

State of the Great Lakes

1996 Annual Report







The Great Lakes Puzzle

As portrayed on the cover of the *State of the Great Lakes 1996 Annual Report*, the Great Lakes region represents a puzzle. For the region to be sustainable, all of the integral parts, including the environment and the economy, must fit together. A proper fit means continuing the high quality of life for the more than 33 million people who benefit every day from our stewardship of the Great Lakes.

During 1996, we acted to strengthen and improve each piece of the puzzle. For example, new pollution prevention initiatives implemented by the Department of Environmental Quality are protecting the Great Lakes through voluntary, cost effective efforts. These include the Pulp and Paper Industry Pollution Prevention Project, the Michigan Great Printers Project, the Great Lakes Automobile Pollution Prevention Trading Project and the Agricultural Pollution Prevention Project.

One piece of the Great Lakes puzzle that is of serious concern is the impact on the entire ecosystem by exotic species such as the zebra mussel, the ruffe, the goby and other foreign invaders. The research community has worked diligently to assess the impact of the many species that have been introduced into the Great Lakes via shipping through the St. Lawrence Seaway.

Thanks to a recent grant from the Great Lakes Protection Fund, we are now taking dramatic steps toward reducing the risk of future introductions of foreign pests. In particular, the Fund committed \$1 million to develop a new ballast water filtration technology for vessels using the Great Lakes.

In my 1998 budget, I am recommending an increase in Michigan's commitment to controlling foreign aquatic species that threaten the Great Lakes. This includes an increase of \$100,000 for the Office of the Great Lakes to assist in the implementation of Michigan's *Nonindigenous Aquatic Species State Management Plan*. This will result in enhanced information and education efforts, monitoring, research, and

programs to prevent the spread of these invaders.

New market-based incentives are being developed which go beyond the requirements of our regulatory compliance programs to realize even greater returns to both the Great Lakes environment and the economy. We are working with the Council of Great Lakes Governors in a partnership with The Conservation Fund to determine if a water quality-based trading program can help fill the void between point source controls from municipal and industrial facilities, and nonpoint source controls from urban runoff, agricultural activities and other sources.

In addition, we are also reengineering existing programs to make better use of resources already available. An example of this is the on-going effort to provide low-interest loans to help farmers control problems caused by agricultural activities.

While we continue to realize success in protecting and improving our Great Lakes resources, today's environmental problems demand innovative solutions. The articles in this year's *State of the Great Lakes Annual Report* reflect these innovative, forward-looking and common sense approaches by public, private and citizen-based efforts.

These new initiatives will help make the restoration and preservation of our Great Lakes a successful example of what can be accomplished when innovation and creativity are combined with old-fashioned midwestern common sense. Many pieces of the Great Lakes puzzle are brought together in this report, illustrating a success story for which we should all be very proud.



John Engler
Governor



Magnificent Resources, Major Industry And Lessons For A World Economy

As every Michigan student knows, the Great Lakes contain 95 percent of the nation's freshwater and 20 percent of the world's surface freshwater. What he or she may not know is that the region showed greater growth in productivity during the 1980s (36 percent) than any country but for Japan.

This juxtaposition of magnificent resources and a major economy often results in the early identification and resolution of environmental issues on a national, even global scale. This year's *State of the Great Lakes 1996 Annual Report* provides ample proof of these dynamics.

So it is not surprising, but no less remarkable, that one of our guest contributors, Dr. Richard Florida, director of Carnegie-Mellon's Center for Economic Development, describes "zero defects, zero inventory, and zero emissions" as signs of a new high-performance economy emerging in the Great Lakes region. Zero defects and zero inventory manufacturing strategies are yielding substantial environmental benefits. These lessons point toward a reconciliation of environmental quality and economic productivity for a growing world economy.

The debate on endocrine-disrupting chemicals ("gender benders" in the idiom of the tabloids) burst upon the national scene with the publication in 1996 of *Our Stolen Future* by Theo Colborn, Dianne Dumanoski, and John Peterson Myers. This issue is given thorough airing in our annual report, from two differing perspectives. Whatever the reader's perspective, this, too, is an issue originating in numerous studies in the Great Lakes basin.

The amicable mediation of the latest controversy surrounding the Chicago diversion of the water of Lake Michigan, as well as a million dollar investment in ballast control technologies to reduce the introduction of exotic species, are the direct result of the leadership of Governor John Engler and his colleagues in the Council of Great Lakes Governors. The success of these kinds of collaborative processes, as well as an emphasis

on preventing future harm to the Great Lakes, are typical of the progressive approach to problems in the region. They offer models for other regions struggling with intractable resource controversies.



The rebound of the Great Lakes forests is recounted herein along with the opportunities and challenges in managing a renewable resource. Savaged in the 19th century, the forests' growth exceeds harvest which has increased by approximately 50 percent over the past forty years!

If these topics do not satisfy the reader's thirst for knowledge, this year's annual report offers a kaleidoscopic view of: lake trout restoration; toxaphene; the Great Lakes Commission; an agricultural profile of the region; and other topics of concern to the Great Lakes community.

