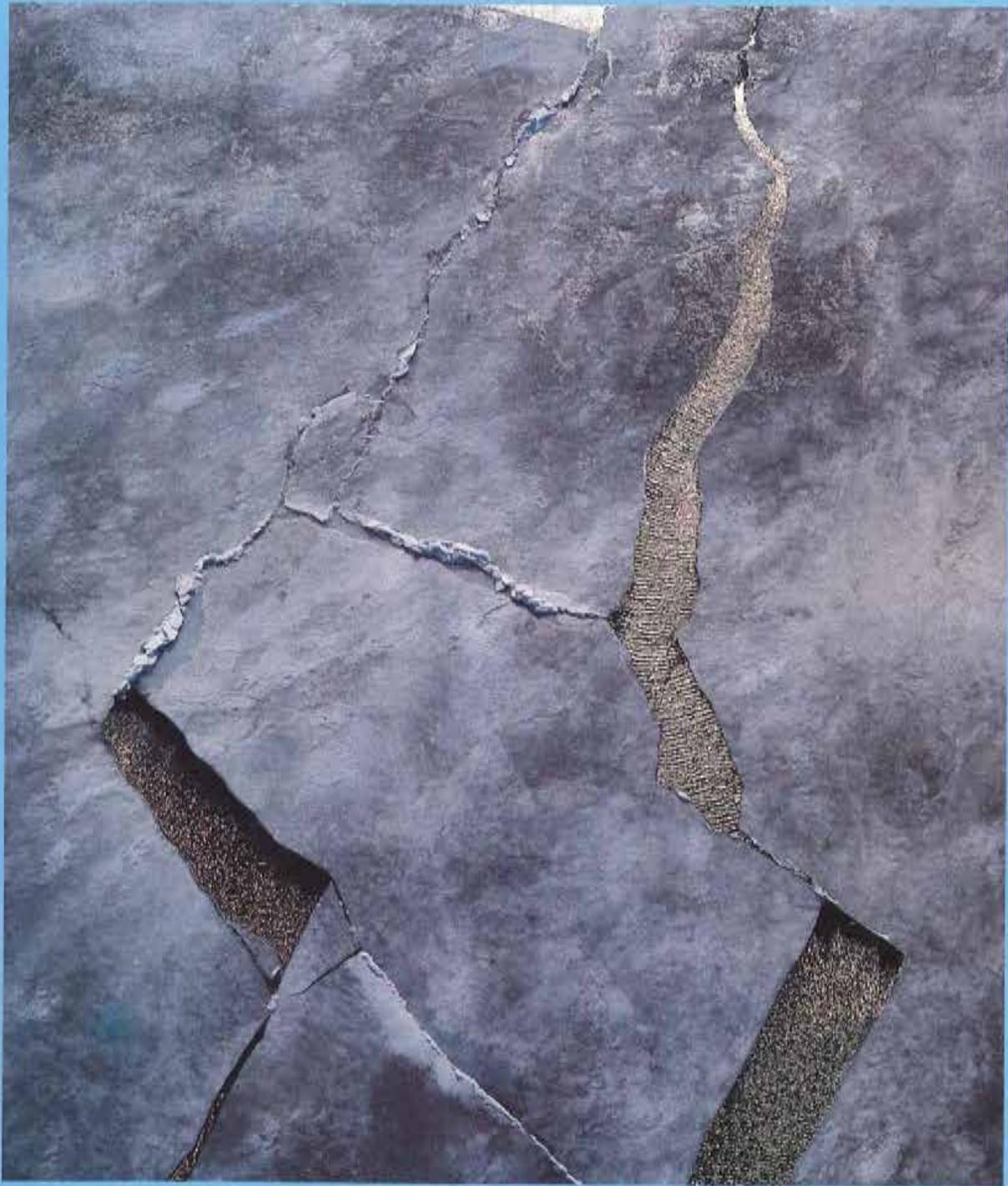


State of the Great Lakes



1993 Annual Report

Message from the

All of us who live on these peninsulas, proudly standing guard over the Great Lakes, know we are blessed beyond measure. It is hard to imagine Michigan without the Great Lakes. And, it has been Michigan that has led our neighbor states in protecting America's most important water resource.

I encouraged the Office of the Great Lakes to, once again, publish this *State of the Great Lakes* report because it seemed an appropriate time to take stock of our stewardship of these most precious of natural resources. As an ecosystem, and as an integrated economic system, the region has taken great strides toward maintaining and enhancing its stewardship of our human and natural resources.

Over the last three years, I have worked to forge effective partnerships with many stakeholders, inside and outside government, on both sides of our international borders, to further our twin goals of environmental protection and economic development in the Great Lakes Basin.

I have worked with the United States Environmental Protection Agency, the governors of the Great Lakes states, our own Office of the Great Lakes, as well as the water directors of other states, to forge new regulations aimed at reducing the flow of persistent, bioaccumulative toxics into the open waters and tributaries of the Great Lakes in as cost-effective or least costly manner as possible.

Moreover, I have joined Wisconsin, Minnesota and the Province of Ontario in supporting a unique Bi-national Program for the protection of Lake Superior, the crown jewel of the basin, and to carry out a zero discharge demonstration program, as advocated by the International Joint Commission, to eliminate persistent toxics from that awesome body of water.

Through the Council of Great Lakes Governors, I have supported Great Lakes Recycle, a nationally recognized effort by the eight member states to pool procurement efforts for recycled products such as office paper. We are also working to expand tourism in the region to provide an economic incentive for our citizens and local communities to treasure natural resources and environmental protection as necessary means for economic ends.

I believe that environmental protection and economic development are not only compatible, but over the long run, mutually dependent. Here in Michigan, the state most closely linked to the Great Lakes, we have the opportunity to prove that world class natural resources can coexist with a world class economy. In fact, we're already doing just that. As many indicators of water quality continue to improve, Michigan's economy is leading the nation in job growth and new business startups.

While maintaining this competitive economic position, Michigan still is a leader in environmental protection and natural resources stewardship on an international scale. No doubt Michigan's strong preference for vibrant environmental and natural resources programs is predicated on a strong economy and industrial base.

Yet, it is not given to us to have the best of both worlds indefinitely, without hard work and wise public policies. We need to keep three principles

Governor

at the forefront of our deliberations on the future course of environmental and natural resources policy: good science, relative risk and pollution prevention. These concepts help us to focus on the highest priorities with cost-effective solutions that reduce public risk and environmental pollution, and promote — rather than discourage—economic development.

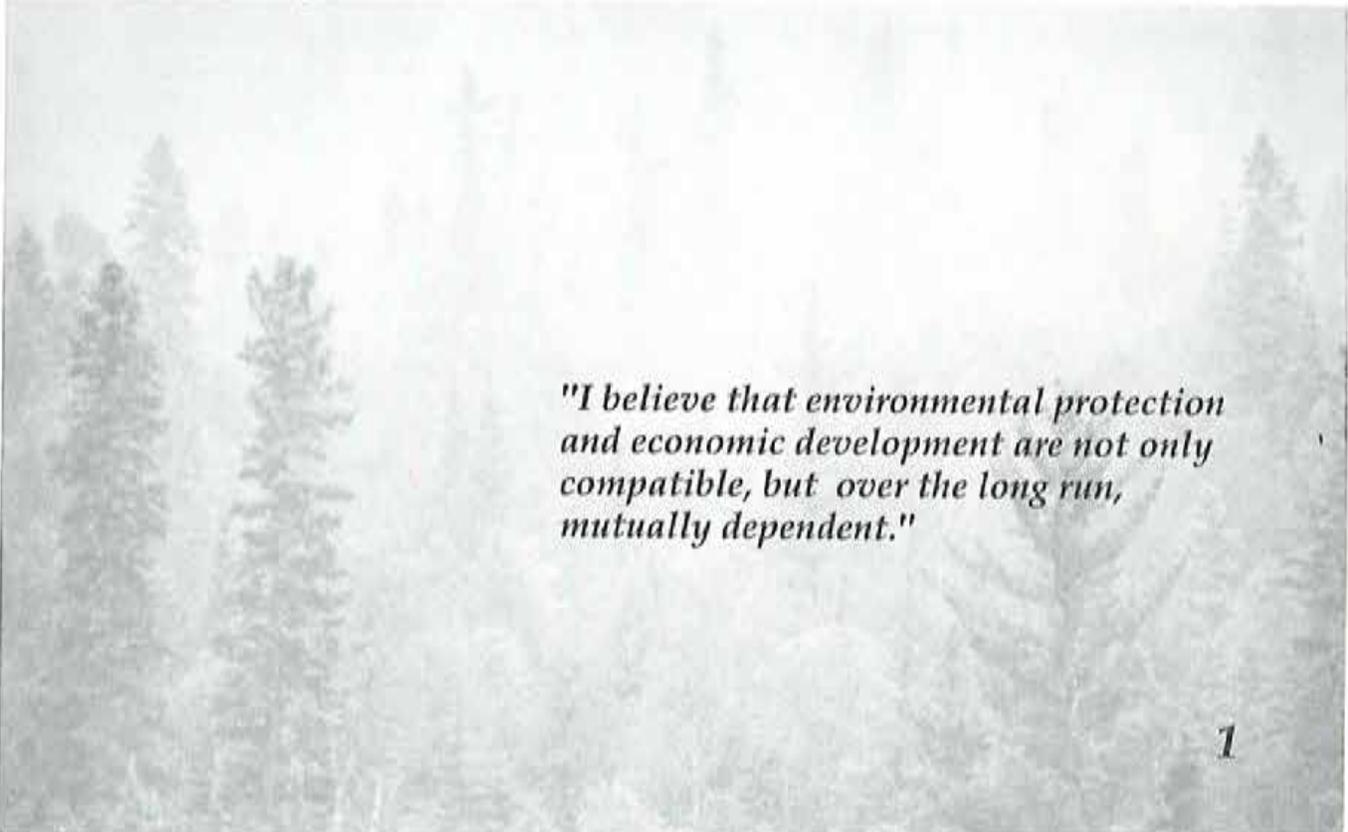
One example of the application of these principles to environmental policy, the Auto Industry Pollution Prevention Project, entered into by the Big Three automakers and the Michigan Department of Natural Resources, allows us to utilize prevention techniques on key toxic chemicals that pose the biggest threat to the unique ecosystem of the Great Lakes watershed. This cross-media (air, land and water) effort will achieve cost-effective reduction in toxic pollution for the auto companies and their suppliers.

We are privileged to take up the challenge of stewardship for our beloved Great Lakes. This year's *State of the Great Lakes* report recounts our successes as well as those areas where more effort is needed. It provides fundamental, scientific information to evaluate our efforts so far. Finally, it offers stimulating discussion by a variety of noted experts on the subjects of Great Lakes policy and science.

As you read this report, put it to good use and let your voice be heard in Michigan's ongoing conversation on the state of the Great Lakes.



John Engler
Governor
State of Michigan



"I believe that environmental protection and economic development are not only compatible, but over the long run, mutually dependent."

Director of the Office of the Great Lakes Embarking on a Major



G. Tracy Mehan, III, Director
Office of the Great Lakes
Department of Natural Resources

Any conversation on the Great Lakes inevitably stumbles upon the question, "What is the current condition of the Great Lakes?" Usually, this question elicits a response similar to, "Well, they're a lot better off than they were, but . . ."

Most of us, who call Michigan home, view the Great Lakes in a much improved condition compared, say, to the days of our youth. The fishing is better. The water is cleaner. The graphs charting various contaminants have plunged dramatically over the last twenty years.

Yet, there is always that hesitation that comes after the initial positive statement on the state of the Great Lakes. There is still lingering concern evidenced by use of the all-purpose qualifier, "but."

- But for the sea lamprey, the zebra mussel and a hundred other exotic species,
- But for the fish consumption advisories,
- But for the contaminated sediments,
- But for the air pollution coming from who knows where,
- But for the persistent, bioaccumulating toxics, and
- But for the ever-encroaching shoreline development.

But. But. But. The litany goes on, almost to the point of depriving the initial, positive reaction of any real meaning. But that may be overstating the case. For, in truth, the quality of the Great Lakes, both the open waters and the tributaries, has improved. The first order of business has been successfully completed. Improved treatment of municipal wastewater, reduced nutrient loadings, declining levels of PCBs, dioxin, and pesticide contamination are indications of progress in controlling pollution in the basin. These gains were the result of hard work and financial sacrifice of taxpayers, industry, agriculture and government over the last two decades.

These accomplishments have both emboldened and empowered all of us to set our sights on new, more intractable issues. Flushed with our past successes, still boasting a standard of living which is the envy of the world, we show no reluctance to embrace, wholeheartedly, a "revolution of rising expectations" with respect to a major ecological restoration of the largest body of fresh water in the world.

In some cases, such as Lake Superior and Grand Traverse Bay, we strive to keep the genie in the bottle by means of our efforts to preserve and protect the more pristine and unblemished portions of the region's watershed. In others, most cases in fact, we strive, mightily, to put the genie back in the bottle. In the Saginaw River and

Introduction

Ecological Restoration

Bay, the Rouge River and in 12 AOCs (areas of concern) throughout Michigan, we painstakingly work to remediate the damage of historic neglect and ignorance.

No longer do we simply worry about the quality of the water in terms of its impact on human health. We look to the health of the entire food chain as we try to cope with toxic contaminants that biomagnify throughout the food web with ill effects on aquatic, avian and wildlife species. Nor do we only focus on the traditional point source of pollution, the discharge pipe to the air and water, so to speak. Now we focus on the entire watershed or ecosystem, encompassing land, air and water, in recognition of the interdependence of all media. What we do on the land can affect the water in many ways never before imagined.

No longer do we expect businesses and municipalities to simply treat or dispose of waste "at the end of the pipe." We continually harry them to pursue sophisticated pollution prevention techniques across a broad front: product substitution, closed-loop processes and the husbanding of toxic materials. We look to farmers to keep more soil on the land and to search for ways to reduce their application of pesticides, herbicides and fertilizers. And, by the way, watch out for wetlands!

This edition of the *State of the Great Lakes* report offers several perspectives on these themes. The staff of the Office of the Great Lakes, under the direction of the estimable Jim Bredin, as well as many guest contributors, have worked hard to provide the reader with good data and informed opinion, sometimes conflicting, on the state of Michigan's most significant resources, the Great Lakes. With this report, we revive a tradition dictated by both law and custom. It is our hope that this will be one government document that is actually read—and debated—over the coming months and year. We welcome your comments on both the form and content of this publication in the hope of continually improving this aspect of our work for the citizens of Michigan.

I want to offer my personal thanks to the staff of the Office of the Great Lakes and the Michigan Department of Natural Resources in helping to bring this report to press. I also congratulate our contributing writers for their fine contributions to the public debate on the future of the Great Lakes.



G. Tracy Mehan, III
Director
Office of the Great Lakes



Introduction

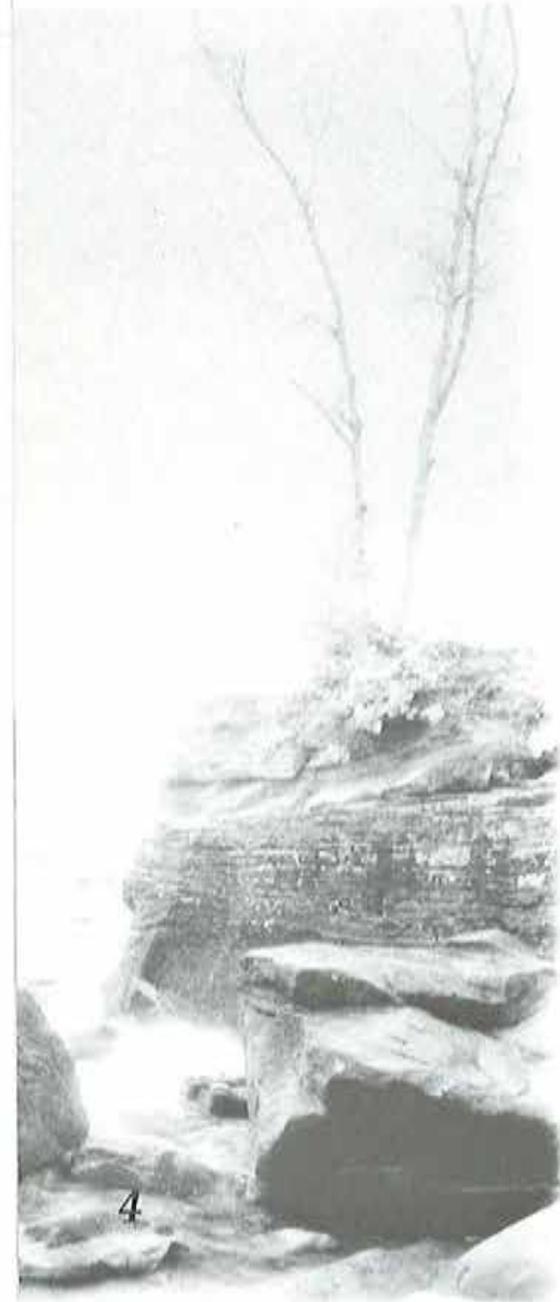
For this year's *State of the Great Lakes* report, we asked several guest writers, many of them experts in their fields, representing diverse interests, to give their perspective on the state of the Great Lakes. While each perspective is different, all concede that the Great Lakes have improved over the last few decades.

