.

REMEDIAL ACTION PLANS

THE WATER QUALITY BOARD DEVELOPED THE CONCEPT OF REMEDIAL ACTION PLANS (RAPs) TO REHABILITATE AREAS OF CONCERN AROUND THE LAKES. IN 1987, CANADA AND THE UNITED STATES INCORPORATED THE RAP CONCEPT INTO THE PROTOCOL TO THE 1978 GREAT LAKES WATER QUALITY AGREEMENT. TRADITIONALLY, HAZARDOUS WASTE CLEANUP PLANS HAVE BEEN DESIGNED BY GOVERNMENTS, SOMETIMES WITH PERIODIC CONSULTATION WITH OTHER GROUPS AND INDIVIDUALS. RAPs ARE A BREAKTHROUGH IN CLEANUP PROGRAMS IN THAT THEY FORMALLY BRING GOVERNMENTS, BUSINESSES, ENVIRONMENT GROUPS AND INDIVIDUAL CITIZENS TO THE TABLE ON A LONG-TERM BASIS TO DISCUSS HOW TO RESTORE POLLUTED AREAS IN THEIR REGIONS TO A HEALTHY STATE. THE AIM IS TO FOCUS LOCAL ATTENTION ON DEFINING PROBLEMS AND FINDING SOLUTIONS, BASED ON WHAT RESIDENTS WANT FOR THEIR WATERS.

There are already hundreds of people involved in RAP public advisory committees and thousands more who are keeping in touch with the RAP process. By early 1991, a stakeholder group, basin committee, citizen advisory committee or comparable group broadly representative of environmental, social and economic interests, had been established in 33 of the 43 Areas of Concern. One advantage of the RAP process is that it allows very long term planning, longer than the average political term of office and longer than many government funding programs. The work has been ongoing for several years and will continue for many years in the future. In a number of RAP programs, detailed project outlines exist, but work has not yet commenced on major cleanups. RAP committees for the Rouge River and Fox River have set the goal of re-establishing healthy ecosystems by the year 2005. In the case of Green Bay, the target is 2000.

COSTS OF CLEANING UP OUR GREAT LAKES

In some cases, old pollution can be dug up from hazardous waste sites or dredged from polluted harbors. It can be destroyed by incineration, chemical or biological means, or by other technologies. In some cases, it can be stored pending safe destruction. The cleanup ahead will not be cheap. Reports from the Northeast-Midwest Institute, U.S. General Accounting Office and a study by scientists from the Canada Centre for Inland Waters calculate that it will cost several billion dollars to clean up toxic hotspots around the lakes. Much of the cost involves removal and destruction of pollutants in sediments in river bottoms and harbors and attempts to stop leakage of toxic chemicals from underground dumps.



RENDERING WATERS FISHABLE IN URBAN AREAS IS A MAJOR CHALLENGE FACING RAP PARTICIPANTS

In addition, our industries will have to spend hundreds of millions, if not billions, of dollars more in re-tooling many factories and building containment systems to stop pollution at its source. Municipal governments will have to spend large amounts to prevent hazardous chemicals from slipping through their sewer systems.

We must further control the release of air pollution in the United States and Canada and we must negotiate international agreements to control pollution that blows in from other nations. This action may require subsidizing pollution controls in poor nations in our common interest. This principle has already been adopted in the case of protecting the ozone layer from chemical attack.

TEST CASE- DECONTAMINATION OF TORONTO HARBOR COMMISSION LANDS

The Toronto Harbor Commission has announced that it will start a test program to decontaminate soils on industrial lands that were used for coal storage and an oil refinery. The project will start with a shipment of soil to a plant in Europe, where it will be chemically "washed" to reduce pollution. The Commission has said that if the experiment is successful, a treatment plant will be built at the harbor. The Harbor Commission considers that the cleaned-up land can then be developed commercially, thus paying for remediation. The Commission estimates that this cleanup could cost \$320 million.