The Office of the Great Lakes, along with our associates in the departments of Environmental Quality and Natural Resources, invite you to explore the many facets of Great Lakes science and policy with a view to understanding and protecting these greatest of natural resources.

A handwritten signature in cursive script that reads "G. Tracy Mehan, III".

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

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Collective Action: Advancing Ecosystem Initiatives Through The Great Lakes Commission

by Dr. Michael J. Donabue

The decade of the 1990s has seen a pronounced change in Great Lakes governance. Our historical approach, which might be characterized as top down, command and control, and government-driven, is giving way to a bottom up, partnership-based, inclusive approach. "Reinventing" government is the order of the day as federal/state relationships are redefined, as fiscal realities are accommodated, and as our institutions adapt to meet new challenges and opportunities.

Of particular note is the re-emergence of the Great Lakes states as leaders and innovators as they embrace their stewardship responsibility for the resource. Singly and collectively, they have begun to exercise an unprecedented level of self-determination in the use, management and protection of the Great Lakes. In brief, they have rediscovered the Great Lakes Commission.

Established in 1955 via state and federal legislation, the Commission serves its eight member states by developing, coordinating and advocating sound public policy on environmental protection, resource management, transportation and economic development issues. "Our vision," proclaims the membership, "is a Great Lakes basin that offers a strong and growing economy, a healthy environment and a high quality of life for its citizens by applying principles of sustainable development in the use, management and protection of its water, land and other natural resources."

At the organizational level, this vision has brought unprecedented inclusiveness to the organization's operations. U.S. and Canadian federal and provincial agencies, as well as regional bodies, tribal authorities and other public institutions, are valued observers that contribute to all member state deliberations. Industry associations and citizen organizations are increasingly viewed as partners and

collaborators on matters of shared interest. The addition of a policy research and development function in the 1990s has brought a tenfold increase in budget and added programs, member services and a substantial return on investment that far exceeds state dues.

At the program level, recent years have seen the Great Lakes states broaden their collaborative efforts and, in so doing, move the notion of an "ecosystem approach" from concept to reality. For example:

- The Great Lakes Commission staffed the development of The Ecosystem Charter for the Great Lakes St. Lawrence Basin.
- An Agricultural Profile of the Great Lakes Basin was produced by the Great Lakes Commission and several project partners.
- The Commission-staffed Great Lakes Panel on Aquatic Nuisance Species also helped move the Great Lakes states from a reactive to proactive mode on a leading issue of the 1990s: that of biological pollution.

The strength of the Great Lakes Commission lies in its membership, and their realization that collective action on public policy issues is a "win-win" proposition for both the Basin and their own jurisdiction(s).

Dr. Michael J. Donabue is Executive Director of the Great Lakes Commission, an eight state compact commission based in Ann Arbor, MI.



State Demonstrates Ongoing Commitment To Great Lakes Protection

by Russell J. Harding

Identifying, measuring and managing the vast array of complex features that encompass the Great Lakes demand that the Michigan Department of Environmental Quality, as caretaker, acquire a comprehensive ecosystem perspective.

We have shed the outdated notion that the Great Lakes' needs can be addressed on a piecemeal basis. The broader concepts of physical, chemical, biological and social linkages within the ecosystem are now considered. Issues ranging from land-use permits to waste management are viewed from the integrating perspective of the entire environment.

Numerous success stories indicate that proper ecological patterns are being followed:

- An increase in the number of fish-eating birds, which are the top of the biological food chain and excellent ecological barometers, continues.
- The total amount of organic toxins and heavy metals are still decreasing.
- Contaminated sites, which eventually work their contents into the Great Lakes watershed, are being reduced due to aggressive cleanup efforts.
- Pollution prevention efforts also have soared, addressing many point-source problems.

We are aggressively pursuing water quality enforcement actions in southeast Michigan. The state is working with several communities to ensure compliance with National Pollutant Discharge Elimination System permits.

The state also is an active partner in developing Remedial Action Plans for such designated Areas of Concern as the Detroit, Clinton and St. Clair rivers.

At the governor's direction, the Mercury Pollution Prevention Task Force released nearly 60 recommendations to reduce mercury in the

environment. The governor also expressed his concern to top federal officials regarding the proposed resumption of sales of more than 11 million pounds of stockpiled elemental mercury.

The National Forum on Nonpoint Source Pollution, chaired by Governor Engler, has yielded the landmark Great Lakes Watershed Initiative. Under this strategy, the Council of Great Lakes Governors will launch a series of demonstration projects in eight states and two Canadian provinces to address water quality issues relating to nonpoint source pollution in urban and rapidly growing areas.

We must, however, also acknowledge the enormous challenges still confronting us: atmospheric deposition, exotic species control, biological diversity, and land use are some of the questions that must be addressed.

Michigan's emphasis on bolstering traditional regulatory programs with innovative, voluntary approaches has undoubtedly laid the groundwork for continued progress in restoring the Great Lakes' vitality.