Concerns remain about contaminants found in the Great Lakes ecosystem. The lakes have come a long way from the time when Lake Erie was pronounced "dead." However, there is still room for improving their quality.

We hope you enjoy reading these contributions provided by our guest writers. These statements represent some of the most respected opinions on Great Lakes issues. They should offer a stimulating survey of current thinking on matters of concern in the Great Lakes Basin.

Contents

Great Lakes Water Quality Issues	
Great Lakes Water Quality Guidance	10
Making a Great Lake Superior	12
Remedial Action Plans	16
Lakewide Management Plans	17
Great Lakes Environmental Pollution Issues	
Mercury	20
Chlorine	21
Pollution Prevention	24
Atmospheric Deposition	25
Great Lakes Fishery and Health	
Fish Consumption Concerns.	28
Human Health Effects	29
Great Lakes Protection Fund/ Michigan Great Lakes Protection Fund	30
Non-Indigenous Aquatic Nuisance Species	32
Taking a Watershed Approach	
Saginaw Bay National Watershed Initiative	34
Grand Traverse Bay Watershed Initiative	36
Other Great Lakes Issues of Interest	
New Water Use Reporting Program.	38
Lake Levels Reference Study.	39
Extended Shipping Season at the Soo Locks	40
Great Lakes Biological Diversity	41
The Great Lakes: Environmental Trends	42



Opinions from the Experts



6

George L. Cornell, Director of the Native American Institute, Michigan State University
A Native Perspective on the Great Lakes

"We may be responding too little too late in our effort to clean-up and protect the world's largest bodies of fresh water."

8

Mark Van Putten, Director of the Great Lakes Natural Resource Center, National Wildlife Federation
Protecting the Great Lakes . . . and Ourselves

"...our health and well-being ultimately depends on protecting the land, air and waters of the Great Lakes ecosystem."



14 **Glenda Daniel**, former Executive Director of the Lake Michigan Federation
Contaminated Sediment: Some Reason for Cautious Optimism

"How clean can water be if the bowl that holds it is dirty?"

William Cooper, Professor of Zoology, Michigan State University
An Ecologist's View

18

"The biggest risk to the integrity of the natural fauna and flora of the Great Lakes is not due to toxic substances, but due to the introduction of exotic species."



22

Grace Wever, Vice-President of Environmental Affairs, Council of Great Lakes Industries
Responsible Choices . . . Responsible Stewardship

"The region's preoccupation with pollution . . . has distracted us from other pressing environmental management concerns ..."

Robert W. Beecher, Executive Secretary of the Great Lakes Fishery Commission

26

Managing Great Lakes Fisheries in the 1990's

"...Great Lakes fisheries has become a major challenge as our initial successes . . . have ushered in a new generation of even more-complex challenges."

46 **Tom Martin**, Executive Director of the Everglades System Restoration Campaign, National Audubon Society, former director, Office of the Great Lakes
Restoration of the Great Lakes Ecosystem

"We must make our programs like the ecosystems they protect, connected and cooperative."

A Native Perspective on



*Dr. George L. Cornell, Director
Native American Institute
Michigan State University*

For thousands of years, indigenous populations have been relying, to some extent, on the Great Lakes for their livelihood. The earliest people to inhabit the region followed the receding glaciers and hunted large mammals and fished the waters of what we would eventually call the Great Lakes. These waters provided an abundant fishery for the peoples of the emerging peninsula, and the large lakes were viewed with wonder and awe. Cultures rose and were supplanted by other indigenous cultures. Eventually, the Anishnabeg (Ojibway, Ottawa, and Potawatomi) took possession of the land after a series of migrations which originated on the Eastern Seaboard. They moved from one aquatic environment to another and possessed the technology to effectively harvest large numbers of fish from the waters of Mi-chi-gum, Mi-chi-ganing, or Mi-chi-go-nong, as the lakes were called. The name translated to "big or large lake/water" and was used to collectively refer to the very large bodies of water that surrounded the region's peninsulas. Of course there are many variants of the Algonquin word and this is where our state derived the name Michigan: great/big waters. The name is an important part of a tradition and legacy that has been bestowed on the region by Native peoples.

The waters that covered the land and flowed underground were viewed as the life blood of the Earth, the Mother of the people. The waters were a life force within the Mother's body and contributed to her ability to nurture and sustain plants and animals which ensured the well-being of the people. This relationship between the Mother and the people was a spiritual bond that dictated actions and behavior. Native people made gifts to the water out of respect. The waters were powerful forces that aided the people but they could also destroy and must be propitiated. Over centuries, the bond remained strong. But then, things began to change.

After a series of international wars, the United States wrested control of the continent from European adversaries and maintained their control regardless of challenges to that authority. The resources of the continent became fuel for the industrial engines of the 19th century and great undertakings like the construction of the Sault Ste. Marie Locks were completed to accommodate shipping and trade. America began a period of rapacious resource use the likes of which the world has seldom seen since. In the post Civil War period, millions of Bison were killed for hides; Great Whales were slaughtered by the thousands for oil and corsets; and the Great Lakes fishery was "harvested" with a vengeance. Na-me, the Sturgeon, an important fish to the Anishnabeg, became a rarity as a result of targeted commercial fishing. The large Sturgeons wreaked havoc with commercial nets and therefore were marked for extermination. The average size of Lake Trout declined precipitously. Fifty and sixty pound fish became rarer and rarer and the end was not in sight. On land, the same things

the Great Lakes

were happening. The enormous White Pine forests were being cut at an astronomical rate while market hunting was taking an enormous toll on wildlife. Unfortunately these trends continued into the 20th century and in many instances were responsible for irreparable harm to the fishery, flora and fauna.

This collective history, shared by citizens of Michigan, leaves me with serious doubts when I ponder the future of the Great Lakes. Over the last fifty years, we have witnessed one crisis after another in relation to Mi-chi-ga-ning (the big waters). We have convinced ourselves that we need to become better managers and scientists. Yet, Na-me, the Sturgeon, has not returned and may be in danger of being unable to reproduce in the waters of the Great Lakes. This is one of many sad commentaries that color my perceptions of the future of the Great Lakes. By many apparent indicators we seem to be doing at least an adequate job in working to clean up and protect the Great Lakes watershed. Yet, water quality along with groundwater contamination continues to be a major issue and problem that demands more attention and resources. We may be responding too little too late in our effort to clean-up and protect the world's largest bodies of fresh water.



" ... I'll remember that to Native peoples the Eagle is a messenger, a harbinger of things to come."

The accumulation of toxic substances in the food chain supported by the Great Lakes is still a very serious problem for people and wildlife. We need to continue to work to reduce point-source contamination and airborne pollution which threatens water quality in the Great Lakes as well as in inland lakes. We need to move to a position of fewer compromises on water quality issues and ensure the steady, continued revitalization of the Great Lakes; and we need to do it now.

In slightly more than one century we have witnessed, and in some instances participated in, the near destruction of one of the world's truly great resources. Over the intervening years, and particularly in the last three decades, we have begun to realize our folly. Our attempts to "fix" the problem have paid some dividends, but we still have a long way to go. When Lake Trout and Na-me, the Sturgeon, are once again naturally reproducing in Great Lakes waters, I'll begin to utter a sigh of relief. When I stop reading reports of Bald Eagles born with deformed beaks and other birth defects, I'll become a bit more of an optimist. Until then, I'll remember that to Native peoples the Eagle is a messenger, a harbinger of things to come. The signal is clear. We need to redouble our efforts and ensure sustained, enforceable protection of Mi-chi-ga-ning, the Great Waters.

Protecting the Great Lakes



Mark Van Putten, Director
Great Lakes
Natural Resource Center
National Wildlife Federation

We have made substantial progress in controlling many sources of Great Lakes pollution, especially municipal discharges of human wastes and nutrients—so-called “conventional” pollution. One result is that Lake Erie has been reborn and is currently one of the world’s finest walleye fisheries.

Unfortunately, toxic pollution continues at harmful levels. Scientists have found evidence of subtle effects on people, including responses to hormone-mimicking pollutants that may be harming infants and children. As a result, public health officials warn children and women of child-bearing age not to eat many species of Great Lakes fish.

The well-being of wildlife is particularly revealing of the health of the Great Lakes ecosystem. Wildlife, especially eagles, first revealed the harmful effects of DDT and other pesticides. Recently discovered deformities in eaglets from nests along Great Lakes shorelines suggests that other toxics contaminating fish consumed by adult eagles also threaten the ecosystem. This is a critical warning since the effects on children of women who eat these fish, while less dramatic, may hinder normal development and learning.

Recently, the United States and the eight Great Lakes states have taken important steps toward controlling continued dumping of the most dangerous toxics. For example, the U.S. Environmental Protection Agency and the Great Lakes states have completed the first phase of the Great Lakes Water Quality Initiative. The Initiative is a collaborative effort between governments, industry, academics and environmentalists to develop new toxic pollution standards that will apply consistently throughout the U.S. waters of the ecosystem.

But the Initiative has yet to be finalized by EPA and additional measures must be negotiated to control atmospheric sources of toxics, urban and rural runoff sources, and to clean up contaminated sediments lining many of the Great Lakes harbors and tributaries. And, the Canadians must be encouraged to develop comparable controls for their part of the ecosystem.

Governments have also begun to recognize the special challenges presented by Lake Superior, called the “crown jewel of the Great Lakes” by Governor Engler. In October 1991, an international and interstate agreement was signed to manage Lake Superior as a “zero discharge demonstration” zone to protect it from toxic pollution and to protect the Lake’s largely-undeveloped shoreline and forests. Implementation of this program has been erratic and a renewed commitment from government agencies is needed.

These programs, if completed, will significantly improve the health of people and wildlife in the region. But, wildlife is threatened by more than toxic pollution. Urban sprawl, the loss of open spaces, and the dredging and filling of wetlands all destroy critical wildlife

... and Ourselves

habitat. Notwithstanding the recommendations of Governor Engler's Relative Risk Task Force, comprehensive land use planning is nowhere near becoming a reality in Michigan.

As a result, Michigan's biological diversity — the rich mixture of animal and plant species — is threatened on several fronts. As open spaces and wetlands are converted to malls, housing tracts and factories, the wildlife and plant species dependant on these habitats disappear. Forest harvesting practices also reduce the diversity of habitats, favoring wildlife and plants dependent on young forests and banishing species that prefer older thicker stands of trees.

The fate of wildlife teaches us an important lesson. The toxic pollutants dumped by our factories and cities poison the food chain on which we ultimately rely. The spread and stresses of urbanization not only banish wildlife, but harm people both psychologically and physically. And the wild places in which we seek to recreate and recuperate become fewer and more crowded. It's an important reminder that, like the wildlife, our health and well-being ultimately depends on protecting the land, air and water of the Great Lakes ecosystem.



"...our health and well-being ultimately depends on protecting the land, air and waters of the Great Lakes ecosystem."

Great Lakes Water Quality Guide

Tens of thousands of chemicals are created, used and released to the Great Lakes each year from a variety of sources. The discharge of materials from point sources, such as waste treatment plants, has been regulated under the Federal Clean Water Act. Yet, each State has

independently established discharge limitations for its own waters. This has resulted in some extreme disparities in pollution control requirements between the states. Certain types of contaminants threaten the ecosystem far beyond the immediate vicinity of a discharge, and lax pollution control standards can encourage unhealthy competition among industrial dischargers looking for minimum environmental restrictions.

In April 1993, the U.S. Environmental Protection Agency unveiled draft regulations that would substantially eliminate the discharge of persistent toxic contaminants from point sources throughout the Great Lakes ecosystem. The Great Lakes Water Quality Guidance, also known as the Great Lakes Initiative, or GLI, is intended to bring consistency to water quality protection among the Great Lakes states. EPA identified 28 bioaccumulative contaminants of concern (BCCs) that do not break down in the environment, are highly toxic to fish, wildlife and humans, and accumulate over a lifetime, reaching higher and higher concentrations as they move up the food chain. The discharge of these and other potentially persistent toxic chemicals, will be strictly limited by the GLI. The new guidance encourages a pollution prevention approach through facility environmental audits, so persistent toxics can be substituted, isolated or eliminated from processes and discharges.

Governor Engler has clearly established his support for the uniform limitations established by the GLI. These limitations will protect the Great Lakes and balance the possible economic disadvantage associated with Michigan's fairly restrictive standards for discharge of toxic contaminants. Many key components of the GLI were patterned after Michigan's regulatory program. Point source discharges are regulated and recognized as a fraction of the total loading of contaminants to the lakes.

EPA's focus on point sources has been challenged as inconsistent with a risk-based approach to addressing environmental and public health problems with the highest gain and least cost. Governor Engler and the Michigan Department of Natural Resources have

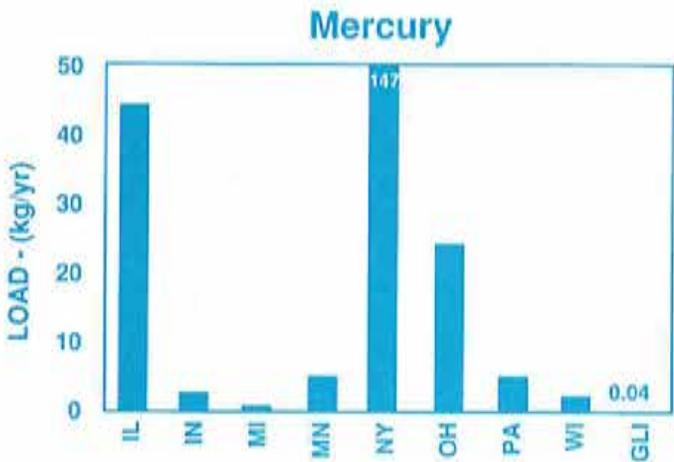
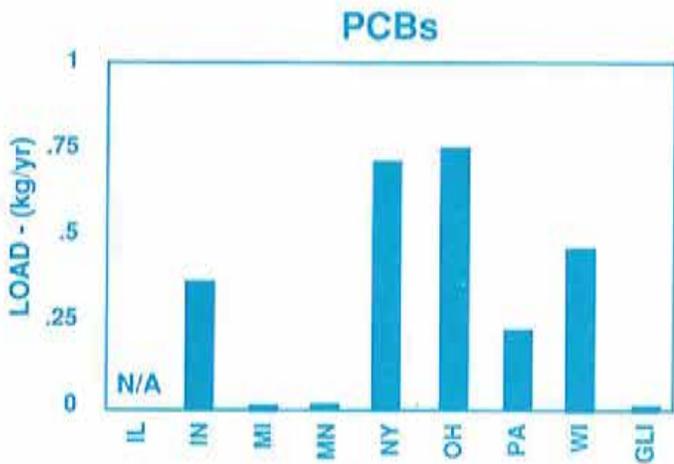


recommended certain cost-effective changes to the GLI about intake credits, anti-degradation procedures and the mercury criterion. Opponents to the GLI suggest that investment of limited financial and government resources in further control of point sources will limit their ability to respond to other, more significant sources of toxic contaminants. EPA and the Great Lakes states view the GLI as a single piece of a much broader program addressing persistent toxic contaminants and their ecological impacts to the Great Lakes. Separate programs will also target historic contamination sites, non-point source pollution, and atmospheric transport of contaminants into the Great Lakes.

A final version of the Guidance is expected by early 1995. The States will then have two years to promulgate their own rule changes to implement the new standard-setting program. In the interim, Michigan business, government and environmental leaders will continue the dialogue with EPA to complete the process to protect water quality fairly and effectively throughout the Great Lakes basin.

Bioaccumulative Chemicals of Concern (BCCs):

- Aldrin
- 4-Bromophenyl phenyl ether
- Chlordane
- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Dieldrin
- Endrin
- Heptachlor
- Heptachlor epoxide
- Hexachlorobenzene
- Hexachlorobutadiene
- Hexachlorocyclohexane
- alpha-Hexachlorocyclohexane
- beta-Hexachlorocyclohexane
- delta-Hexachlorocyclohexane
- Lindane
- Mercury
- Methoxychlor
- Mirex
- Octachlorostyrene
- Polychlorinated Biphenyls
- Pentachlorobenzene
- Photomirex
- Dioxin
- 1,2,3,4-Tetrachlorobenzene
- 1,2,4,5-Tetrachlorobenzene
- Toxaphene



Annual PCB and Mercury loads discharged by a "hypothetical facility." Comparison shows differences allowed by current state standards and the proposed Great Lakes Initiative standards.