TEST CASE - DECONTAMINATION OF WAUKEGAN HARBOR

In the case of Waukegan Harbor, Illinois, just north of Chicago, over 150 tons of PCBs have escaped from industry into the harbor in the past. As part of a settlement between the federal and state governments and Outboard Marine Corp., PCBs are to be excavated from the harbour, starting in 1991. Starting in 1992, the PCBs are to be extracted from the sediments, using a heating process, and sent for proper disposal. The U.S. Environmental Protection Agency has put the cost of removing the contamination at \$19 million.

THE CHALLENGE AHEAD

GOVERNMENTS FACE THE DAUNTING TASK OF CO-ORDINATING POLLUTION CONTROL PROGRAMS AMONG TWO NATIONAL, EIGHT STATE, ONE PROVINCIAL AND HUNDREDS OF MUNICIPAL GOVERNMENTS, OFTEN WITH DIFFERENT ENVIRONMENTAL LAWS. IT REQUIRES AN UNDERSTANDING OF THE ECOSYSTEM APPROACH BY THOUSANDS OF OFFICIALS IN HUNDREDS OF SPECIALIZED AGENCIES, COMMISSIONS, BOARDS AND GOVERNING BODIES, MANY OF WHICH DO NOT HAVE ENVIRONMENTAL PROTECTION AS THEIR TOP PRIORITY.

Even though laws in Canada and the United States have reduced the discharge of a number of toxic chemicals, they have not virtually eliminated the release of persistent toxic substances. In addition, chemicals still seep into the lakes from diffuse sources and arrive as toxic fallout.

Industries face a major task in better understanding their environmental impacts, and in changing processes and products to virtually eliminate the discharge of persistent toxic chemicals. This task involves not only the major industries, which have or can hire environmental experts, but thousands of small companies, most of which do not have the staff or finances to develop or implement sophisticated environmental plans. They will need to cooperate and probably to receive technical advice from larger companies.

Individuals must go through the same process of analyzing their environmental impacts. It is individuals who run governments and companies and who shape their policies. It is individuals who choose whether or not to buy products made from or containing toxic substances and to dispose of them in safe or unsafe ways.

THE DISCHARGE OF TOXIC MATERIAL IS STILL ALLOWED UNDER CURRENT PERMITS, MOST OF WHICH ARE STILL BASED ON THE PRINCIPLE OF DILUTION OF WASTE DISCHARGES.

*BUSINESS PEOPLE
CAN PLAY A VITAL
ROLE IN POLLUTION
PREVENTION BY
GETTING THEIR
COMPANIES AND
BUSINESS
ASSOCIATIONS
INVOLVED IN
REDUCING
POLLUTION AND
RECYCLING*

HOW CAN WE DO A BETTER JOB OF CLEANING UP?

OUR INDUSTRIAL SOCIETY, INCLUDING ITS GOVERNMENTS, WAS NOT DESIGNED TO ANTICIPATE AND PREVENT SERIOUS ENVIRONMENTAL PROBLEMS. IT HAS GENERALLY OPERATED ON THE PRINCIPLE THAT WHEN PROBLEMS ARE FOUND, SOCIETY WILL REACT AND CURE THEM. POLLUTION OF THE GREAT LAKES AND MANY OTHER ENVIRONMENTAL PROBLEMS HAVE SHOWN THAT IT IS ALMOST IMPOSSIBLE TO RECAPTURE PERSISTENT, TOXIC POLLUTANTS ONCE THEY HAVE BEEN DISPERSED IN THE ENVIRONMENT.

For several years, expert groups have been developing a new definition for the kind of industrial society that we need in order to adequately protect our environment. One term that has been adopted by a number of governments, businesses and environmental groups is environmentally-sustainable economic development. Often it is simply called sustainable development. The term was popularized by the 1987 report of the World Commission on Environment and Development, the Brundtland Commission. This UN-appointed body defined sustainable development as that which "meets needs of the present without compromising the ability of future generations to meet their own needs."