Michigan and its Great Lakes neighbors cannot veer from this course if we are to fully protect the assets in our care.



Russell J. Harding is Director of the Michigan Department of Environmental Quality.

The Environment And The High-Performance Revolution

by Dr. Richard Florida

The Great Lakes region is on the cusp of a new paradigm for regional growth and development revolving around zero defects, zero inventory, and zero emissions. The pursuit of zero defect and zero inventory manufacturing strategies is creating considerable environmental benefits as well, leading toward zero emission manufacturing strategies.

This article reports the key findings of a major study of the environment and high-performance economic organizations. The study was based on a national survey of corporate environmental best-practices at 450 corporations and also included extensive field research including factory visits and extensive telephone interviews with companies throughout the Great Lakes basin and region.

The high-performance revolution is causing a massive shift in corporate environmental strategy and pollution prevention. Three elements of this transformation, in particular, are worth noting.

The High Performance Paradigm: Competitive and Clean

First, corporate environmental efforts are increasingly bound up with broader efforts to improve competitiveness by adopting high-performance manufacturing systems and strategies. Manufacturing firms are leveraging their industrial modernization strategies to achieve environmental improvement. Manufacturing firms prefer productivity-enhancing process improvements over traditional approaches to treatment and end-of-pipe controls. Environmental performance — and particularly pollution prevention — is an increasingly important component of overall corporate performance.

More than three-quarters of companies report that pollution prevention is important to overall corporate performance. Nearly 90 percent of companies said that pollution

prevention, broadly defined (including source reduction, recycling, and end-of-pipe), is an important element of their overall environmental compliance strategy. More than three-quarters of

companies report production process improvement, source reduction, and recycling are main elements of their pollution prevention strategies. Significantly smaller percentages use control or end-of-pipe technology as main elements of their pollution prevention strategy.

Furthermore, roughly two-thirds of companies upgraded their existing process technologies and introduced wholly new process technologies in their efforts to prevent pollution and improve their environmental performance. In addition, more than three-quarters of companies were involved in recycling. Nearly half of companies introduced new product technology or closed loop production systems. Instead of cutting production, outsourcing polluting processes, or simply treating wastes, firms are investing in continuous improvement of their manufacturing processes to simultaneously prevent pollution and increase productivity.

Quality manufacturing is a key feature of the new paradigm. More than forty percent of companies said that they use a Total Quality Environmental Management (TQEM) program. Furthermore, a growing number of manufacturing firms in the Great Lakes are migrating from the traditional ISO 9000 standards to the new ISO 14000 standards which include standards for environmental quality. Ray-O-Vac was already operating at 95 percent of ISO 14000 standards. Safety Kleen's Elk Grove, Illinois, plant was in the process of



moving from ISO 9000 to ISO 14000 standards. Sony Corporation was shifting from ISO 9000 to ISO 14000 standards for its North American and worldwide manufacturing operations.

Zero emission manufacturing involves the complete elimination of all environmentally damaging byproducts from the production process. A significant number of companies — more than 15 percent — are actively pursuing zero emission manufacturing. And, nearly 85 percent of companies are pursuing reduced emission strategies. Most companies said that zero emission manufacturing is in its early stages of development, and that at this point it functions as a goal or target rather than as an adopted practice or standard. A number of companies drew a parallel between zero emissions manufacturing and the quality or zero defect movement of the 1970s and 1980s, citing zero emission strategies as an emerging source of competitiveness for the 1990s and beyond.

Importance of Employee Involvement

Second, employee involvement in continuous manufacturing improvement is a key element of high-performance manufacturing. Two-thirds of companies in the survey involve production workers in their pollution

prevention efforts. Companies rated only two other groups — top management and engineers — ahead of factory workers in pollution prevention efforts. These groups are increasingly working together in teams to generate productivity-enhancing environmental outcomes. The role of employees in pollution prevention was highlighted by a number of firms.

Quad/Graphics used employee teams to reduce hazardous waste by 27 percent and non-hazardous liquid waste by 47 percent over two years with estimated cost savings in excess of \$600,000. IBM's disk drive plant involved workers, engineers, and R&D scientists in a plant-wide effort to reduce chlorofluorocarbons (CFCs). Safety-Kleen used teams of workers and engineers to reduce solvents, minimize waste, and redesign equipment for increased resource efficiency and pollution prevention. Crown Cork and Seal's Fairbault, Minnesota, plant involved production workers as the centerpiece of its efforts to eliminate waste and reduce toxins, forming teams of production workers to focus on environmental issues — for example, a *Recycling Team* whose objective focused on an environmental problem, and a *Color Cats Team* whose main effort was quality improvement, but whose work had considerable impact on hazardous waste generation. As a result of these efforts, the plant achieved a 60 percent reduction in use of its primary solvents between 1991 and 1993, a 36 percent reduction of air emissions in 1993, and a three-fold reduction in solid waste disposal from an annual level of 300 tons to 100 tons that same year.