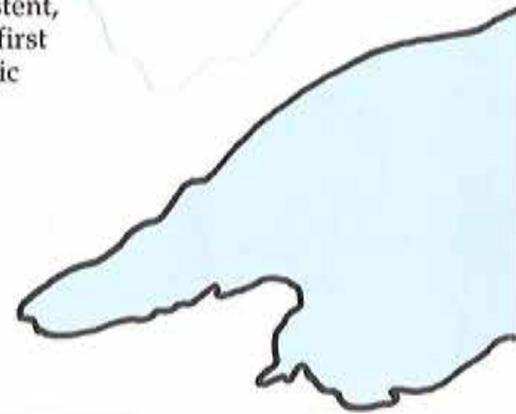
Figure from: National Wildlife Federation, 1993. *Cutting the Poisons*.
 Data from: Foran, Jeffery A. 1991. *A report to the International Joint Commission, Washington, D.C. and Ottawa, Ontario.*

“Making a Great Lake Superior”

Nowhere else in Michigan is the vast, wild beauty of the Great Lakes better captured in our imagination than it is by the largest of all the lakes, Lake Superior. The Upper Peninsula is remote and rugged enough to have missed the urban, suburban and agricultural development that crowds the natural landscape in much of the remainder of Michigan. The areas surrounding Lake Superior continue to be a place of outstanding natural beauty.

In recognition of Lake Superior's relatively pristine character, the state governments of Michigan, Minnesota, Wisconsin, and the Province of Ontario have joined forces with the U.S. and Canadian governments to develop cooperative environmental protection initiatives between public and private interests, using a more holistic approach to environmental protection of the Lake Superior basin. The Binational Program to *Restore and Protect Lake Superior*, initiated in October of 1991, was created with two purposes. First, to be a demonstration area for the goal of achieving “zero discharge” of certain persistent toxic chemicals in the Lake Superior basin; and second, to identify ecosystem impairments and develop strategies for protection and restoration of its highest priority fish and wildlife habitat. The goal of “zero discharge” is of critical significance in the Great Lakes because of the limited capacity of the ecosystem to assimilate persistent toxins without adverse effects. The “residence time” for the waters of Lake Superior is estimated to be 191 years, so persistent toxic substances entering those waters may spend decades doing harm to the fish, wildlife and people that consume them. The Binational Program, which has initially targeted nine persistent, bioaccumulative toxic contaminants, will be the first practical test of the “zero discharge” goal. Specific activities to achieve this goal include pollution prevention projects to reduce and eliminate the production of toxic contaminants, improved regulation and remediation techniques, and designation of special areas for expanded protection from discharge impacts. The broader program will use an ecosystem approach to improve fisheries resources, enhance efforts to control nuisance exotic species and identify critical fish and wildlife habitat and suggest strategies to protect high priority areas through acquisition, management and restoration efforts by means of public and private partnerships.

The ultimate goal of the Binational Program is to prove that economic and ecologic objectives are not mutually exclusive and, in fact, must be considered together to sustain the character of the Lake Superior region. The Binational Program includes representatives from the State, Federal and Provincial governments who confer with a diverse network of business, industry, municipal and public interest groups active in the Lake Superior watershed. Working together, the participants and volunteers are exploring ways to recruit clean industry and to provide incentives or technical



assistance that will move the basin toward "zero discharge" operations. The Binational Program is supported in part by U.S. Environmental Protection Agency grant funding to the states and participating organizations. While the Lake Superior region and its inhabitants are unique in the Great Lakes, hopes are high that the Binational Program can set an example that can guide other parts of the Great Lakes.



The "residence time" for the waters of Lake Superior is estimated to be 191 years . . .

Contaminated Sediment: Some Reason for Cautious



Glenda Daniel,
former Executive Director,
Lake Michigan Federation

How clean can water be if the bowl that holds it is dirty?

Contaminated sediment is toxic muck lining the bottom of many nearshore areas of the Great Lakes along with bays, harbors and tributaries that flow into the lakes. There was a time when we thought sediment was a sink for toxic chemicals. We now know sediment, along with the contaminants bound to it, are stirred up constantly through the action of wind, waves and currents, the movement of microscopic bottom-dwelling organisms or ocean-going vessels. Through this resuspension, contaminants find their way into the food chain. Levels of persistent organic chemicals, including PCBs and DDT, banned from current use, are still showing dangerous levels in fish, fish-eating birds and mammals. So are volatile metals like mercury that lodge in fish muscle tissue and not just in fat. "Wasting syndrome" in fish, the inability of young fry to thrive when they leave their mothers, is tied to PCBs.

For many years, the difficulty of finding money and safe ways of dredging, storing and treating contaminated sediment has offset the positive efforts made by manufacturers, municipalities and farmers to reduce current loadings of toxic chemicals to the Great Lakes ecosystem. As we begin the new year of 1994, however, there are some reasons for cautious optimism.

First, the six-year, multi-agency effort called Assessment and Remediation of Contaminated Sediment (ARCS) is drawing to a close, and guidance documents providing cost-effective choices for finding, assessing and treating contaminated sediments are about to be published for use by states and other jurisdictions. It is broadly assumed and often said that technologies for treatment of contaminated sediment are still in their infancy, but the ARCS program has identified a handful of technologies that can potentially be "sized-up" for use in full-scale remediation with very little modification.

Second, legislative authority and appropriations are being proposed at the Federal level to transfer the ARCS knowledge and secure some funding for states to begin cleanup efforts or, at a minimum, full-scale demonstration of the most promising technologies. Saginaw River and Bay in Michigan's Thumb Area have already benefitted from being one of the five sites chosen for ARCS research and technology demonstrations, so a great deal of up-to-date information at that site is already available for use in state cleanup actions.

Revisions to Superfund's scoring system for National Priority Sites is also likely to benefit in-water contaminated sites like the Kalamazoo River in Western Michigan. Substantial cleanup of

Optimism

contaminated sediments has already taken place at several Great Lakes Superfund sites. Bioremediation has been involved in the Sheboygan River cleanup in Wisconsin, and a technology involving "thermal desorption," heat short of burning, to isolate PCBs from sediment was used in the Waukegan, Illinois cleanup. Federal/State commitments requiring contaminated sediment cleanup as part of consent agreements with point source discharge permit violators is also a positive sign. This federal approach has been used in a series of consent agreements with industries and municipalities within the Grand Calumet River/Indiana Harbor Canal Area of Concern, and it has been proposed for federal action Great Lakes-wide in legislation



"Public/private partnerships . . . will be essential in providing the leadership to make sure momentum continues and a sense of urgency on this issue is not lost."

proposed by Congressman Peter Visclosky from northwest Indiana.

Finally, it is important to remember that while contaminants from sediment are a major source of pollutants to the Great Lakes, possibly even a larger source than air, contaminated sediment is not scattered evenly throughout the Great Lakes, but is highly localized. If Michigan and other states continue to support Remedial Action Plans in Areas of Concern, and if that support can be escalated to require some real prioritized action instead of long-term planning and dialogue in the absence of results, there is real hope that substantial progress can be made.

Public/private partnerships involving local and state governments, port authorities, private companies and environmental groups will be essential in providing the leadership to make sure momentum continues and a sense of urgency on this issue is not lost. The continuing progress on technology and a speed-up of criteria development already underway is likely to speed up funding for essential environmental dredging and disposal decisions, but public ports, in particular, need to take an active role in support of contaminated sediment clean-up in order to make it happen sooner rather than later.

Remedial Action Plans

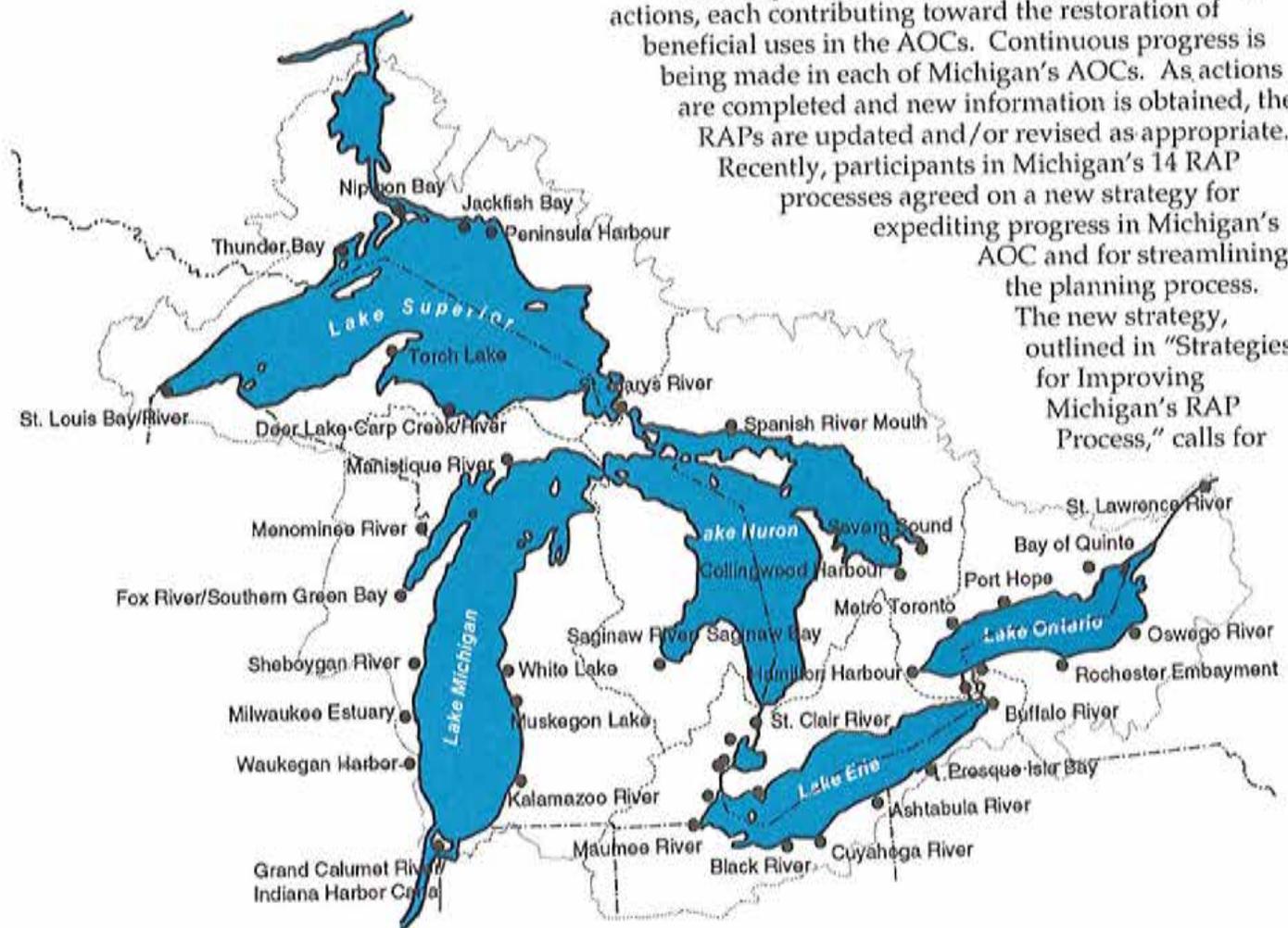
In 1985, the Great Lakes states and the province of Ontario instituted an aggressive program to address severe pollution problems in 42 specific Areas of Concern (AOC) in the Great Lakes. As of 1991, there are now 43 AOCs. Fourteen of these AOC are in Michigan. For each AOC, Ontario and the states agreed to develop a Remedial Action Plan (RAP) to identify the pollution problems and cleanup actions necessary to restore and protect beneficial uses.

A RAP is a long-term, iterative planning process meant to define the environmental problems, identify the actions needed to restore and protect beneficial uses, and document beneficial uses that have been restored. Great strides have been made in the development and implementation of Michigan's RAPs. RAPs have been developed for thirteen of Michigan's fourteen AOCs. Four of the RAPs focus primarily on the problem definition; nine also include recommendations for resolving identification problems.

The focal point for RAPs in Michigan is continuing actions, each contributing toward the restoration of beneficial uses in the AOCs. Continuous progress is being made in each of Michigan's AOCs. As actions are completed and new information is obtained, the RAPs are updated and/or revised as appropriate.

Recently, participants in Michigan's 14 RAP processes agreed on a new strategy for expediting progress in Michigan's AOC and for streamlining the planning process.

The new strategy, outlined in "Strategies for Improving Michigan's RAP Process," calls for



strengthening partnerships among State, Federal and local agencies and the public, emphasizing actions to restore and protect beneficial uses rather than detailed documents, and streamlining the RAP review process.

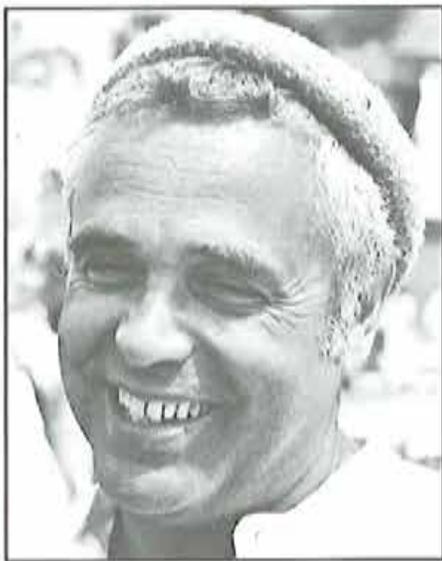
A vital component to Michigan's success is its strong commitment to pursuing public input and support. In 1991, a Statewide Public Advisory Council (SPAC) was established to advise the Michigan Department of Natural Resources on key aspects of the AOC Program including priorities, policies, public participation, and technical issues relevant to all 14 AOCs. In addition to the SPAC, local public participation programs involve the public in the development and implementation of each RAP. Annual conferences sponsored by the DNR and SPAC are held for citizens and technical experts from all 14 Michigan AOCs to discuss successful RAP development and implementation strategies. Participants have the opportunity to share information among the different AOCs and to strengthen existing partnerships.



Lakewide Management Plans

The Great Lakes Water Quality Agreement requires that Lakewide Management Plans (LaMPs) be developed and implemented for each of the Great Lakes. The purpose of a LaMP is to provide a comprehensive strategy to restore and protect "beneficial uses" in the open waters of each Great Lake. The U.S. Environmental Protection Agency, in cooperation with other State and Federal agencies, has initiated LaMP activities in Lakes Michigan, Superior and Erie. The agencies hope to initiate efforts for Lake Huron in 1994. Public Advisory Forums will also be used to help guide development and implementation of the LaMPs.

An Ecologist's View



Bill Cooper, professor
Michigan State University

My perception of the conditions of the Great Lakes is based upon some 40 years of direct involvement through recreation, research, policy and environmental impact review activities. These experiences were further enhanced by the Relative Risk Analyses that I directed for both the United States Environmental Protection Agency and the State of Michigan. With the exception of a few "hot spots," most of which are located in riverine and/or estuarine locations adjacent to the lakes, the Great Lakes are generally in good condition. Lake Ontario is the most impacted by persistent toxicants since it is located at the bottom of the drainage basin.

Some continue to claim that the Great Lakes' ecosystems are at high risk and that more draconian regulatory actions must be taken to "save the lakes." This is reflected in the attempts to declare Lake Superior a "toxic free zone," in sections of the proposed Great Lakes Initiative and the proposed water quality criteria designed to protect wildlife.

Toxic substances that are persistent and bioconcentrate in aquatic food chains are of most concern. The hard pesticides (DDT, dieldrin, etc.) and the polychlorinated biphenyls (PCBs) have been banned from use because there was no way to guarantee adequate regulations. Current input of these substances is primarily (80%+) airborne and the sources mostly exist outside the airshed of the Great Lakes. These levels are consistently decreasing as the sources are eliminated. The residual concentrations in fish are low, and they will continue to slowly decline.

The more difficult toxicants are mercury, dioxins and polycyclic aromatic hydrocarbons (PAHs). These materials are either natural (mercury and PAHs) or secondary byproducts of oxidative processes (dioxins). Within this subset, mercury constitutes the largest regulatory challenge. Roughly 50% of the mercury cycling in the environment is from natural sources. The remaining sources are split equally between coal combustion and incineration. Again, about 80% of the input to the aquatic system is airborne deposition. Most of the mercury bioconcentration is observed in inland lakes and rivers, not in the Great Lakes, due to the warmer temperatures and high enrichment conditions.