To reach sustainable forms of development and living we will have to make significant changes in the way we produce energy, use cars, farm, produce and handle oil and chemicals, and manage our forests. We will have to stop or reduce not only the direct discharges into our waters, but find ways of stopping the insidious spills, leaks, runoff and illegal dumping from millions of diffuse sources.

We will have to develop towns and cities in ways that reduce the daily discharge of wastes into the waters. In the case of the Great Lakes and St. Lawrence basins, this action means preventing pollution in the future and restoring a seriously damaged ecosystem by cleaning up the mess created by years of carelessness and neglect. This process has been referred to as "sustainable re-development."

Sustainable development means setting goals for the kind of ecosystem we want for ourselves and our children. To put it in simple terms, how clean do we want it? Do we want to be able to swim virtually anywhere, eat fish without fear of contaminants and drink the water with less risk from contamination? What future do we see for other species? This is the kind of decision-making process that is now taking place in a number of towns and cities around the lakes under the Remedial Action Plans.

There are a number of obvious measures that can be taken, but they involve costs. We can do a better job of handling and storing hazardous materials that keep leaking into the waters. Industries can install more closed-loop processes that minimize the release of hazardous wastes. They can switch to less hazardous products and use less toxic material. If we want zero discharge of certain substances, then we will probably have to stop making them altogether. We may have to give up certain products that we now use and pay more for others.

We can improve farming and land development practices to prevent pollution from washing off the land. These improvements will involve less use of certain pesticides, safer use of others and land management techniques that reduce the amount of polluted runoff. Often improvement means maintaining more marshes and vegetation along shorelines to provide natural filters for water. It can mean the redesign of drainage systems to reduce the amount of water that is flushed rapidly off the land.

We can do a much better job of educating and training people in government and industry to understand the effects of their decisions and actions on the environment. Such people will require education on how ecosystems work and how actions in one part of the environment can have impacts over long distances and time frames in natural systems.

As individuals, we must realize that any waste we put down the drain or into garbage will sooner or later pollute the environment. When chemicals go down the drain, they add a chemical load to somebody's source of drinking water. We can stop pouring old paints and waste chemicals down our sinks and throwing batteries and chemicals into the garbage. In many areas, these products can be removed for proper disposal by hazardous waste pickups provided by municipal, provincial or state governments.

If we are going to have environmentally-sustainable lifestyles, we will have to choose techniques, technologies and products that have a lower total impact on our environment. We can reduce our use of electricity and heating fuel at home, buy fuel-efficient cars and use them less often. These actions will cut the discharge of many toxic pollutants from factories, electric generating stations and exhaust pipes. We can reduce our use of toxic chemicals in the home and garden and buy fewer throwaway products.

One way to get a sense of our individual responsibility is to do a waste inventory at home, looking for hazardous products and finding ways of reducing their use or substituting less toxic materials or techniques. It is worth remembering that most toxic products were only brought onto the market in the last generation, and our parents operated without them. There is a flood of information on how individuals can protect the environment. The material is in books, pamphlets and newsletters from environment groups, governments, businesses and in bookstores.

Individuals can also play a direct role in helping to clean up our Great Lakes by becoming involved in Remedial Action Plans for polluted areas. Citizens also have the power of electors and consumers. The way to let people know what changes you want is to write or phone your elected officials and to let manufacturers know what you like and don't like about their products.

RECOMMENDATIONS

THE PARTIES HAVE PREVIOUSLY AGREED TO REGULATORY STRATEGIES AND PROGRAMS TO VIRTUALLY ELIMINATE THE INPUT OF PERSISTENT TOXIC SUBSTANCES INTO THE GREAT LAKES ECOSYSTEM, IN ORDER TO PROTECT HUMAN HEALTH AND LIVING AQUATIC ECOSYSTEMS AND THE HUMAN USE THEREOF. THE PHILOSOPHY ADOPTED FOR THE CONTROL OF INPUTS OF PERSISTENT TOXIC SUBSTANCES SHALL BE ZERO DISCHARGE.