Harnessing the Supply Chain

Third, greater corporate reliance upon key suppliers is opening up new pathways for regional environmental improvement. The biggest payoffs come from ongoing joint efforts between companies and their suppliers to improve productivity, eliminate defects, and reduce costs, rather than from direct efforts to transfer pollution prevention technology or organizational strategies designed expressly to eliminate toxins or prevent pollution.

High-performance companies are increasingly involving their key suppliers in

Key Actors in Pollution Prevention Efforts

<i>Actor</i>	<i>Percent of Respondents</i>	<i>Number of Respondents</i>
Top Management	81.1%	173
Engineers	75.0	159
Line Workers	64.6	137
R&D Staff	55.2	117
Suppliers	49.1	103
Customers	37.7	81
Consultants	28.3	60
Environmental Organizations	20.8	44
Distributors	7.5	16

N = 212

Source: Richard Florida, *Survey of Environmental Manufacturing Processes* (Pittsburgh, PA: Center for Economic Development, Carnegie Mellon University, 1995).



efforts to improve environmental outcomes and increase productivity. Roughly half of companies in the corporate environmental best-practice survey identified suppliers as a key player in pollution prevention efforts. Suppliers were the top ranked player in pollution prevention efforts outside the corporation, and ranked fifth overall. Only key groups inside the corporation ranked higher: top management, engineers, R&D staff, and production workers. In addition, nearly 40 percent of companies said that customers are key players in driving pollution prevention efforts. As these responses make clear, there can be little doubt that the entire production chain from supply to final delivery is an increasingly important player in pollution prevention.

Sony's Westmoreland, Pennsylvania, advanced television plant and its suppliers provide a compelling example of how environmental improvements can flow naturally from ongoing joint efforts to improve productivity, eliminate defects, and reduce costs, rather than from direct efforts to transfer pollution prevention technology or organizational strategies designed expressly to eliminate toxins or prevent pollution. As part of its efforts to reduce cost and waste, the Sony plant worked with its suppliers of plastics, metals, solder, and other materials to completely recycle all of the scraps and other products of the production process. Sony worked closely with one of its suppliers, Tuscarora Plastics, to redesign its packaging to be less costly—a design which also used less material and generated less waste. The Sony plant also collaborated with a major paint supplier to reduce the cost of paint by switching to a water-based substitute which was also more environmentally sensitive than chemical-based paints.

The Path to High-Performance

The high-performance revolution can—and is—being leveraged for environmental ends. The efforts of firms to improve manufacturing processes and increase productivity are opening up new opportunities for environmental improvement for the Great Lakes region and basin. The adoption of high-performance manufacturing, which has helped

to revitalize the region's manufacturing base, is creating incentives for innovative pollution prevention strategies and environmentally-conscious manufacturing. The region's growing base of highly innovative, high-performance firms is leading the race to improve industrial productivity and reduce environmental costs and risks.

Policy-makers can take advantage of these trends by integrating environmental policy into their competitiveness agendas. Existing environmental policies should be reviewed in light of the demands of high-performance production. The region should involve the CEOs of leading manufacturing companies in this effort, establish teams of environmental, economic and trade policy-makers to better link programs and efforts, and establish reliable performance benchmarks to chart progress toward joint economic and environmental goals. By linking the region's environmental strategy to its high-performance competitiveness agenda, the Great Lakes can continue to improve its environmental quality, while strengthening its manufacturing base and securing long-run economic growth for its workers, citizens, and communities.

Dr. Richard Florida is Director of the Center for Economic Development at Carnegie Mellon University.

Elements of Pollution Prevention Efforts

<i>Type of Pollution Prevention Effort</i>	<i>Percent of Respondents</i>	<i>Number of Respondents</i>
Source Reduction	89.6%	190
Recycling	85.8	182
Production Process Improvements	77.8	165
Treatment	36.3	87
End-of-Pipe Control Technology	25.0	52
Facility Downsizing	7.1	15
Other	9.4	18

N = 212

Source: Richard Florida, *Survey of Environmental Manufacturing Processes* (Pittsburgh, PA: Center for Economic Development, Carnegie Mellon University, 1995)



The Endocrine Disruption Forum

Introduction To The Issue Of Environmental Endocrine Disruption

During the past five years there has been a great deal of discussion concerning the potential for chemicals to disrupt the endocrine systems of humans and wildlife. The endocrine system affects metabolism, growth, development, reproduction and cardiovascular function via the secretion of hormones. An "endocrine disruptor" theory has been proposed which suggests that there are currently numerous chemicals in the environment which have been or are currently at levels which could adversely affect the endocrine systems of humans and wildlife. Examples of effects which have been identified as supportive of this concept include the formation of vitellogenin in male fish, a protein normally associated with egg production in females, exposed to the discharge from some municipal wastewater treatment plants. A highly debated finding which has been suggested to be linked to endocrine disruption is the possible decrease in sperm production in human males in industrialized nations. The theory of endocrine disruption was popularized after a multidisciplinary group of experts gathered at the Wingspread Center in Racine, Wisconsin, in 1991 to determine the magnitude of the problem of endocrine disruptors in the environment. A consensus statement published following the "Wingspread Conference" warned of current and future uses of these chemicals. The consensus statement also contained a lengthy list of chemicals which were considered "known endocrine disruptors." In the years following this conference, there has been a followup conference as well as much scientific research, many meetings of experts, and numerous articles published in scientific journals and popular magazines. All of this information has shown that there is still much disagreement on this issue.