The continued presence of these toxic materials in the Great Lakes' ecosystem does not appear to be threatening the ecological resources. The biggest negative impacts are not to the ecology, but rather to the economy. The ambient concentrations of mercury are not killing the fish, but they are having a negative impact on the recreational fishing industry. Given the nature of the non-distinct sources (nonpoint source), the regional distribution of the sources, the atmospheric transport of the toxicant and the uncontrollable residual component (those residues still remaining after the implementation of Best Available Technology), alternative regulatory activities will

probably be required. For toxicants like mercury, we will probably need to regulate exposure (fish consumption advisories) as well as end-of-the-pipe controls.

The Relative Risk Analyses included the risks associated with the exposure to toxic substances. If there is little exposure, there is, generally, little risk. The mere presence of a material in the environment is not a threat to the health of humans and/or the environment. The presence of high concentrations of copper in Lake Superior sediments by the Keweenaw Peninsula should have impacted the resident benthic invertebrate community. The ionic state of the copper renders it inert and a very healthy benthic community with many sensitive species is coexisting with the metallic residue.

The biggest risk to the integrity of the natural fauna and flora of the Great Lakes is not due to toxic substances, but due to the introduction of exotic species. The impacts of the carp, alewife, sea lamprey, zebra mussel, purple loose strife, smelt, salmon, etc., are well documented, very large and irreversible. Introductions are not dose/exposure/response phenomena like the impacts of toxic substances. Rather, they are episodic events which only have to happen once. There are few, if any, enforceable regulations that limited these events. Many of these introductions were intentional. Humans still have this arrogant attitude that they can improve on "Mother Nature."

If one wished to allocate scarce monetary and human resources so as to maximize the reduction in ecological risk per unit resource expended, one would do more good by regulating and/or limiting the introductions of exotics than by obtaining marginal reductions in trace levels of existing toxicants.

The same argument can be made for the destruction of habitat and the concomitant loss of endemic species. The habitat loss issue is one of land use. We have no integrated land use policy in Michigan that includes both human and ecological resources. Again, one will get more bang-for-the-buck by addressing land use issues than manipulating marginal chemistry.

In conclusion, we have done a rather remarkable job protecting (Lake Superior) and restoring (Lake Erie) our Great Lakes. A continued effort is absolutely necessary to maintain this profile. Some specific "hot spots" will require additional remediation. Our most important new regulatory efforts in the future should involve exotic introductions and habitat alterations. One does not have to be apologetic or defensive over our past commitments and regulatory activities. Rather, one should maintain our baseline regulatory activities and initiate new activities where they produce demonstrable reductions in risk to ecological and human health.

"... one will get more bang-for-the-buck by addressing land use issues than manipulating marginal chemistry."



Mercury

Mercury has been widely used for a variety of medical, electrical and manufacturing purposes. It also occurs naturally and is released by burning fossil fuels. It readily evaporates into the air where certain forms of mercury can be transported considerable distances before being deposited. The cycling of mercury when it reaches the aquatic environment is an extremely complex process, dependent on the chemical and physical properties of a given water body. Microorganisms convert some of the mercury into a toxic form called methylmercury that is easily absorbed by fish and other aquatic organisms directly from the water, as well as through dietary ingestion.

An adult can readily excrete mercury from the body, but children and fetuses are more vulnerable to the adverse health effects of mercury exposure. Concern about mercury in game fish has resulted in fish consumption advisories throughout the Great Lakes region. Wildlife are also vulnerable to the toxic effects of mercury. Michigan-based field studies of mercury effects on wildlife populations are limited, but available data indicates that mercury levels in fish-eating species are near or slightly lower than residue levels associated with toxic effects in laboratory studies.

At the request of Governor Engler, the Michigan Environmental Science Board developed a report that reviews our current knowledge about mercury in the environment, titled "Mercury in Michigan's Environment: Environmental and Human Health Concerns." As a result, the Michigan Departments of Natural Resources and Public Health, along with the Public Service Commission, have recently completed an action plan describing the cooperative steps necessary to reduce the threat of mercury in the environment. Particularly important will be pollution prevention and waste reduction, coupled with reductions in air emissions of mercury required by the new Federal Clean Air Act amendments.

The Federal Clean Air Act amendments of 1990 will require maximum achievable control technology (MACT) for specific sources of mercury which should facilitate the reduction of mercury loading to our lakes as well. Removing mercury containing products from the waste stream going to incinerators, recycling mercury containing products, and reducing mercury emissions from coal-fired power plants are other mechanisms recommended to minimize the adverse environmental and health effects of methylmercury. The U.S. Environmental Protection Agency is coordinating a comprehensive assessment of atmospheric deposition of hazardous air pollutants, including mercury, known as the "Great Waters Study." Based on their findings, EPA must promulgate emission standards or control measures to prevent adverse environmental effects by 1995.



Chlorine

The International Joint Commission's (IJC) Sixth Biennial Report (1992) recommended, "The parties, in consultation with industry and other affected interests, develop timetables to sunset the use of chlorine and chlorine-containing compounds as industrial feedstocks and that the means of reducing or eliminating other uses be examined."

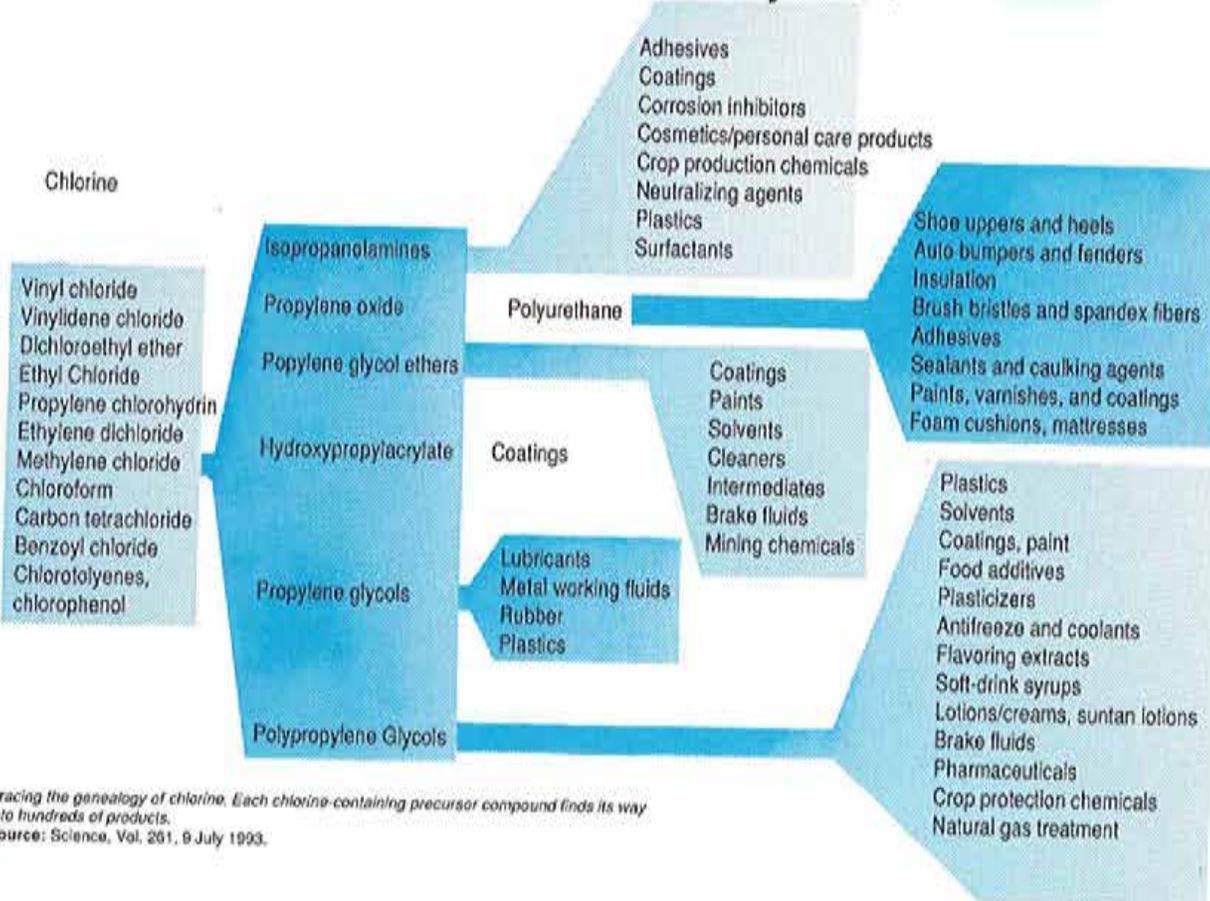
This recommendation followed the IJC's Virtual Elimination Task Force investigation of the amended Great Lakes Initiative requirement to virtually eliminate the input of persistent toxic substances into the Great Lakes Basin Ecosystem. The recommendation to sunset chlorine use has generated controversy. Some groups believe that more than enough evidence exists to document unacceptable biological effects from a wide range of chlorine-containing compounds; others believe that chlorine containing compounds should be evaluated on a compound by compound basis.

The U.S. Environmental Protection Agency indicated that the issue needs further examination while Environment Canada found a lack of scientific evidence to support the ban. Recently, Governor Engler asked the Michigan Environmental Science Board to study the use of chlorine and its input on our environment and public health. While chlorine is critical to the protection of our drinking water and vital to many industries and jobs they support, questions about chlorine's relative risk to public health must be answered. Governor Engler asked the Board to evaluate the scientific basis for the IJC recommendation, and to evaluate and propose options to protect the public and the Great Lakes.

12 Million tons of Chlorine is produced annually in the U.S., with major uses in:

- **plastics (52%)**
- **organic chemicals(18%)**
- **pulp and paper (14%)**
- **inorganic chemicals (11%)**
- **wastewater treatment (4%)**
- **drinking water (1%)**

One Branch of the Chlorine Family Tree



Tracing the genealogy of chlorine. Each chlorine-containing precursor compound finds its way into hundreds of products.
Source: Science, Vol. 261, 9 July 1993.

Responsible Choices . . . Re



Grace Weaver, Ph.D.
Vice-President
Environmental Affairs, Council of
Great Lakes Industries

The State of the Lakes Today, thanks to the efforts of many, the Great Lakes are not in crisis. Over a decade ago, their problems were highly visible. But two decades of intervention by governments and the public and private sectors have done much to alleviate this through improved treatment, tighter standards, and voluntary pollution prevention addressing both conventional and toxic pollutants. Data from both Canada and the United States indicate that such point source programs have been highly effective. Discharge levels of chemicals have been drastically reduced, and in turn, their levels have dropped in fish tissues, in sediments, and in the water column. Concerns remain, however, about a small subset of chemicals that are persistent, bioaccumulative, and toxic. Nonpoint sources are by far the greatest contributors of these materials. For example, air deposition contributes 90% of the mercury entering the lakes, and residual chemicals are still found in sediments and landfills. While many programs have been established by both Canada and the U.S. to address nonpoint sources, the issue still begs for better coordination of both point and nonpoint source programs. Cost-effective technologies, including innovative remediation, are needed, and barriers to the use of these methods need to be removed.

Far more controversial is the topic of human health effects of bioaccumulative persistent toxic chemicals. Definitive data needs to be gathered that establishes where risks are real, and where they are perceived or phantom in nature. Several studies are underway that will provide sound science for decision-making. While this issue awaits resolution however, we are not standing still, nor are we slipping backward. Tighter discharge standards and ongoing pollution prevention programs continue to diminish point source discharges of these materials. Some have proposed broad-brush chemical bans for whole classes of chemicals. This clearly is not a viable solution. Removing chemicals such as chlorine, for example, from commerce would rapidly lead to very real (not phantom) effects on both the region's economy as well as its underlying social systems. Today, approximately 40% of all U.S. jobs and income depends on chlorine chemistry, including the synthesis of 85% of all pharmaceutical products. The safety of drinking water supplies has been ensured since chlorine disinfection was adopted. Regional leaders need to find consensus on a more rational, science-based approach to such issues, that includes analysis of such risks, benefits, and costs as a part of the decision-making process.

The region's preoccupation with pollution over the past two decades has distracted us from other pressing environmental management concerns such as land-use and biodiversity. We are beginning to develop systems (e.g., GIS, or Geographic Information Systems) that will allow us to understand the extent of our urban and rural encroachment on habitat and its effects on the diversity of our biological base. If the region truly intends to adopt an ecosystem-

Responsible Stewardship

based approach to environmental management, then it will need to expand its vision beyond a single parameter such as chemicals to effective analysis and management of all factors that affect the well-being of its natural resource base, including land-use and other such lifestyle-based choices. We will need to adopt a more integrated approach to plan for the sustainability of both our natural resource base and the economic system that underwrites the stability and health of our social systems as well.

Accomplishments and Progress: The Good News Business, throughout the past decade, has done its part re-thinking its responsibilities and adopting a more holistic approach to environmental and economic management. Perhaps our most unique contribution has been applying business and technical skills, such as Total Quality Management and environmentally sound technologies in a way that has added great value to the environmental movement. The effect of the quality movement on corporate culture has been dramatic, driving home the need to expand its more traditional focus on customers to include all stakeholders. Many have adopted sustainability principles and use quality-based systems translating principles into action through business plans that integrate economic and environmental priorities.



"Today, approximately 40% of all U.S. jobs and income depend on chlorine chemistry."

The results of such change have been startling over the past decade. Voluntary programs such as the U.S. Environmental Protection Agency's 33/50 program and the chemical industry's Responsible Care are bearing fruit. Many partnerships have been launched, e.g., the automakers' separate agreements with the Canadian and U.S. governments on reducing toxic emissions, and a Council of Great Lakes Governors' initiative with the printing industry. While the latter two efforts are limited by the fact that they mainly focus on a single variable—materials—rather than on the entire lifecycle, they still set a benchmark for future partnering. Continued research will be needed before lifecycle analysis can become a valid and reliable technique for the development of new and innovative technologies that would enhance economic growth in areas such as manufacturing, waste management, and remediation.

The good news from business, chronicling our environmental progress over the past decade, far exceeds the space allotted to this essay...

.... and that is also the good news!

Pollution Prevention (P²)

Environmental problems have traditionally been addressed through "command and control" regulatory programs. While it has been effective, the approach is expensive, confrontational and complex. Recently, more cooperative and mutually beneficial approaches are being pursued. Pollution prevention is one of these concepts, capitalizing on business' goals to minimize waste and cut costs, while working with government and public interests in health and environmental protection.

P² in industry refers to the examination of manufacturing operations and practices with the aim of reducing waste. Every aspect of an operation, from materials handling, production, finishing and packaging, has the potential to produce emissions, waste or otherwise limit efficient use of resources. By finding the source of wastes and reducing their volume or toxicity, P² can substantially reduce costs associated with pollution control, treatment and disposal, and limit future liability associated with regulated discharges. The concept also applies to farms and agricultural operations in the form of soil conservation and cost-saving reductions in applications of herbicides, pesticides and fertilizers. P² is applicable to any waste-generating facility, such as hospitals, laboratories, factories, and offices.

P² programs tend to be specific to a particular facility or production process, and often occurs at the initiative of an innovative plant manager. Unfortunately, the knowledge gained may never leave the facility. Several academic, government and

EPA identified 17 chemicals associated with serious environmental and human health problems, and called for goals to reduce the releases of these chemicals by 50% by 1995. To date 1,150 companies have signed up nationally to participate, committing to more than 354 million pounds of reduction in toxic chemical emissions.

private organizations are advocating pollution prevention concepts and extending the opportunity for information exchange. The Michigan Departments of Commerce and Natural Resources, for example, have jointly supported the Environmental Services Division, a customer-oriented service group that is completely non-regulatory. They provide information, training, and technical assistance to Michigan businesses. A wealth of information on waste reduction issues can be found through their toll-free number (1-800-662-9278).

The Council of Great Lakes Governors is supporting several pollution prevention initiatives in the Great Lakes, including "Great Lakes Recycle" and the "Great Printers Project." The Governors have joined forces to boost recycling by drawing on their collective purchasing power and have set standards for recycled content of copy paper, other paper products, and refined lubricating oil used in state-owned vehicles. The Great Printers Project is a cooperative agreement between the Environmental Defense Fund, the Council and the Printing Industries of America. The goal of the project is to reduce pollution from solvents used in cleaning, waste inks and photo processing materials, and to reduce energy consumption where possible. The Council is also assisting the American Automobile Manufacturers Association (AAMA) and the DNR in a pollution prevention project designed to reduce the use and discharge of persistent toxic substances associated with auto parts manufacturing.