- The Water Quality Board confirms that many of these persistent toxic substances are so troublesome as to require clear and absolute bans. Severe restrictions to date have produced significant reductions of some of these substances in the Great Lakes ecosystem, including its fish, wildlife, water and sediments. But experience shows that these reductions are not as comprehensive as we now think necessary. Studies suggest that these substances actually have or threaten to have continuing important, if very subtle effects, on human health and wildlife, even in very low concentrations.

The Parties have not yet adequately dealt with the manufacture, import, use, storage, transportation and disposal of these substances. The Board recommends that this situation be rectified as a matter of urgency. Actions should target six of the persistent toxic substances on the list of Critical Pollutants prepared by the Board in its 1985 report. These are: PCBs, DDT, dieldrin, toxaphene, mirex and hexachlorobenzene.

- Some of the sources of the Critical Pollutants in the 1985 Board report lie outside the Great Lakes basin. Recognizing the increasing importance of out-of-basin sources in the contamination of the Great Lakes with persistent toxic substances, the Parties should take a leadership role in promoting the elimination of the use of these substances, world-wide.

Other substances have been confirmed as present in the Great Lakes basin. The extent of their potential for harm

is not clear, but it is likely that some ought to be considered for absolute bans.

The Parties must identify those chemicals that should be added to the list of substances which should be banned. In order to accomplish this task, the Parties jointly need to develop a process with a fixed timetable and schedule. The 1987 Protocol to the Great Lakes Water Quality Agreement calls for the Parties to establish a list of critical toxic substances, [List No. 1, Annex 1].

However, the Board thinks that the definition of persistent toxic substances in the Agreement is too general. The Board also thinks the criteria for this list are too general and do



*CORMORANT WITH
BIRTH DEFECTS CAUSED BY
PERSISTENT TOXIC SUBSTANCES*

not reflect the high potential for certain substances to cause harm. On the basis of the weight of evidence, the Board thinks that there are factors which should be included in any criteria used for assigning priorities to substances. These include bioaccumulation, persistence, exposure potential and a range of toxic end points that is broader than cancer. These toxic end points include developmental effects in the offspring of exposed adults.

- The Board recognizes that the Parties and other international bodies, such as the Organization for Economic Co-operation and Development, have processes for evaluating the potential hazards of new substances. The Board recommends that the Parties establish a new joint approval process for new substances proposed for the marketplace when those substances might have toxic effects on the Great Lakes ecosystem. This process could cover the manufacture in Canada and the United States and the distribution and sale of such products in any market. This approval process should embody such factors as bioaccumulation, persistence, exposure potential and a broad range of toxic end points, including cancer and developmental effects. The approval process should place the burden of proof on the manufacturer and it should be open to public scrutiny.

PRIORITIES OF THE WATER QUALITY BOARD

IN JUNE, 1991, THE WATER QUALITY BOARD DEVELOPED A LIST OF 15 PRIORITY ISSUES THAT NEED TO BE ADDRESSED IN ORDER TO ACHIEVE THE BOARD'S VISION FOR A HEALTHY GREAT LAKES ECOSYSTEM. THEY ARE:

- The next Great Lakes Water Quality Agreement
- Risk and injury assessment and management
- Regulatory regimes-- current and emerging
- Integrated approaches to watershed and shoreline management
- Groundwater management practices
- Role of/how to involve municipalities in the management and clean-up of the Great Lakes
- Role of industry in managing the Great Lakes basin
- Role of the agricultural and forestry sectors in managing the Great Lakes basin
- Evaluation of education and information policies and programs in the Great Lakes basin
- Applying sustainable development in the Great Lakes basin
- Control options for out-of-basin loadings
- The real public health issues in the Great Lakes basin; are standards consistent?
- Water quality-- tourism and recreation in the Great Lakes basin
- Fish and wildlife restoration-- competing visions
- Relationships between water quality and water quantity