The following two articles provide the reader with a view of the differing opinions scientists have concerning the endocrine disruptor theory. The first article by Michael Gilbertson mentions numerous findings which

he believes supports the contention that chemicals have caused and continue to cause adverse effects on the endocrine systems of wildlife and humans and that these effects are widespread. The other article, written by Dr. John E. McCarthy, notes an awareness of the same findings mentioned by Gilbertson but comes to a different conclusion. He defends the thoroughness of pre-market testing of agricultural chemicals and suggests that there are only isolated cases of chemicals affecting the endocrine system and that for the most part these effects occurred only at high exposure concentrations (i.e., effects occurred at concentrations higher than the existing background levels in the environment). He suggests that individual findings by scientists warrant concern for potential endocrine effects, but that there is insufficient evidence at present to necessitate alarm.

To address this concern, the U.S. EPA is developing a screening method to determine which chemicals may disrupt the endocrine system and is funding additional research on this issue. The National Academy of Science is also examining the potential impacts of chemicals on the endocrine systems of humans and wildlife and is expected to release a report on the state of the science this year. Hopefully, the research which is presently being conducted will help resolve this issue.

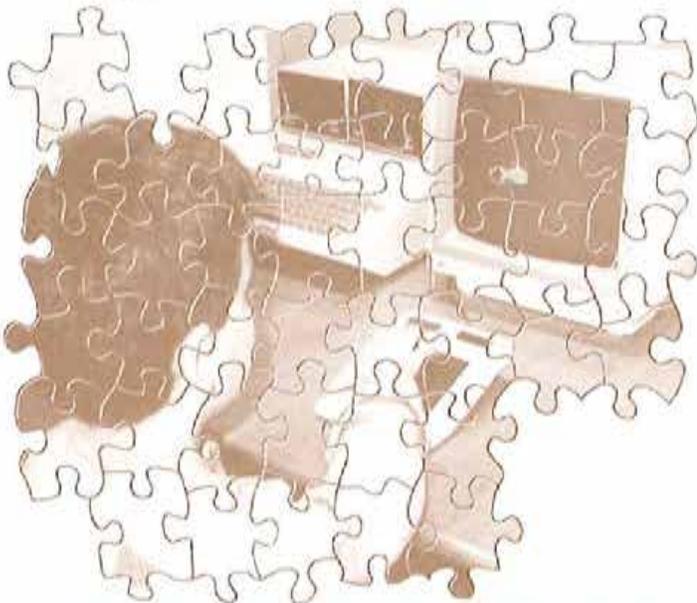


The Endocrine Disruptor Theory And The Test Of Time

by Michael Gilbertson

About a year ago, I was at a neurotoxicity and endocrine disruptor meeting in Little Rock, Arkansas, when Dr. Theodora Colborn reminded me that six years ago she had first tried out the theory of endocrine disruptors on me and, while I had been skeptical, I had not tried to dissuade her. In retrospect, I am glad I did not! My own research on deformities in fish-eating birds in colonies on the Great Lakes seemed to have very little to do with interference with hormones, and so I found it difficult to see how the concept was going to help me explain my observations of twisted beaks, deformed feet, and missing eyes in bird embryos. What I had not appreciated was that Theo had formulated a general explanatory principle about the role of several man-made chemicals which interfere with the exquisitely sensitive communication and control systems guiding the normal development of the structure and functioning of all organisms.

The original name of "endocrine disruptors" arose at her now famous 1991 workshop published as a volume entitled



A four-year old child being tested for impaired cognitive development caused by his mother eating a pound per month of Lake Michigan fish for six or more years prior to pregnancy.

Chemically Induced Alterations in Sexual and Functional Development: The Human/Wildlife Connection. The thesis of the book has now been popularized in Theo's 1996 bestseller entitled *Our Stolen Future.*