Source reduction, waste minimization, pollution prevention. . .these phrases represent the future for the manufacturing and industrial segment because these efforts can immediately improve "bottom line" costs. But P² should not be considered just an industry response to environmental concerns. Hospitals, offices, communities, households and individual consumers can also make an important, collective contribution to waste reduction. While recycling of solid waste, such as paper, tin, glass and some plastics, has caught on in many communities, other important P² opportunities will be explored in the coming year to help address problems with mercury, pesticides and hazardous household wastes.

Atmospheric Deposition

Atmospheric deposition has been demonstrated as being a significant source of certain toxic pollutants entering the Great Lakes. These toxic chemicals enter the atmosphere through a variety of mechanisms and sources. The pollutants may adhere to particles, snow or rain, then settle into the Great Lakes through direct deposition or run-off from land. Studies have shown that atmospheric deposition can account for as much as 90% of the loadings to some of the lakes of such pollutants as PCBs, DDTs, lead, mercury and benzo(a)pyrene. Much of the atmospheric contribution in the Great Lakes Basin is believed to result from long range transport to the region, including distances as far away as Mexico and Central America. State and Federal agencies will continue to focus efforts on identifying and reducing the sources of atmospheric deposition.

In our efforts to implement an ecosystem approach to deal with the Great Lakes, the atmospheric component is often the area where data gaps still exist. Identifying the last piece of the "environmental puzzle" will provide environmental managers with the critical information needed to prioritize resources and implement effective multi-media pollution prevention, control and management initiatives.

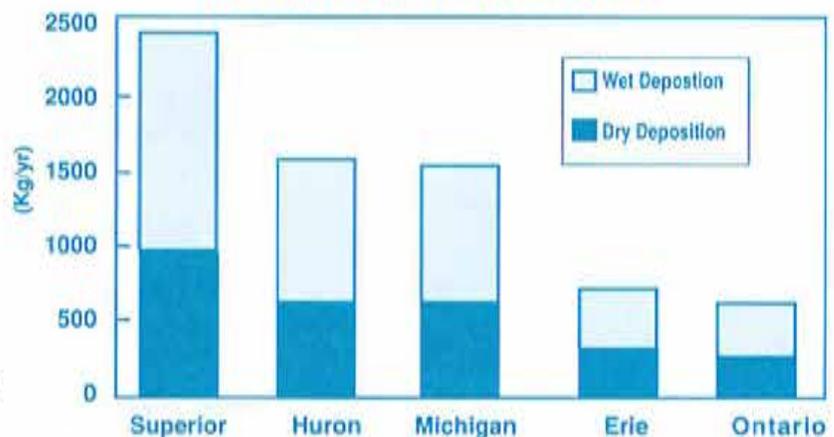
State and regional initiatives are being developed to protect the Great Lakes from air toxics deposition, and include the development of a Regional Great Lakes Air Toxics Emissions Inventory. This inventory is one of the tools necessary to identify air sources of hazardous pollutants. Michigan continues to serve as the lead agency for the development of a comprehensive, computerized regional emissions inventory database for pollutants of concern for the Great Lakes Basin.

Air toxics monitoring is another tool needed to identify air sources emitting hazardous air pollutants. Funded by the Michigan Great Lakes Protection Fund, and in partnership with the University of Michigan, the State conducted air monitoring of several pollutants including PCBs and pesticides. The University of Michigan is also conducting a mercury

monitoring study, which the State is participating in. Applying highly specialized air trajectory modeling and data interpretation, the University of Michigan researcher will evaluate the monitoring data to determine source regions of these pollutants and prepare estimates of the atmospheric deposition to the waters of Michigan. Also, representatives of the U.S. Environmental Protection Agency and the other Great Lakes states participated in a regional workshop which focused on environmental mercury reduction efforts. Proposed projects discussed included pollution prevention, public education, source identification and control of mercury emissions. Michigan will continue to implement its Department of Natural Resources' Action Plan which addresses the Michigan Environmental Science Board's recommendations on mercury.

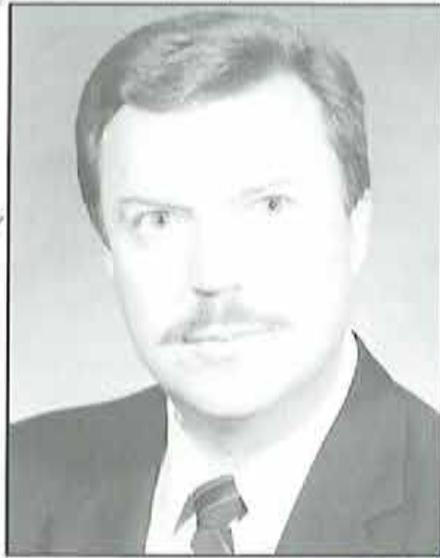
State and Federal regulations which protect the Great Lakes from air toxics include Michigan's air toxics rules. These rules, effective last year, require sources which emit toxic air contaminants to apply the best available control technology for these contaminants. Following this, a screening analysis is required to insure the levels found do not result in impact to human health. In addition, other programs through the Federal Clean Air Act amendments will help address the air toxics issue over the next few years and hopefully reduce air toxic emissions both within and outside the Great Lakes Region.

Estimated Atmospheric Deposition of Mercury to the Surface of the Great Lakes



Data Source: "Mercury in Michigan's Environment: Environmental and Human Health Concerns" (Michigan Environmental Science Board, April 1993, 2nd print, p. 11)

Managing Great Lakes Fis



Robert W. Beecher,
Executive Secretary
Great Lakes Fishery Commission

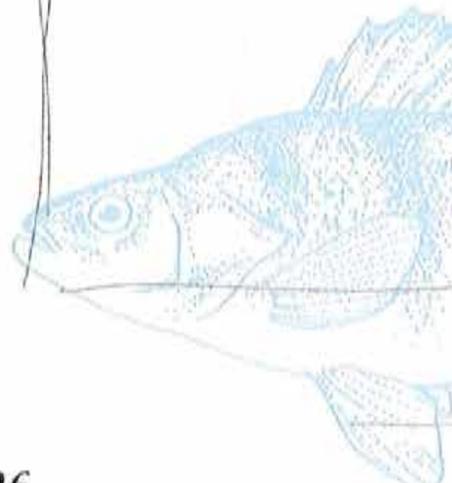
The 1955 Convention on Great Lakes Fisheries between the United States and Canada led to the creation of the Great Lakes Fishery Commission (GLFC) and gave it both the mandate to control sea lamprey, which had devastated the lake trout populations of the upper Great Lakes, and the responsibility to address fishery issues, which led to the infrastructure necessary to support coordinated fisheries management.

The Great Lakes Fish Management Miracle Less than ten years ago, the Great Lakes represented an unprecedented success for fisheries management. Walleye in western Lake Erie and lake trout in Lake Superior had virtually recovered from their slide toward commercial extinction. Whitefish, yellow perch and chubs were plentiful once more. Long-depleted populations of lake herring began to increase in Lake Superior, as did whitefish in Lakes Erie and Ontario. Hatchery-reared salmon and trout were recognized as supporting a recreational fishery with economic impacts estimated at \$2 to \$4 billion. Suppressed by stocked salmonids, rotting nuisance alewife no longer littered beaches annually. This fish management miracle resulted from the previous thirty-plus years of collective effort from federal, state, provincial and tribal agencies, and the GLFC.

New Challenges Sustaining this miraculous recovery has proven difficult. Beginning in the late 1980s, the chinook salmon fishery in Lake Michigan experienced a dramatic decline marked by an outbreak of bacterial kidney disease. Alewives, the main food of chinook salmon in Lakes Michigan and Ontario, had declined in Lake Michigan in the early 1980s. One objective of the salmon stocking program was to suppress alewives which had been at nuisance levels. Maintaining the robust salmon fishery may require abundant levels of alewife, but their future even in Lake Ontario is uncertain. Thus, it may not be possible to sustain the highly-valued salmon fishery in these two lakes at the high levels enjoyed during the past decade. On the bright side, smaller alewife populations in Lake Michigan are associated with the recovery of species such as, deepwater ciscoes, a native planktivore, and yellow perch.

Throughout the Great Lakes, the demand for fishing opportunities remains high and many fish populations have reached harvest levels that may be excessive. Weak recruitment of yellow perch resulted in intensive negotiation among Lake Erie fish managers on issues of harvest sharing. In Lake Superior, annual total mortality for lake trout exceeds the target rate of 45% in most jurisdictions, and yield is divided about equally between lamprey predation and fishing.

Most fishery uses of the Great Lakes depend upon annual control of the exotic sea lamprey. However, difficult fiscal challenges in both the U.S. and Canada have precluded funding levels sufficient for the GLFC to continue its historical level of sea lamprey control, to register chemical lampricides (as required by law), to research alternatives to



heries in the 1990s

lampricides and to initiate a course of action that will bring Lake Huron sea lamprey populations to a level comparable to that of the other lakes. (Lake Huron is home to more sea lamprey than the other four Great Lakes combined due to reproduction in the difficult-to-treat St. Marys River).

Finally, a new set of invading species threatens to alter the ecosystems of the Great Lakes. The zebra mussel invasion in Lake Erie has begun to influence nutrient and contaminant cycling, as well as food web dynamics. Ruffe have, in their Lake Superior foothold, become predominant and yellow perch has declined. Intentional introductions, undertaken for objectives other than fishery rehabilitation or generation of fishing opportunities, continue to occur without the scrutiny and consultation accorded those undertaken for fishery purposes. In short, sustaining the miracle of Great Lakes fisheries has become a major challenge as our initial successes (i.e. phosphate control, sea lamprey management and fish stocking) have ushered in a new generation of even more-complex challenges.

Opportunities for Collective Stewardship In a larger sense, our inability to meet these new challenges successfully will be a failure of collective stewardship. Although binational agreements have called for management in an ecosystem context, no one agency has the mandate for such a broad management approach.

The new challenge is to achieve true ecosystem management. This will require unprecedented cooperation among neighboring jurisdictions and allied disciplines in proactive planning and program delivery to allow a more profound realization of the 1980s fish management miracle. This cooperation will advance progress on basic fishery objectives of balancing predator and prey populations, preventing unplanned or ill-considered introductions and optimizing habitat.

Only by cooperating and coordinating efforts can fish management jurisdictions achieve these objectives for an entire lake. Similarly, the management of fish habitat including contaminants cannot be accomplished in isolation by fishery, water quality or public health agencies. Partnerships with environmental agencies are required to advance habitat restoration needs identified by fishery managers. Concurrently, biological integrity envisioned by the U.S. and Canadian Great Lakes Water Quality Agreement can be achieved only through a true partnership of fish and environmental managers. The bottomline is that renewed commitment to collective stewardship is a prerequisite for continuing progress in managing the Great Lakes ecosystem.



"... renewed commitment to collective stewardship is a prerequisite for continuing progress in managing the Great Lakes ecosystem."

Human Health Effects

In 1990, Congress amended the Great Lakes Critical Programs Act requiring a research report to Congress by September 30, 1994, to assess the harmful human health effects of water pollutants in the Great Lakes region. In support of this directive, Congress appropriated \$2 million in 1992 to the Agency for Toxic Substances Disease Registry (ATSDR) to support human health effects studies in the Great Lakes region.

The ATSDR Great Lakes Human Health Effects Research Program is designed to investigate and characterize the association between the consumption of contaminated Great Lakes fish and long-term harmful health effects.

Toward this end, ATSDR has developed a Great Lakes Health Effects Research Strategy. The goal of this strategy is to identify human populations residing in the Great Lakes basin who may be at greater risk of exposure to chemical contaminants present in one or more of the Great Lakes and to help prevent any adverse health effects. This strategy is built upon five traditional elements of disease prevention: identification, evaluation, control, dissemination and infrastructure.



Great Lakes Protection Fund

Regional

When Great Lakes governors created the Fund in 1989, they envisioned an organization that could reach across state and national boundaries, helping to solve the problems of the Great Lakes ecosystem. The Fund is the nation's first multi-state environmental endowment. The past year has seen progress on three fronts. First, the Fund's grantees have been achieving substantial results in the quest for answers to Great Lakes environmental problems. Second, the

Fund's board and staff have begun a demanding evaluation process to keep the funding program effective and tightly focused. Third, the endowment is growing toward its \$100 million goal. Since its inception, the Fund has awarded 65 grants totaling nearly \$8 million.

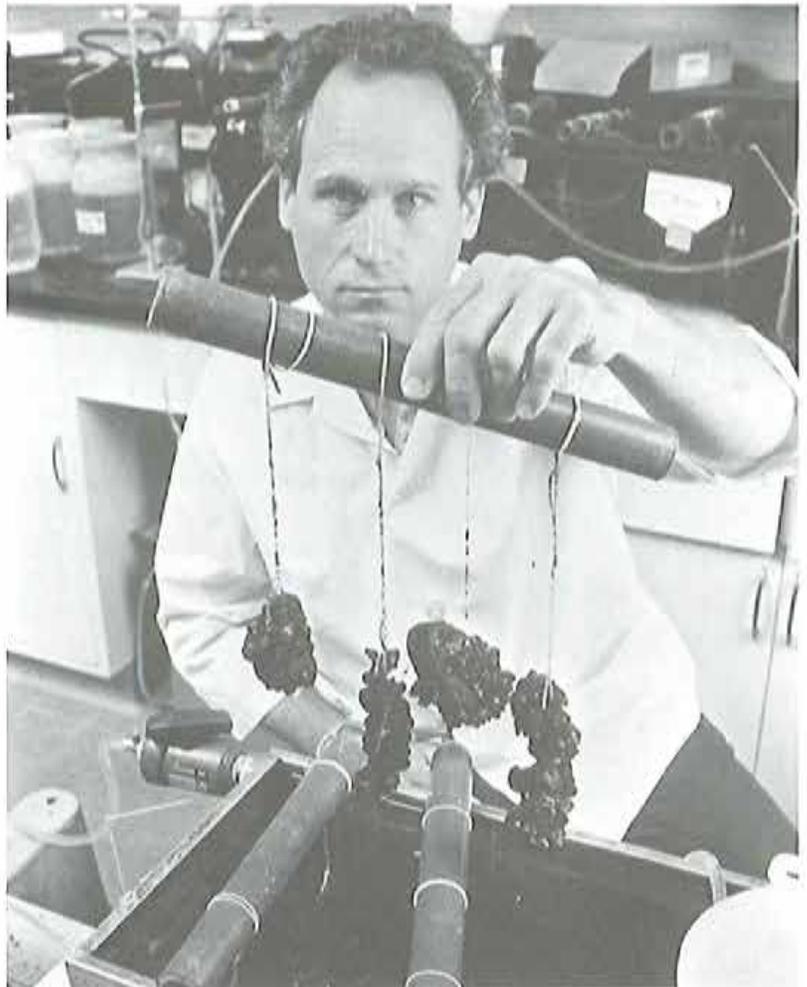
The Fund has four primary goals: prevent toxic pollution, identify effective cleanup approaches, demonstrate natural resource stewardship and clarify health effects of toxic pollution on humans and wildlife. The Fund is continuing its emphasis on projects that are collaborative and basin-wide in scope. Therefore, it seeks support from the states and provinces within the lakes ecosystem to become a global model of political and economic cooperation in the management of a shared natural resource.

The Fund supports projects that identify, demonstrate and promote regional action to enhance the health of the Great Lakes ecosystem.



Michigan Great Lakes Protection Fund

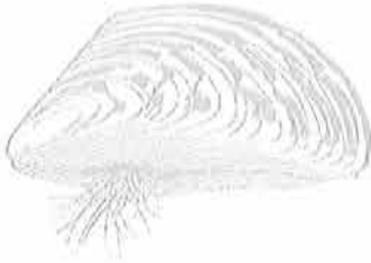
One-third of the Great Lakes Protection Fund earnings are returned to the states based on their contribution to the Fund. This allows for the development of regional programs and simultaneously promotes activity within the state. Michigan's \$25 million contribution to the Fund is the largest and returns \$600,000 in annual earnings to the State. These earnings are the source of funds administered through the Michigan Great Lakes Protection Fund. The Michigan Fund has an eight member Technical Advisory Board, which is responsible for development of annual priorities, in addition to reviewing and making funding recommendations for project proposals. Since 1989, the Michigan Fund has progressed through four funding cycles, awarding 37 grants totaling \$2.4 million. The primary method used to evaluate proposals are reviews by scientists that determine if the proposed work will make a significant contribution toward carrying out the objectives of the U.S./Canada Great Lakes Water Quality Agreement and the Toxics Substances Control Agreement.