LONG TERM GOALS

WE WHO LIVE IN THE GREAT LAKES - ST. LAWRENCE ECOSYSTEM HAVE A RESPONSIBILITY TO RESTORE AND PROTECT THE GREATEST SOURCE OF FRESH WATER ON THE PLANET. WE HAVE A DUTY TO PROTECT IT FOR OURSELVES, OUR CHILDREN AND OTHER SPECIES OF LIFE. WE HAVE STARTED THE JOB, BUT THERE IS STILL A LOT OF WORK TO DO. IT IS IMPORTANT TO SET A SERIES OF MILESTONES SO THAT WE CAN SEE PROGRESS BEING MADE.

Most people want the lakes to be drinkable, swimmable and fishable. We have seen the green slime vanish from most of the areas that suffered from excess phosphorus pollution in the past 30 years. A number of fish that were once unsafe to eat can now be consumed. Most bird species that were failing to reproduce are now hatching young, though some are still deformed.

There are a number of signs to look for in a campaign for decontamination of our ecosystem. One would be the lifting of all bans on the consumption of fish. Another would be to find no pollution-caused deformities in wildlife, especially at the top of the food chain. We should see healthy wildlife that can reproduce and thrive everywhere. One worthy symbol of restoration could be healthy populations of bald eagles, the top predator, living all around the lakes. If they are healthy, then we will be approaching an ecosystem virtually free of persistent toxic substances.

*THIS IS OUR VISION
OF THE GREAT LAKES
OF THE FUTURE.
THIS IS WHAT WE ARE
STRIVING TO ACHIEVE.*

*THE GREAT LAKES WATERSHED
IS A CLEAN, SAFE ENVIRONMENT
WHERE LIFE FORMS EXIST IN
HARMONY. PEOPLE TAKE PRIDE IN
THE GREAT LAKES. WE SHARE
AND LIVE AN ETHIC WHICH
RECOGNIZES THAT ENVIRONMENTAL
INTEGRITY PROVIDES THE
FOUNDATION FOR A
HEALTHY ECONOMY. WE ARE
SECURE IN THE KNOWLEDGE THAT
THE FISH AND WILDLIFE ARE
HEALTHY AND THE WATER CAN BE
ENJOYED BY ALL. WE
UNDERSTAND OUR RESPONSIBILITY
FOR ENSURING A SELF-SUSTAINING
GREAT LAKES ECOSYSTEM. THIS
IS THE EXAMPLE WE SET FOR THE
REST OF THE WORLD AND THE
LEGACY WE LEAVE OUR CHILDREN.*



BALD EAGLE IN FLIGHT

APPENDICES

READING LIST

COLBORN, THEODORA, ALEX DAVIDSON, SHARON N. GREEN, R.A. HODGE, C. IAN JACKSON AND RICHARD A. LIROFF. 1990. GREAT LAKES, GREAT LEGACY?, CONSERVATION FOUNDATION, WASHINGTON, AND THE INSTITUTE FOR RESEARCH ON PUBLIC POLICY, OTTAWA, ONTARIO.

ENVIRONMENT CANADA, DEPARTMENT OF FISHERIES AND OCEANS AND HEALTH AND WELFARE CANADA. CONTAMINANTS IN HERRING GULL EGGS FROM THE GREAT LAKES. OTTAWA, ONTARIO. (SOE FACT SHEET No. 90-2)

GOVERNMENT OF CANADA. 1991. TOXIC CHEMICALS IN THE GREAT LAKES AND ASSOCIATED EFFECTS. VOLS. I AND II. OTTAWA, ONTARIO.

KEATING, MICHAEL. 1986. TO THE LAST DROP. MACMILLAN OF CANADA, TORONTO, ONTARIO.

NATIONAL WILDLIFE FEDERATION AND CANADIAN INSTITUTE FOR ENVIRONMENTAL LAW AND POLICY. 1991. A PRESCRIPTION FOR HEALTHY GREAT LAKES: REPORT OF THE PROGRAM FOR ZERO DISCHARGE. WASHINGTON, DC.