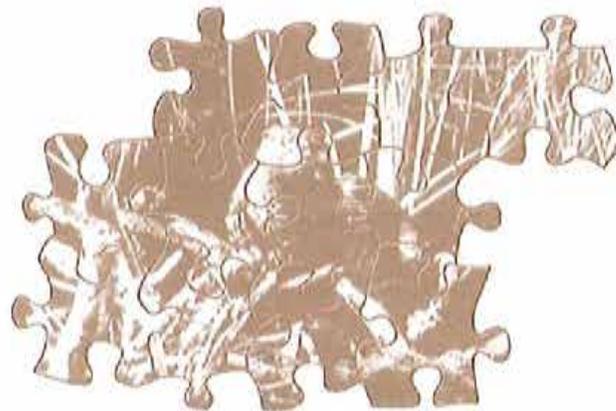
How has the explanatory principle stood up to the test of time? First, there continues to be a seemingly unending stream of case studies from around the world that relate observations of abnormal development of organisms exposed to man-made chemicals. For example, in the Columbia River, river otters have a baculum or bone in the penis which is smaller than in those from reference areas around the basin. The development of the baculum is under the control of testosterone, but the levels of estrogenic polychlorinated biphenyls (PCBs) in the Columbia River fish the otters eat are so high they counteract the normal effect of the testosterone. This new case can now be placed along with the infamous story of the Lake Apopka alligators with the small penises caused by a spill of dichlorodiphenyltrichloroethane (DDT), and the reduction in the size of the penis in the cohort of boys accidentally exposed in utero in Taiwan in the 1970s to PCBs. The consistency of the observations of abnormal structural and functional development being reported by scientists from around the world in a variety of organisms lends validity to the theory of endocrine disruptors.

The second source of support for the hypothesis is the coherence of the evidence at all levels of biological organization. Observations made at the population level in fish and wildlife or in clinical situations in humans are consistent with the known biological facts and underlying mechanisms at

the tissue, cellular, and biochemical levels. For example, the 1970s field observations of many female herring gulls sharing nests was at a time when there was an apparent insufficiency of functional males during the period of high levels of PCBs and DDT and metabolites. Histological observations of the gonads in male herring gull embryos showed they had been feminized and contained both male and female cells. This process of feminization could be either a result of the well established estrogenic effects of these organochlorine compounds, or it could be the result of the DDE, a metabolite of DDT, on the expression of the testosterone on the developing testes, and acting as an antiandrogen.

The third source of support for the theory is the way in which it can be used to predict previously unknown phenomena. Part of the evidence, from the experimental work that has been undertaken on rodents and from the clinical observations of the children exposed in utero to diethyl stilbestrol (DES), has led to the theory of the tight coupling of the development and functioning of the reproductive, neural, and immune systems with the endocrine system. The neurological observations that have been made on the cohorts of the infants in western Michigan and upper New York State whose mothers ate fish from the Great Lakes contaminated with organochlorine compounds are predictable from the endocrine disruptor theory. The children in the Michigan cohort have lost over 6 IQ points and are a year behind in school at eleven-years-old compared with a reference group. This unrealized intellectual potential is correlated with the PCB concentration in the blood sampled from the umbilical cord at birth, but not with the PCB in the blood at eleven years of age, suggesting that it could be difficult to undertake retrospective neurological research in the general population. Further confirmation of the predictive power of the theory derives from the results of investigations of a cohort of Dutch children perinatally exposed to dioxin-like compounds. In addition to the poorer psychomotor development, the more highly exposed infants had altered thyroid status and a deficit in functioning of the immune system.

A fourth series of pieces of evidence concern the exposure-response correlations and



The river otter is one of many animals exhibiting abnormal hormonal development.

thus give a strength to the associations that have been postulated. For example, research on the immune competence in gull and tern chicks from colonies throughout the Great Lakes show an inverse dose-response relationship between PCB levels and immune function. Similar linear dose-response relationships have been documented on a colony basis for embryonic mortality and the content of dioxin-like activity in the eggs of double-crested cormorants. Similarly, in the cohorts of infants of mothers who ate Great Lakes fish prior to pregnancy, the relative risk of poorer psychomotor development is related to the PCB burden.

As an explanatory principle, the concept of endocrine disruptors has withstood five years of vigorous critical examination by the scientific community. More importantly, the theory has been a powerful force for integrating scientists from a variety of disciplines, backgrounds, and nationalities to coordinate their focus of attention on ways in which man-made chemicals interfere with the development of embryos and fetuses, and on the implications for subsequent functioning throughout a lifetime. This has appropriately moved some of the attention from cancer, as the predominant concern of researchers and regulatory officials, toward teratology or the science of structural and functional abnormalities. In retrospect, could I have dissuaded Theo from pursuing her theory?

Michael Gilbertson has been a biologist with the Great Lakes Regional Office of the International Joint Commission since 1988.

Industry Scientists Share Concern, Not Alarm

by Dr. John E. McCarthy

Among the many health concerns commanding public attention in 1996 was one related to human and animal endocrine systems and use of various chemicals in our society.

The concern advanced is that certain synthetic chemicals can mimic naturally occurring hormones and disrupt their normal role in the human and animal system. Among the potentially adverse effects suggested by such disruption are cancers (breast, testicular, prostate), reduced sperm count, abnormal fetal development, and species-threatening disorders in wildlife.

While some aspects of this theory may be biologically plausible, the available data fail to support a claim that synthetic chemical compounds cause substantial harm by hormonally mediated mechanisms. Massive consumption of some chemicals by animals, either in the laboratory or through environmental accidents, has shown endocrine systems can be adversely affected. At issue is whether exposure to minute amounts of such chemicals in human and animal environments creates a risk. The conclusion by most medical and scientific authorities, including those within the chemical industry, is the fact we share the concern, but do not see cause for alarm.