Program Priorities:

- *Pollution Prevention*
- *Sources of Persistent Toxic Atmospheric Deposition*
- *Determination of Pollutant Loadings to the Great Lakes, Risk Assessment/Education*
- *Remedial Action Plans/Lakewide Management Plans, and Health Effects*

Nonindigenous Aquatic Nuisance

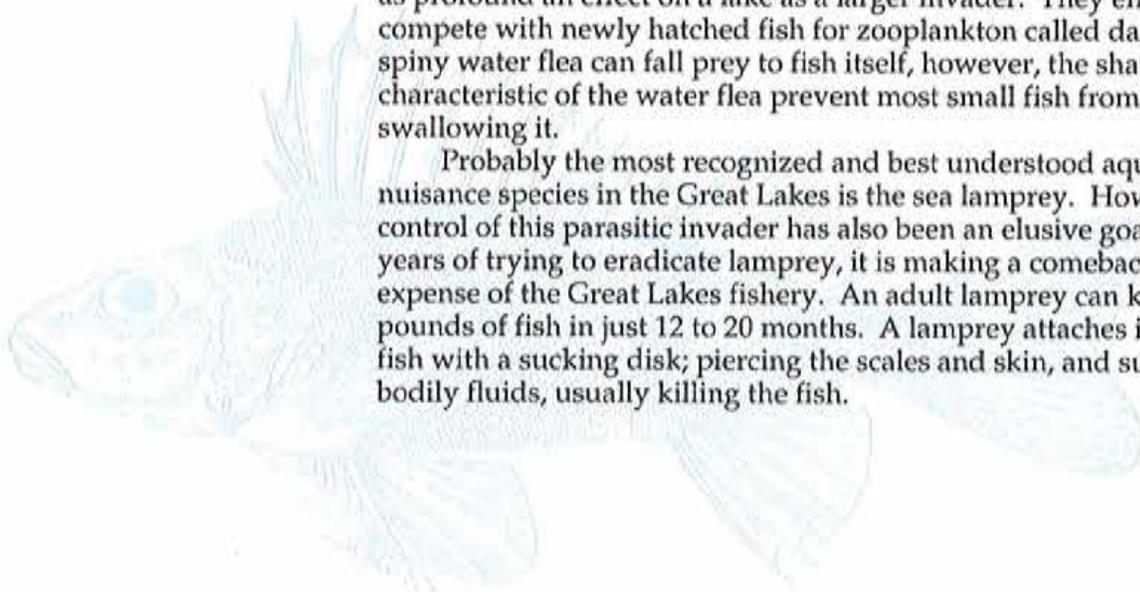


Non-indigenous (non-native) aquatic nuisance species introduced into the Great Lakes seriously disrupt existing plant and animal relationships. These species can alter a variety of Great Lakes' human uses, including commercial and recreational fishing, power generation, manufacturing, navigation, tourism and beach use, natural area/native species appreciation and public water supplies. Most aquatic nuisance species entered the Great Lakes through the release of ballast water from European vessels entering the St. Lawrence Seaway, and have also been introduced nation-wide through the aquaculture trade and tropical fish industry.

The implications of the zebra mussel, river ruffe, round goby, spiny water flea, sea lamprey, and other aquatic nuisance invasions into the Great Lakes are widespread. Zebra mussels readily attach to submerged hard surfaces including boats, rocky shoals, water intake pipes, navigational buoys, docks, piers and indigenous species such as clams. They also affix themselves to shells of their own species and are able to form dense layered colonies of over 1 million per square meter. Intake pipes and structures of municipal water supply systems and electric power plants are susceptible to zebra mussel colonization. Cost estimates by the U.S. Fish and Wildlife Service assess the potential economic impact of the zebra mussel alone at \$5 billion over the next ten years.

The river ruffe, a small Eurasian fish in the Great Lakes, feeds on fish eggs and competes with the yellow perch for habitat. The spiny dorsal fins on the ruffe discourage predation by other fish. The round goby, another aquatic nonindigenous species in the Great Lakes, is an abundant fish species from the Black and Caspian Seas. They feed on mollusks, crustaceans, small fish and fish eggs. Studies suggests round gobies have a negative impact on native species through competition for food and predation on eggs and young fish. The spiny water flea, rarely more than one centimeter in length, can have as profound an effect on a lake as a larger invader. They effectively compete with newly hatched fish for zooplankton called daphnia. The spiny water flea can fall prey to fish itself, however, the sharp spines characteristic of the water flea prevent most small fish from swallowing it.

Probably the most recognized and best understood aquatic nuisance species in the Great Lakes is the sea lamprey. However, control of this parasitic invader has also been an elusive goal. After 30 years of trying to eradicate lamprey, it is making a comeback at the expense of the Great Lakes fishery. An adult lamprey can kill 40 pounds of fish in just 12 to 20 months. A lamprey attaches itself to a fish with a sucking disk; piercing the scales and skin, and sucking out bodily fluids, usually killing the fish.



Species

During 1993, the Office of Great Lakes, the Michigan Department of Natural Resources' Fisheries Division and the Governor's Office worked closely with members of Congress, Great Lakes Task Force, Great Lakes Fishery Commission, Michigan United Conservation Clubs and the Michigan Charter Boat Association addressing a funding shortfall for the 1994/1995 Sea Lamprey Control Program. To that end, Michigan Senator Carl Levin worked to successfully increase funding from \$8.5 million to \$10.5 million. While this was not a complete response to the overall need, it will provide a continuing level of treatment, lessening the impacts of the anticipated economic consequences associated with the resurgence of the sea lamprey.



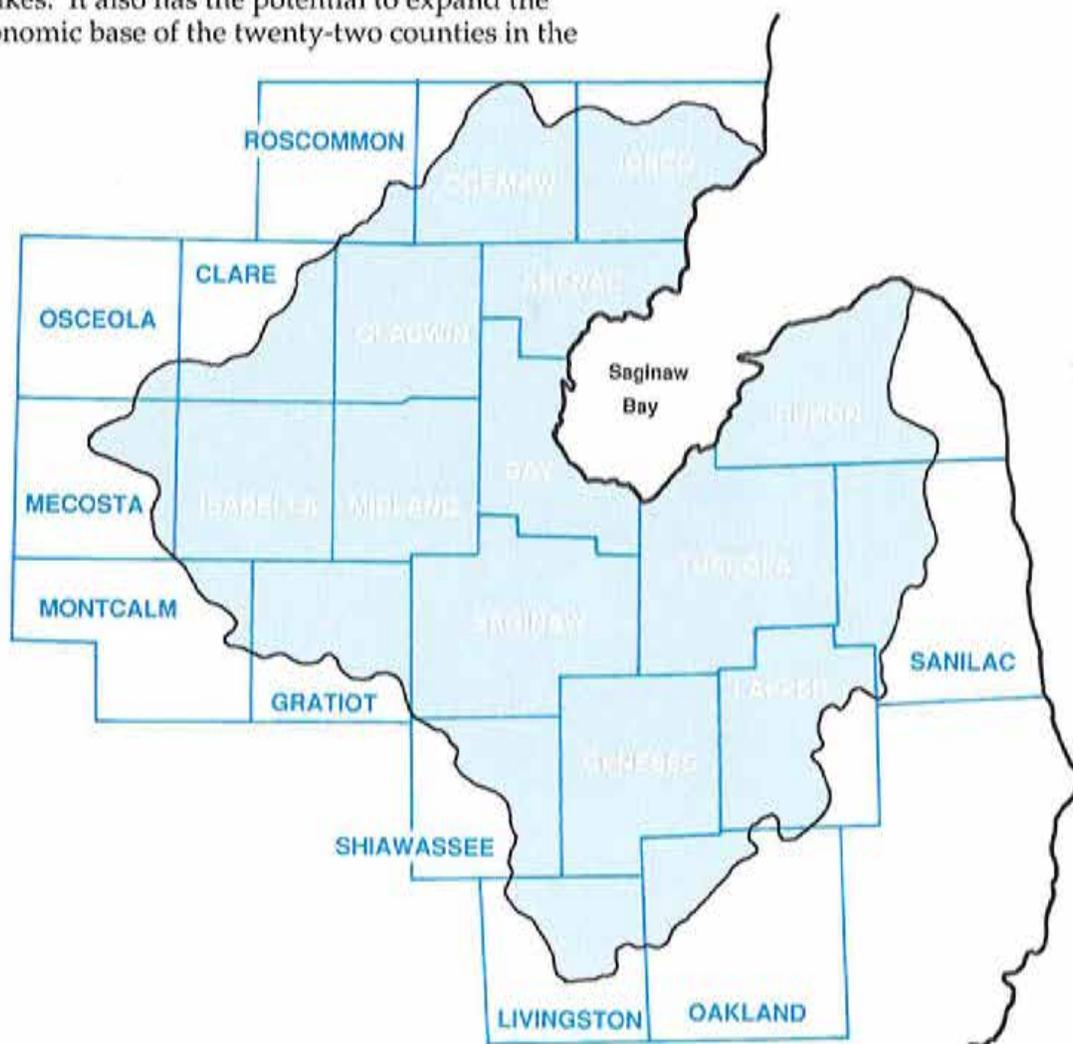
Taking a Watershed Approach

Saginaw Bay National Watershed Initiative

In September 1991, Governor John Engler and the U.S. Environmental Protection Agency designated the Saginaw Bay Watershed for funding through the Watershed Protection program. The Saginaw Bay National Watershed Initiative was developed to bring together local, state and federal resources, with citizens input, to ensure that actions are directed toward issues which will have the greatest impact within the Saginaw Bay Watershed.

The Saginaw Bay Watershed has been designated as one of 43 "Areas of Concern" within the Great Lakes. Contaminated sediment, fish consumption advisories, degraded fisheries and loss of significant recreational values are the major reasons for this designation. The major causes of these problems are contaminated sediment, soil erosion and excessive nutrients such as phosphorus and nitrogen entering the water.

The Saginaw Bay Watershed is a great fishery and waterfowl area in the Great Lakes. It also has the potential to expand the recreational and economic base of the twenty-two counties in the



watershed. To unlock these potentials, local, state and federal interest must work together to ensure the wise use of all available resources to restore the environmental quality of the Saginaw Bay Watershed.

Over the last two years, the Initiative's focus has been directed toward three primary areas:

- Implementation of local pollution control measures,
- Developing a strong local-state-federal partnership, and
- Developing educational activities to promote greater awareness of the problems, opportunities and values of the Saginaw Bay Watershed resources.

The Initiative is intended to be a forum for local, state and federal agencies and citizens to work together to identify short and long-term water quality and habitat protection objectives that cannot be accomplished by these same interests individually. While building on the cooperative networks already at work in the Bay area, the Initiative is seeking to strengthen and combine efforts and expand existing interagency coordination.

Historically, pollution control activities undertaken in the Saginaw Bay Watershed have focused on industry and municipalities. This focus will continue with the Initiative. However, to a much greater extent, the activities being addressed focus on individual landowners and citizens whose activities affect water quality. New and expanded watershed program activities such as nonpoint source pollution control, wetlands protection, habitat restoration, etc., will impact the daily lives of many citizens within the watershed. Because of this, the importance of public involvement in the decision-making process must be expanded to provide for a strong local role, both now and in the future.

The Saginaw Bay National Watershed Initiative is a program that is structured to ensure that the watershed restoration and protection effort is a locally driven initiative and that the public has a strong voice in the process. The combination of strong local involvement coupled with increased State and Federal participation will ensure that the necessary steps will be taken to improve the Bay's environment followed by appropriate actions to ensure the future of this valuable natural resource.

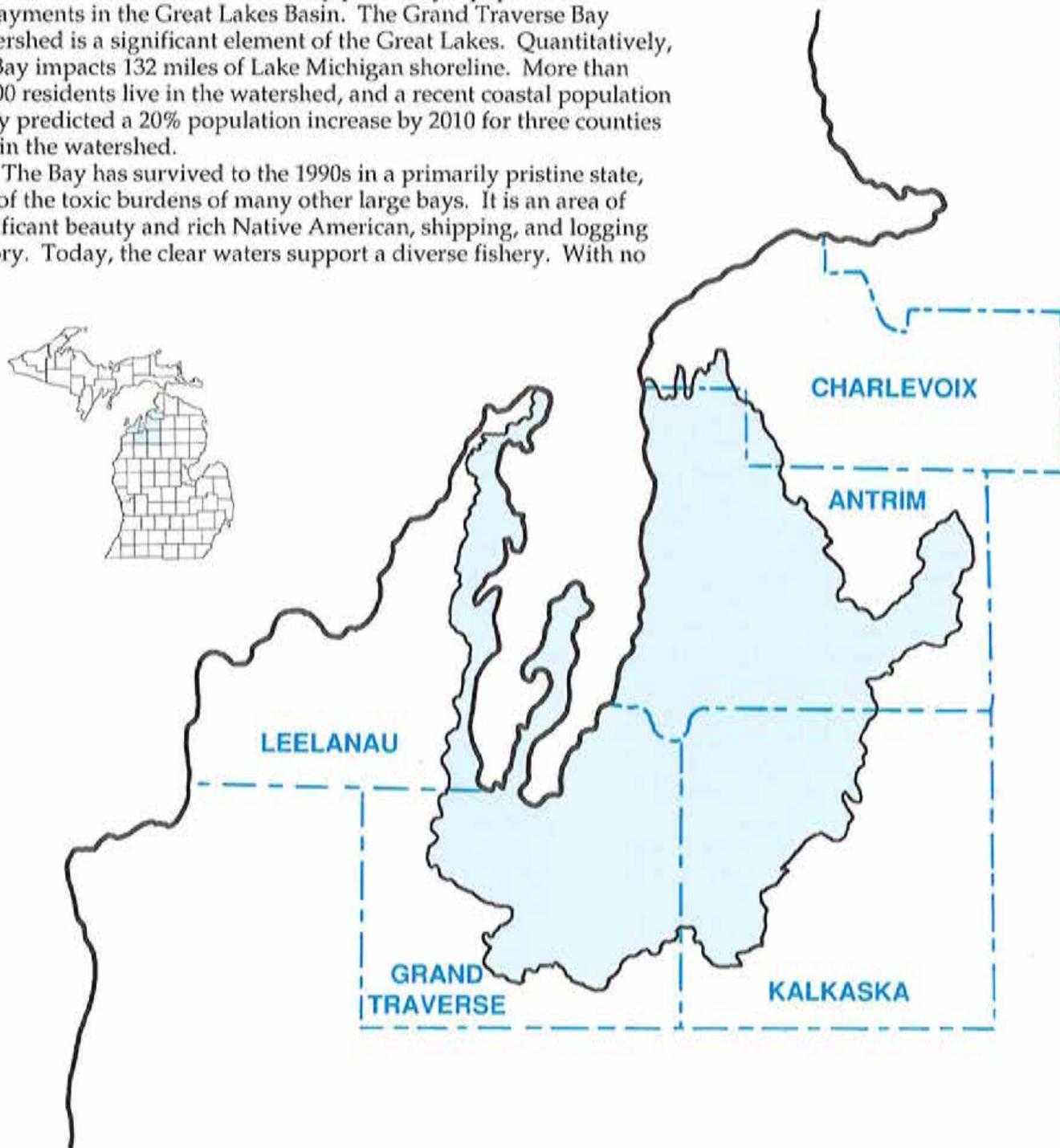
The first two years of the Initiative, on-land controls (best management practices) that were implemented decreased pollutant loadings:

Soil savings	272,000 Tons
Phosphorus savings	253 Tons
Nitrogen savings	200 Tons
Conservation tillage	25,000 Acres
Fertilizer management	21,000 Acres
Wetland restoration	32 Sites
Stream filter strips	260 Acres
Livestock exclusion from streams	5,780 Feet
Integrated crop management	5,400 Acres

Grand Traverse Bay Watershed Initiative

Within the Great Lakes Basin lies a tremendous resource--the Grand Traverse Bay. Located in the northwest corner of Michigan's Lower Peninsula, Grand Traverse Bay is a focal point for many residents and visitors. Despite its rapidly increasing development, the Bay remains one of the few relatively pristine, yet populated embayments in the Great Lakes Basin. The Grand Traverse Bay Watershed is a significant element of the Great Lakes. Quantitatively, the Bay impacts 132 miles of Lake Michigan shoreline. More than 80,000 residents live in the watershed, and a recent coastal population study predicted a 20% population increase by 2010 for three counties within the watershed.