ROYAL SOCIETY OF CANADA AND U.S. NATIONAL RESEARCH COUNCIL. 1985. THE GREAT LAKES WATER QUALITY AGREEMENT: AN EVOLVING INSTRUMENT FOR ECOSYSTEM MANAGEMENT. OTTAWA, ONTARIO, AND WASHINGTON, D.C.

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT. 1987. OUR COMMON FUTURE (BRUNDTLAND REPORT). OXFORD UNIVERSITY PRESS, NEW YORK.

CREDITS

PAGE 17 - DEPARTMENT OF NATURAL RESOURCES

PAGE 19 - NATIONAL PARK SERVICE PHOTO BY BRUCE WEBER

PAGE 25 - GREAT LAKES, GREAT LEGACY ? CONSERVATION FOUNDATION,
WASHINGTON, DC INSTITUTE FOR RESEARCH AND POLICY, OTTAWA, ONT. 1990

PAGE 36 - GARY KASPRZYK

PAGE 37 - NATIONAL WILDLIFE FEDERATION

PAGE 45 - WILSON G. PORTT

CONTACT LIST

International Joint Commission

Great Lakes Regional Office
100 Ouellette Avenue, 8th Floor
Windsor, Ontario N9A 6T3

or

P.O. Box 32869
Detroit, Michigan 48232

Canadian Government

Great Lakes Environment Office
Environment Canada, Ontario Region
6th Floor, 25 St. Clair Avenue East
Toronto, Ontario M4T 1M2

United States Government

Environmental Protection Agency
Great Lakes National Program Office
230 South Dearborn Street
Chicago, Illinois 60604

Ontario

Ontario Ministry of the Environment
1 St. Clair Avenue West
Toronto, Ontario M4V 1K6

Illinois

Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

Indiana

Indiana Department of Environmental Management
105 South Meridian Street
Indianapolis, Indiana 46225

Michigan

Michigan Department of Natural Resources
P.O. Box 30028
Stevens T. Mason Building
Lansing, Michigan 48909

Minnesota

Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155

New York

New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York
12233-3500

Ohio

Ohio Environmental Protection Agency
P.O. Box 1049, 1800 WaterMark Drive
Columbus, Ohio 43266

Pennsylvania

Pennsylvania Department of Environmental Resources
P.O. Box 2063
3rd and Locust Streets
Fulton Bank Building F
Harrisburg, Pennsylvania 17105

Wisconsin Department of Natural Resources
P.O. Box 7921
101 S. Webster Street
Madison, Wisconsin 53707

Council of Great Lakes Governors
35 East Wacker Drive, Suite 1850
Chicago, Illinois 60601

Great Lakes Fishery Commission
1451 Green Road
Ann Arbor, Michigan 48105

ENVIRONMENT GROUPS

Great Lakes United
State University College at Buffalo
Cassety Hall, 1300 Elmwood Avenue
Buffalo, NY 14222

or

Canadian Address:
P.O. Box 548, Station A
Windsor, Ontario N9A 6M6

National Wildlife Federation
Great Lakes Office
802 Monroe
Ann Arbor, MI 48104

Canadian Institute for Environmental Law and Policy
517 College Street, Suite 400
Toronto, Ontario M6G 4A2

The Center for the Great Lakes
435 N. Michigan Avenue, Suite 1408
Chicago, IL 60611

or

320-1/2 Bloor Street W., Suite 301
Toronto, Ontario M5S 1W5

Great Lakes Tomorrow
720 Bathurst Street
4th Floor, Unit 3
Toronto, Ontario M5S 2R4

Pollution Probe Foundation
12 Madison Avenue,
Toronto, Ontario M5R 2S1

World Wildlife Fund
The Conservation Foundation
1250 Twenty-fourth Street, N.W.
Washington, D.C. 20037

Council of Great Lakes Industries
c/o Detroit Wayne County Port Corporation
174 South Clark Street
Detroit, Michigan 48209 U.S.A.