Determining the potential effects of such chemicals to the endocrine system is an emerging science. Scientists from both public and private sectors have broadened the research underway to gain a better understanding of endocrine modulation, the potential relationships between breast cancer, male fertility, child development, and any adverse effects on wildlife. Principle stakeholders — including industry, environmental groups, universities and government — are working cooperatively to develop improved methods and models for testing, screening, and risk assessment. We believe this is important. We believe this is the right thing to do, and we support such efforts.

For pesticide manufacturers, this is familiar territory. Each pesticide product must successfully pass as many as 120 tests or more,

as mandated by the U.S. Environmental Protection Agency (EPA), before it can be approved for use by farmers or consumers. Many of these tests are specific for health, safety, and environment. This testing and evaluation process

can take as many as 10 years or more, and includes specific hormonal-effects studies.

The crop protection industry is committed to using its strengths in scientific research and development to discover, produce, and refine the products that protect and improve the safety and quality of our food and fiber supply. Because scientific testing is the foundation of our business, we are just as committed to finding the answers to estrogenic effects.

Ultimately, it is the responsibility of regulatory authorities to set priorities for protecting the safety and wholesomeness of our food, water, and environment. Yet industry searches for that data, and that goal, too. However, no one is interested in bearing undue societal and economic costs because of ineffectual or unwarranted regulations.

A turning point in our understanding will come with the report of the National Academy of Sciences' (NAS) Committee on *Hormone-Related Toxicants in the Environment*. The Committee's charge is to assess known and suspected mechanisms and impacts on wildlife and humans. The NAS report is likely to identify areas for further inquiry and offer an appropriate scientific framework in which to address those issues, and is slated for release in mid to late 1997.

Another key development was agreement on a bi-partisan provision for an estrogen-screening program, which became law with passage of the Food Quality Protection Act and the Safe Drinking Water Act Amendments in



1996. Taken together, the laws require the EPA to develop a screening program to determine whether certain chemicals mimic estrogen or pose other endocrine effects in humans. Central to the EPA's development of that program is a multi-stakeholder dialogue process that was begun in 1996 and continues. The EPA has obtained a charter for a 35-member federal advisory group called the Endocrine Disruptors Screening and Testing Advisory Committee (EDSTAC). Participants on EDSTAC include representatives from industry, federal and state agencies, environmental, environmental justice, labor, consumer worker health and public health organizations, and water providers.

Among the EDSTAC's goals is the development of a set of principles to be applied in shaping the committee's screening and testing recommendations, as well as future EPA endocrine disruptor screening and testing policy decisions. These principles will address:

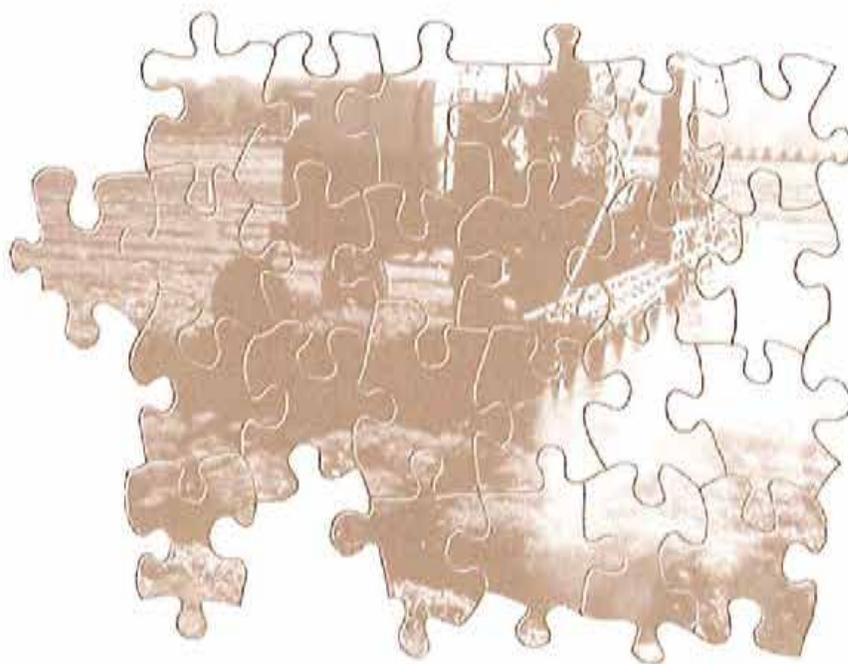
- establishing the purpose of endocrine screening and testing;
- selecting and prioritizing chemicals for screening;
- selecting from alternative screens and tests;
- establishing the order or logical relationships for using different screens and tests;
- validating screens and tests;
- interpreting the results of screens and tests, including the utility of the information both for decisionmaking concerning testing procedures and in the broader arena of risk management.

In addition to its work on the endocrine screening program, the EPA has committed approximately \$10

million in intramural and extramural research projects. Further, the National Science and Technology Council's Committee on Environment and Natural Resources, which advises the White House, is coordinating the research efforts of 14 agencies conducting 394 projects in endocrine disruption. A vital objective is development of a central research data base.