The Bay has survived to the 1990s in a primarily pristine state, free of the toxic burdens of many other large bays. It is an area of significant beauty and rich Native American, shipping, and logging history. Today, the clear waters support a diverse fishery. With no

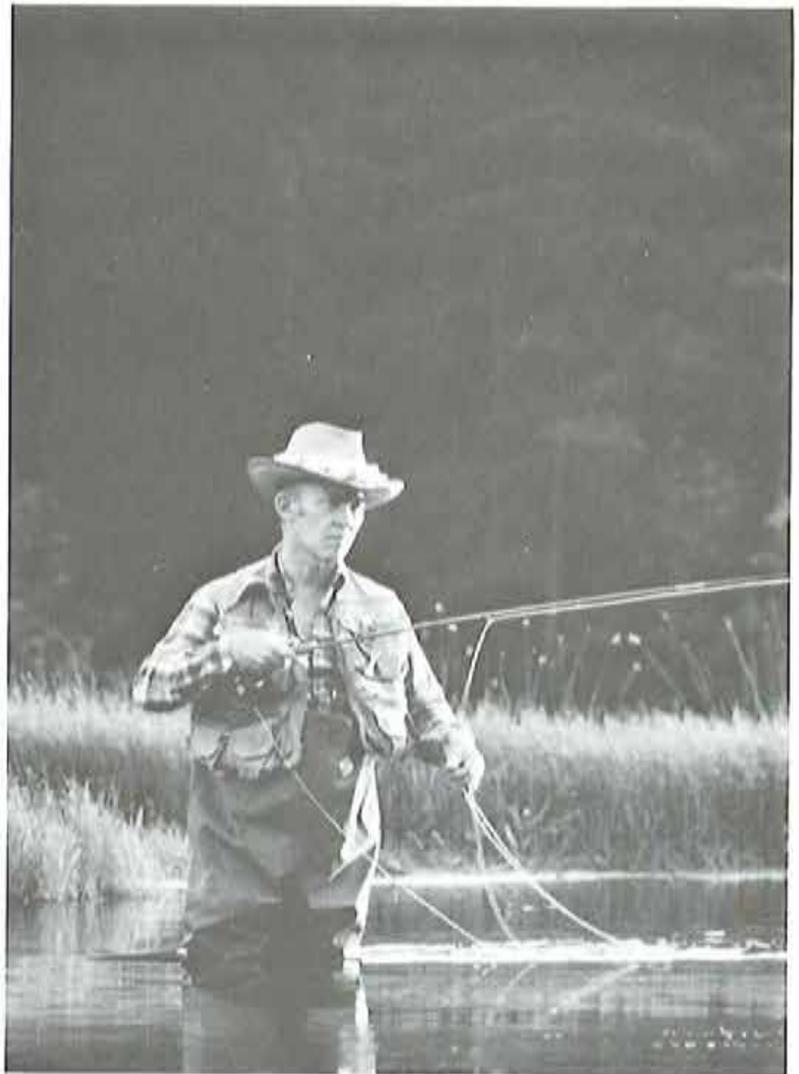


legislative or regulatory mandate, watershed residents, businesses, government agencies and others launched pro-active pollution prevention efforts in early 1990.

Partners of the Grand Traverse Bay Watershed Initiative, a citizen and multi-agency grassroots effort, are concerned for the Bay's future and want to avoid the costs and resource degradation facing many Great Lakes' bays. This requires a pollution prevention agenda to be placed before the watershed residents. Unconsciously, residents' actions, such as lawn fertilization practices, improper storm drain use and the decisions of municipal boards affect the Bay on a daily basis. Through various established channels, active partners and the local media, this pollution prevention and public education program seeks to alert watershed residents of the responsibilities of neighboring the Grand Traverse Bay.

The local Initiative leadership strengthened with the formation of a partnership steering committee in early 1992. Over 80 local units of government, local, State and Federal agencies, citizen groups and businesses, including the Office of Great Lakes have signed the Initiative's Partnership Agreement, becoming members of the steering committee. The Initiative continues its commitment to citizen based efforts to preserve and protect the Grand Traverse Bay Watershed.

In 1991, the International Joint Commission designated the Grand Traverse Bay region as an area of high quality. Hopefully, through this designation, the area will be able to protect the local environment through community-based programs that ensure development sustainable in economic and environmental terms.



Other Great Lakes Issues

New Water Use Reporting Program

Michigan enjoys an abundant supply of fresh water. Past conflicts between water users over water supplies have been relatively rare in Michigan. However, the U.S. (and Canada) face increasing water resource development costs, capital shortages, strict limits on government participation in public works and diminishing sources of available fresh water. In addition, water resource contamination, coupled with a growing concern for fish and wildlife dependant on fresh water sources, have all combined to encourage a shift in national water resource management policy that emphasizes conservation and recognizes the need to balance competing new water resource needs.

The Great Lakes States and Canadian Provinces responded to these concerns by developing the Great Lakes Charter in 1985, a cooperative agreement to protect and preserve the waters of the Great Lakes basin. As part of that commitment, they have each implemented a program to register existing water uses. Water withdrawals and returns, including diversions into and out of the Great Lakes basin are compiled by the Great Lakes Commission in Ann Arbor. This information will assist the Great Lakes region in resisting competing claims for water use, speculative and unrecorded water uses would not be recognized even if they predated new proposed water uses. Michigan is the only state in the Great Lakes region that has not secured our current and future water uses with a water use registration program. However, in 1994 for the first time, Michigan will move toward registering significant water uses. The Legislature

included an appropriation of \$100,000 to the Office of the Great Lakes to initiate a water use reporting program. This program will protect current water users from losing out to competing water use requests. The information gained will also improve water resource management by providing valuable insight into potential resource depletions, adverse environmental or economic effects, and improve projections of future water resource needs and trends.



of Interest

Michigan water users withdrawing over 100,000 gallons per day (30-day average) from surface water, groundwater or the Great Lakes will be asked to assist the Michigan Department of Natural Resources in protecting the Great Lakes basin, by registering their uses for the first time in 1994. The DNR hopes to work cooperatively with other state agencies and the U.S. Geological Survey in conducting an initial survey of water resource uses, as called for in the Great Lakes Preservation Act of 1990, and the Great Lakes Charter.

Lake Levels Reference Study

Storms, combined with unusually high water levels, have caused extensive flooding, erosion, and severe property damage along the lakeshore and the St. Lawrence River in years past. In response to widespread public concern about these extreme conditions, the governments of Canada and the U.S. requested that the International Joint Commission recommend methods of alleviating adverse effects of high and low water levels in the Great Lakes and St. Lawrence River systems. The Lake Levels Reference Study, completed this year, culminated an extensive, 6-year effort by many government officials, non-government advocates, citizens and private consultants.

Several methods of physically regulating lake levels using control structures were evaluated, but all were conceded to trade positive benefits gained in one part of the basin or to one interest group, with negative effects to others. The lake levels are so closely tied to precipitation in the basin that even herculean efforts to control the lakes would have very minor effects on lake levels and were prohibitively expensive. No lake level regulation plan would completely eliminate shoreline erosion. All measures were judged using four major criteria: economic and social costs; environmental effects; impact distribution between interests and parts of the region; and technical, legal and public policy feasibility.

The most effective means of minimizing property, economic and environmental damage from extreme high or low lake water levels included land-based measures such as acquisition, relocation, flood proofing, shore protection, beach nourishment and set back requirements. Other important recommendations in the report address options for emergency action, guiding principles for future management of water level and flow, and improved public knowledge of water level risks and prevention methods.



Extended Shipping Season at the Soo Locks

In July 1993, the Michigan Department of Natural Resources, U.S. Army Corps of Engineers, U.S. Coast Guard and U.S. Fish and Wildlife Service signed an agreement that may end 20 years of controversy over winter navigation on the Great Lakes. The four agencies agreed to determine, once and for all, whether winter shipping significantly damages the aquatic ecology of the St. Marys River.

Historically, winter navigation on the Great Lakes involved efforts by the Federal government, primarily the Army Corps of Engineers and the Coast Guard, to extend the length of the navigation season. The Corps operates the Soo Locks at the upper end of the St. Marys River, and the USCG breaks the ice and maintains the shipping lanes, thereby allowing commercial freighters to run longer each season.

A winter navigation demonstration program concluded that although technically feasible, year-round operation was not desirable because the harsh winters hurt both ships and their crews. While the demonstration program was winding down, concerns regarding the environmental impacts of winter shipping were increasing.

In March 1992, the Corps fixed the end of the navigation season at January 15. DNR biologists were concerned that ice-breaking and vessel passages through ice would damage valuable wetlands along the shoreline of the river, and harm whitefish and lake herring eggs that are deposited in shallow water areas in late fall.

Earlier this year, an agreement was reached which established a cooperative approach to conducting a series of very specific and targeted environmental monitoring studies to answer the unresolved questions. The agreement is significant in several ways. First, it demonstrates a high degree of cooperation among agencies. Second, four environmental monitoring studies are now under joint management with a combined commitment of about \$200,000 per year to conduct the studies. Third, the USCG will reduce vessel speeds during the study period to avoid adverse impacts of ship passage during ice conditions. Fourth, the agreement sets the opening of the Soo Locks at March 25 and the closing at January 15, and prohibits deviating from these dates except during a national emergency.

The agreement is an interim solution to a 20-year controversy which, hopefully, will eliminate the need for costly and time-consuming litigation, and result in a much improved understanding of the St. Marys River ecosystem.



Great Lakes Biological Diversity

In certain areas of the Earth, biological diversity is lost at an alarming rate. The Governor's report on Relative Risk (Michigan's Environment and Relative Risk, July 1992) ranked biodiversity, habitat loss, and a lack of integrated land-use planning as major environmental threats in the State. Loss of habitat may have significant economic, social, and ecological consequences. At issue is how biological diversity of various ecosystems can be maintained or enhanced, while providing accelerated human multiple-use demands. Active management must play a key role in conserving biological diversity.

Michigan's Legislature recently passed the Biological Diversity Conservation Act (Public Act 93 of 1992). The Act declares that "it is the goal of this State to encourage the lasting conservation of biological diversity." The Act directs the Legislature to create a joint legislative working committee, who will prepare a recommended State Strategy for Conservation of Biological Diversity. They will also report the costs, benefits, and other implications of the strategy, and will require a report from each of six state departments.

The Great Lakes Commission proposes to undertake, in cooperation with the community of Great Lakes public agencies and non-governmental organizations, the development, adoption and basin-wide implementation of a Binational Ecosystem Charter for the Great Lakes Basin. A statement of goals, objectives, principles and action items, the Ecosystem Charter would present - simply and explicitly - a shared vision of the Great Lakes and a blueprint to achieve it.

Biological diversity, or biodiversity is "...the variety and variability among living organisms and the ecological complexes in which they live," (Office of Technology Assessment, U.S. Congress, 1987). This definition is an all-encompassing one. It incorporates diversity ranging from chemical and genetic levels to landscape patterns.

With a rich mixture of Federal, State, and private holdings across a fairly contiguous fifty million acres of wildlands, the Lakes States (Michigan, Minnesota, and Wisconsin) offer significant potential for large-landscape assessment, planning, and management for a wide range of land uses and values. Although most of the region has been cut and burned over, decades of recovery and restoration have presented new opportunities for the management of diverse, healthy ecosystems.



The Great Lakes: Environ

The Great Lakes are an enormous and complex system, so generalizations about the "state of the Great Lakes" are inherently difficult to make. The lake basins are chemically, physically and biologically as different from each other as they are socially, politically and economically. The more we learn about the physical and biological processes active in the Lakes, as well as the mixture of stresses being placed on the Lakes; the more clear it becomes that the Great Lakes do not respond to those stressors as a homogeneous system of flowing water. Various portions of the Great Lakes system react differently to pollutants, aquatic nuisance species, habitat changes and other effects, depending on a host of localized factors. This section briefly reviews some of the findings of recent environmental monitoring and research in the Great Lakes, and where further research is needed.

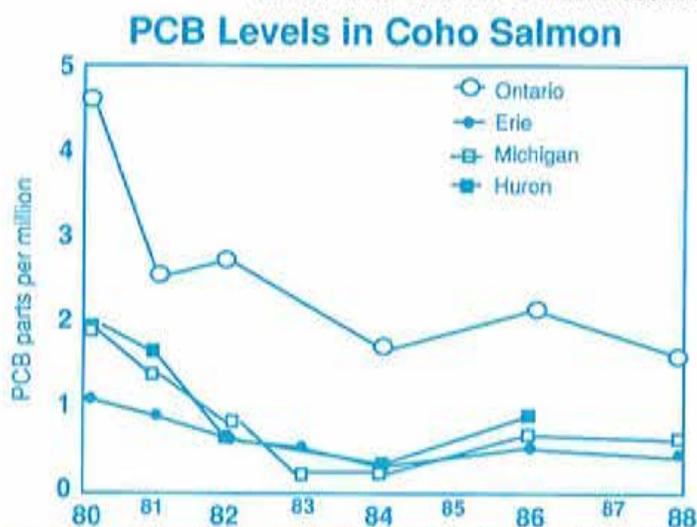
Water Quality The Michigan Department of Natural Resources' Surface Water Quality Division (SWQD) routinely conducts fish contaminant monitoring, including native and caged fish studies, to evaluate 10 Great Lakes and connecting channel locations, and 20 tributary river mouths. Several chemicals appear to be ubiquitous in the aquatic environment based on their presence in native fish tissue from most of the locations sampled, including mercury, dieldrin, PCB, chlordane, DDT, dioxins and furans. PCB continues to be the most frequently detected chemical in channel catfish after 28 days of exposure at select tributary mouths (DNR SWQD Fish Contaminant Monitoring, 1993)

PCB levels in the water column of Lake Superior have declined significantly in the last decade (from 1 ng/g in 1979 to 0.2 ng/g in 1990) according to monitoring conducted by the U.S. Environmental Protection Agency. PCB concentrations in the open waters of Lake Michigan are about half of what they were in 1980 (Pearson et al, University of Minnesota, St. Paul, MN, 1993). PCB levels in fish from Lake Michigan have also declined, but since 1986 there has been no significant further improvement in PCB levels in lake trout. PCB analysis of brown trout and walleye taken from tributaries to Lake Michigan support a downward trend in PCB levels, but analysis for coho and chinook salmon do not.

Contaminant levels in similar fish species vary between the Lakes, but fish contaminant levels are not simply a reflection of the environmental concentrations. Concentrations of PCBs and DDT in Lake Erie water and sediment are similar to those found in Lakes Michigan and Ontario, yet concentrations of these contaminants in the fish of Lake Erie are lower. Recent research suggests that the important factors

determining the distribution of persistent organic contaminants in the environment include fish lipid content, position in the food chain and the trophic structure of the waters. (Rowan et al, McGill University, Montreal, Canada 1992).

High concentrations of major contaminants have been linked to reproductive, developmental and behavioral effects in wildlife species along the Great Lakes. Herring gulls and bald eagles have been the subject of substantial research and tend to exhibit the highest concentrations among the mammalian and avian species examined. Reproductive success for eagles nesting along the Great Lakes, for example, is significantly lower than for eagles nesting along inland waters, yet the total



Source: EPA, "A Report to Congress on the Great Lakes Ecosystem", June 1993, p. 79.

mental Trends

number of nesting pairs has increased throughout the basin. Concentrations of contaminants in avian species has declined from historic levels, but like trends observed in fish tissue, concentrations appear to have leveled off since about 1985.

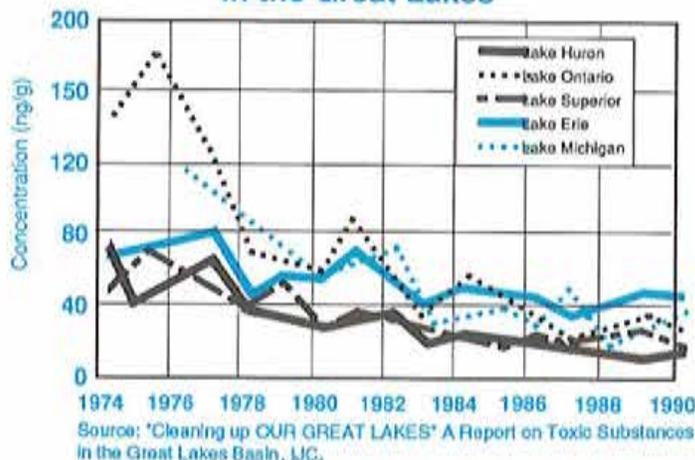
One indication that management of hazardous chemicals may be improving in the U.S., is contained in the annual report released by the EPA entitled the "Toxics Release Inventory." Each year, manufacturing facilities meeting certain activity thresholds must report their estimated releases and transfers of listed toxic chemicals to the EPA and to the state in whose jurisdiction the facility is located. The 1991 report, released in May of 1993, was the fifth such effort, and releases and transfers of the listed toxic chemicals reported declined for the fourth straight year.

The TRI list includes more than 300 chemicals and 20 chemical categories, summarizing releases and transfers as emissions to air or water, to land as solid waste, to a wastewater treatment system or to a deep well injection system. Following passage of the Federal Pollution Prevention Act of 1990, the TRI has been expanded to include mandatory reporting of additional waste management and pollution prevention activities.

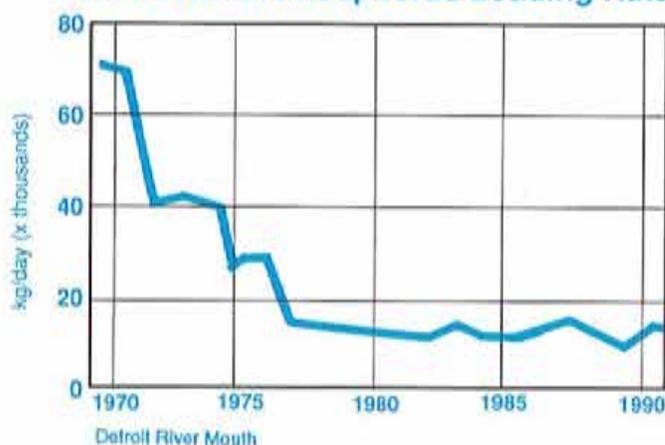
Phosphorus levels in the open waters of Lakes Superior and Michigan have been reduced to levels below those set as objectives in the Great Lakes Water Quality Agreement. Phosphorus levels in Lakes Huron, Erie and Ontario continue to exceed the objectives slightly. Nutrient enrichment continues to be a problem in many nearshore waters of all the Great Lakes except Lake Superior.

Fish Populations Prior to settlement in the Great Lakes basin, over 170 species of fish existed in the lakes. Lake sturgeon lived up to 90 years and lake trout up to 75 years. Fish populations today are drastically different than those found in the 1800's, a result of commercial and sport fishing, introduction of non-native parasites and competitor species, and degradation or loss of spawning and feeding habitat. Great Lakes fish today are smaller, live shorter lives and survive in sometimes substantially reduced numbers.

PCB Concentration in Herring Gull Eggs in the Great Lakes



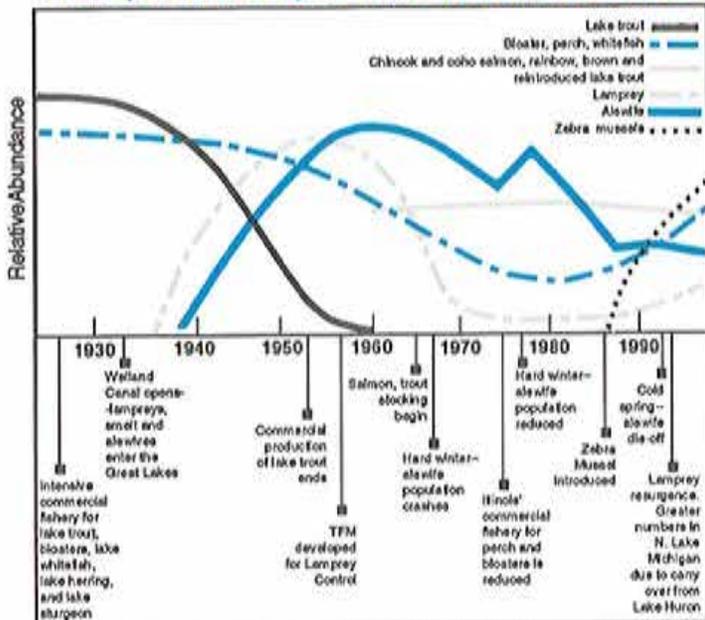
Total Annual Phosphorus Loading Rate



Populations of sturgeon and most of the once plentiful species of chubs are substantially lower than their historic prominence in the Great Lakes. Lake trout must be stocked to maintain minimum populations and to support a recreational fishery. Non-native pacific salmon are now the top predators in Lakes Michigan and Huron, but their fate may hinge on the availability of alewife, their principal and preferred forage. The chinook salmon began a decline in the mid 1980s due, at least in part, to an increase in the incidence of bacterial kidney disease (BKD) seen in the fish, a phenomena often seen in large fish cultural programs.

In western Lake Erie, walleye is the top predator, but it may be vulnerable to water quality changes and food chain effects brought on by the zebra mussel. Walleye populations in Lake St. Clair are also threatened by the zebra mussel, according to fisheries researchers with the Ontario Ministry of the Environment. The extraordinary filtration capacity of the zebra mussel is changing the

A Graphic History of Lake Michigan Fishes



Source: *Aquaticus Journal of the Shedd Aquarium*, Vol. 23, No. 2, 1992

fundamental character of the aquatic plants, insects and zooplankton, favoring pike and bass species that favor walleye fry as a food source.

Computer simulation models are being developed to assist fisheries managers in restoring balance to the predator/prey relationships in the Lake Michigan fish community. In addition, greater attention will be placed on examining the natural carrying capacity of the system. Lakewide limits on Great Lakes stocking will be set and revised through management planning. Sea lamprey control was a necessary precursor to the reestablishment of deepwater fish populations, and remains essential to their survival. The whitefish made a spectacular recovery in northern Lake Michigan waters, in part as a result of sea lamprey control.

Lake trout restoration efforts in northern Lake Huron have been thwarted, despite relatively heavy stocking, by fishing pressure and sea lamprey predation. Lake trout spawning and natural recruitment have been documented since

1985, but the number of wild fish has ranged at or below 10% of total census in recent years. Lake trout numbers have not increased since 1979, in spite of continued stocking at the rate of over one million yearlings annually. Sea lamprey are believed to kill more trout, salmon, and whitefish in Lake Huron than are harvested. If protected from overharvest and the sea lamprey, these once highly productive waters could eventually be supported by natural recruitment. (DNR Fisheries Division 1993 Program Review Report).

Wetlands and Shorelines Coastal wetlands that occur today along the Great Lakes, represent a small fraction of the extensive wetland system that occurred two centuries ago. For example, the inland and coastal wetlands of the western Lake Erie drainage have been reduced to less than 5% of their original expanse. Wetland loss is believed to result in changes to the biological and chemical make-up of the waters which pass through them to the open waters of the Great Lakes. The adverse effects to wetlands from dredging, draining, diking, pollution (particularly sedimentation) and water level management has probably contributed to degradation of Great Lakes water quality and decline in fish and wildlife populations dependant on the coastal and river mouth areas of the Great Lakes.

Very little is known about recent changes in the occurrence of coastal wetland. Regulatory programs at both the State and Federal level have essentially achieved a no net loss goal for coastal wetlands, at least in terms of direct losses from land use changes. High water levels, wave erosion and other natural processes are more likely to be responsible for any significant changes in coastal wetlands. A study has recently been initiated by the DNR Land and Water Management Division to compare aerial photographs of coastal areas taken from 1978 and 1993 in order to gauge the gains and losses of wetlands in coastal areas.

Despite recognition of the importance of wetland systems and the numerous threats to their survival, information about wetland functions; for example, nutrient cycling and erosion control, is rudimentary and fragmented. Historic degradation of coastal wetland areas, as well as natural variability in wetland vegetation, hydrology and substrate, combine to challenge researchers and resource managers in determining how to target priority wetlands for restoration and preservation efforts.

NOAA, the National Oceanic and Atmospheric Administration, in cooperation with the U.S. Geological Survey, will be updating obsolete shoreline maps of the Great Lakes. As part of this effort, federal and state researchers conducted a pilot study of the coastal area along parts of the southwestern Lake Michigan shore. Among their findings was an indication that offshore sand is thin to non-existent in many areas. As much as four meters of the lake bottom had been removed by geologic processes during the past 50 years at the pilot study location. Offshore sand provides protection for the underlying glacial till and for the bluffs along the margin of the lake. Further information about the processes affecting sand movement will be essential for determining the most effective long-term shoreline and property protection measures.

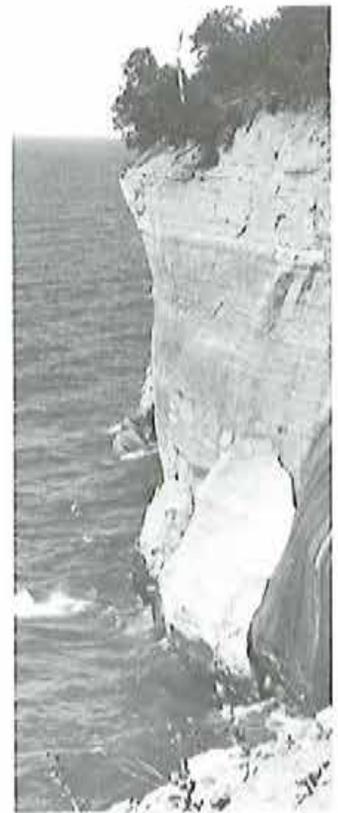
Status of Sea Lamprey and Zebra Mussel Zebra mussel numbers have increased dramatically since their introduction, including two inland lakes of Michigan where infestations were found this summer. Surveys in the Detroit River and Lake St. Clair of the native mussel populations show declines of from 60 to 100% of the species previously found in 1984 surveys. U.S. Fish and Wildlife Service researchers announced last year that no viable native mussel populations are left in Lake St. Clair, and the remaining native mussels species in the Detroit River were predicted to disappear by the end of 1994 (Schloesser, U.S. Fish and Wildlife Service-National Biological Survey 1993).

At many sampling stations in Lake Erie native mussels have disappeared entirely. It is believed the invasion of zebra mussels into western Lake Erie in 1986, and the resulting population explosion, has caused the near extinction of western Lake Erie native mussels. At present, it is not known if zebra mussels will reach high densities in all waters that they invade, but mussels are expected to spread throughout much of North America during the next twenty years.

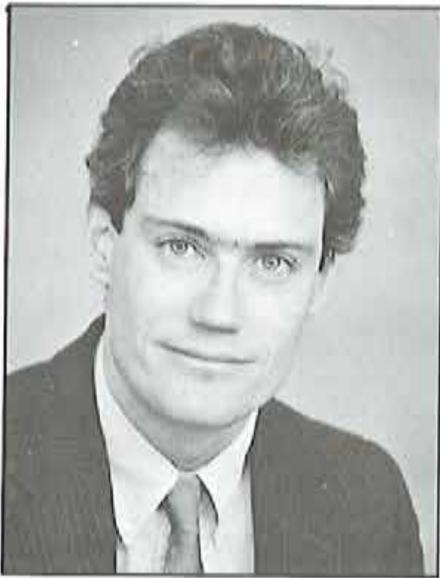
Because the zebra mussel is a very efficient filter feeder, large amounts of suspended matter, (e.g., plankton, silt, etc.) are removed from the water. Zebra mussels therefore have the ability to alter transparency and plankton abundance changing the ecosystem and aquatic food web. The increased transparency of the water allows sunlight to penetrate deeper into the water which can speed the growth of aquatic weeds. This has led to a redistribution of fish species such as the walleye, bass, and muskellunge pike.

Compounding an already complex situation, research initiated in the spring of 1993 with the cooperation of Michigan Sea Grant, discovered zebra mussel larvae (veligers) in 11 of 31 inland lakes studied in Michigan. Pathways by which zebra mussels may have been spread include; boaters; fishermen; birds and waterfowl; bait shops; sub-irrigation and tile drains and; intentional introductions by citizens. All these mechanisms may add to the dispersion rate of the zebra mussel. The DNR will continue monitoring the spread of zebra mussels and further investigate the infected lakes.

In addition, the sea lamprey is expanding its range in response to improved water quality in Great Lakes tributaries, resulting in a resurgence in lamprey populations. More lake trout are killed by lamprey predation than by all other causes, including fishing. If the lamprey control effort underway since the 1950's were to cease, the Great Lakes fishery would collapse, and the lake trout could be lost entirely. Resource managers continually strive for innovative and cost-effective measures to control the lamprey.



Restoration of the Great



*Tom Martin,
Executive Director
National Audubon Society's
Everglades System
Restoration Campaign and
Former Director,
Office of the Great Lakes*

During the past few years, America has moved from talking about protecting its natural resources to restoring ecosystems. These words signal a change in our strategy of dealing with a degraded environment. Instead of merely protecting a few fenced-off pristine places, or slowing the rate of pollution, we are trying to reassemble the elements that support fully functioning ecosystems. This changing philosophy will help us move toward reestablishing the diverse and rich natural heritage of our Nation. Our challenge lies in how to turn this enlightened philosophy into effective public policy.

Twenty-five years ago, at the birth of the environmental protection movement, we saw and attacked a series of environmental problems by addressing each of them individually. Thus, we have a Clear Air Act, Clean Water Act, Federal Insecticide Fungicide Rodenticide Act, Superfund, Toxic Substances Control Agreement. All of these acts have been generally successful in addressing the narrow problem for which they were designed, but they operate in isolation from each other and, at times, at cross purposes. It comes as no surprise that an agency like the Michigan Department of Natural Resources has an Air Quality Division, Surface Water Quality Division, Environmental Response Division, Fisheries Division, Forest Management Division and a Wildlife Division.

We must make our programs like the ecosystems they protect, connected and cooperative. It is essential that we move beyond the language of restoring impaired uses to the language of restoring self-sustaining natural systems. To turn this philosophy into programs, we should look to the following principles. We must:

- Eliminate sources of pollution - not just restrict the discharge of pollutants or their transfer from one media to another.
- Measure our environmental success by the total amount of pollutants eliminated from the system, not the number of permits processed.
- Measure our success by noting the amount of water meeting quality standards or the size of our airshed meeting air quality standards. In other words, focus on the environmental outcomes, not bureaucratic "beans."
- Attack all of the environmental stresses in an area simultaneously. It is no longer acceptable to determine the assimilating capacity of nutrient pollution for a water body and have an independent group making decisions about fishery goals of the system.
- Focus on the conservation of communities of plant and animal species not just the most individually threatened or desirable.

"It is essential that we move beyond the language of restoring impaired uses to the language of restoring self-sustaining natural systems."

Lakes Ecosystem

- Focus on the identification and preservation of healthy natural places and identify the steps that must be taken to allow them to maintain that state.

For the State of Michigan, I recommend the following initiatives:

- The regulatory divisions of the DNR should be required to report on a watershed basis, the maximum permitted loading of nutrients and persistent toxins of concern each year. Michigan should also challenge its sister Great Lakes states and the Province of Ontario to do the same. This strategy will allow us to measure what progress is being made in eliminating pollutants from key watersheds in the State and the Great Lakes basin as a whole.
- To prevent diversion out of the Great Lakes Basin, Michigan must implement the water use reporting required by the Great Lakes Charter. Additionally, the State should develop a water budget for each of its major watersheds to ensure that we are properly planning how to use ground and surface waters in a way that protects not only users of that system but the natural system itself.
- Michigan should develop more aggressive non-point controls for its regulatory program, backing up the incentives we are already providing, to attack the largest single pathway for water pollution left without effective controls. Runoff from our city streets and farmers' fields must be controlled if we are to continue to see improvement in the health of the Great Lakes system.
- DNR should establish a system of setting restoration goals for each major watershed in the state to integrate regulation, with fish and wildlife management, land use and other resource management objectives. This goal should be carried out with annual work plans and measurable benchmarks.
- Michigan should set an aggressive pollution elimination goal for persistent toxic substances of 50% reduction by the end of this century. It's clear that prevention of pollution is much cheaper than restoration.
- Michigan should establish a suite of biologic indicators of ecosystem health that can be measured each year, and overtime will help tell us the overall state of our natural State.
- Michigan should use the Lakewide Management Plans being prepared for each of the Great Lakes to implement the programs listed above on an ecosystem scale.

In the 1970's, many cities promoted redevelopment by creating skyscrapers and through other downtown investments. But the neighborhoods around them continued to decline. In the natural world, as in human society, whole communities are the key. Reducing "point source discharges" to the Great Lakes was just the first step. Now we need to nourish the forests, soils, air, fish and wildlife - and people of the Great Lakes system.

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The Petroglyph, Misshepeshu (shown here and on page 5).
Photograph by
David Kenyon
at the Sanilac Petroglyph State Park



Misshepeshu-The underwater panther or cat was a powerful figure in the incorporeal world of the Anishnabeg. These spirits were capable of befriending travelers or capsizing boats and gifts were routinely offered to these spirits before traveling by water.

Cover Photograph by
David Kenyon, Department of Natural Resources
*From atop the North Tower of the Mackinaw Bridge looking down on the
Lake Michigan side of the Straits (April-Spring ice break-up).*



Michigan Department of Natural Resources
Office of the Great Lakes