The questions at hand are complex, yet we are confident these research activities will yield a better grasp of what we know and what we need to know concerning both the effects of various synthetic compounds and the best methods by which to study them. As with any health or environmental concern, the crop protection industry will continue to ensure safety in the use of its products.

Dr. John E. McCarthy is Vice President of Global Scientific & Regulatory Affairs for the American Crop Protection Association.



Pesticide products are constantly tested and monitored for environmental health and safety.

*F*isheries and Health

Michigan's Lake Trout Resource

A lake trout restoration milestone was reached in Michigan's Great Lakes waters in 1996. After more than 40 years of restoration efforts on Lake Superior, populations of naturally-reproducing lake trout were determined to be sufficiently rehabilitated in most of Michigan waters that fisheries managers could recommend elimination of stocking. This milestone was reached by the combined efforts of Michigan and other state/province, federal, and tribal agencies. Sea lamprey control and stocking hatchery lake trout were essential parts of recovery efforts. However, key to Michigan's success were restrictive regulations which allowed development of large spawning populations of hatchery lake trout which utilized the abundance of in-shore spawning habitat in Michigan waters. Wild lake trout progeny of these hatchery fish increased in abundance during the 1970s and peaked at over 80% of historical pre-lamprey lake trout abundance by 1986. Abundance decreased to 61% of the historical level by 1993, but populations remained self-sustaining. This decrease was believed due to increased fishing and sea lamprey predation, emphasizing the need for continued vigilance by management agencies.

Rehabilitation of self-sustaining lake trout stocks in Michigan waters of Lake Superior, mainly by stocking and protecting hatchery lake trout, has cast an optimistic light on similar rehabilitation efforts in Lake Michigan and Lake Huron. Although self-sustaining lake trout populations have not yet developed in these lakes, there has been scattered evidence of lake trout reproduction over the years, most recently by hatchery lake trout stocked on an off-shore reef in Lake Huron (Six-Fathom Bank). Current management efforts in Lake Michigan and Lake Huron are focused on stocking large numbers of different strains of hatchery lake trout on off-shore spawning areas and protecting these populations by designating the off-shore areas as refuges (Northern Refuge and Midlake Refuge in Lake Michigan, Six-Fathom Bank Refuge in Lake Huron). Minimum size

limits have been increased for lake trout taken in Michigan's Lake Michigan sport fishery in an effort to increase abundance of adult lake trout. Increased size limits are also proposed for the Lake Huron sport fishery. Sea lamprey control efforts by U. S. Fish and Wildlife Service have been diversified with expanded use of barrier dams and release of sterilized male lampreys into spawning populations. Control efforts have also been expanded to reduce the large spawning population in the St. Marys River. St. Marys River is believed to be the biggest producer of sea lamprey that prey on lake trout in Lake Huron.

Toxaphene In The Great Lakes

In the late 1940s the Hercules Company introduced toxaphene in the United States as a broad-spectrum pesticide. Toxaphene is a complex mixture of more than 650 chlorinated chemicals (polychlorinated camphenes) used primarily as an insecticide on cotton crops in the southern United States. Applications in the Midwest accounted for less than 1% of the total annual use. These uses included application as an insecticide and herbicide on soybeans and corn, to treat scabies on livestock, and as a piscicide to remove rough fish from lakes. In Michigan, more than 20 inland lakes and a Lake Erie marsh were treated with toxaphene in the 1950s.

The application of toxaphene was encouraged after the U.S. Environmental Protection Agency (EPA) banned DDT in 1972. Toxaphene was one of the most heavily used pesticides until the EPA canceled the registration for most uses of toxaphene in 1982, and banned all uses of toxaphene in 1990. EPA banned the importation of food containing toxaphene residues in 1993. In addition, the use of toxaphene has been banned in Canada, England, Sweden, Finland, Denmark, France, Germany, Switzerland, Hungary, Italy, Egypt, India, China and Algeria. However, toxaphene-like pesticides are still produced and used in Latin America, India, Eastern Europe, the former Soviet Union and Africa.

In water, toxaphene is strongly adsorbed to suspended particles and sediments and can bioaccumulate in aquatic organisms to relatively high levels. However, as the result of metabolism, toxaphene is not biomagnified to the same degree as other chlorinated compounds such as DDT and PCBs. Consumption of contaminated fish represents a direct route of exposure to humans in the Great Lakes basin. The EPA has determined that toxaphene is a probable human carcinogen. In addition, some scientists believe that toxaphene is one of a group of compounds known as endocrine disruptors.

Some investigators believe that polychlorinated camphenes (the chemicals that comprise toxaphene) may be unintentional by-products of manufacturing processes that use chlorine. Existing analytical methods cannot distinguish between polychlorinated camphenes that originated as the pesticide toxaphene and polychlorinated compounds that may have originated from other sources. In addition, existing analytical methods are subject to interferences from other chlorinated organic compounds commonly found in the environment. For these reasons, many investigators characterize the results of their analyses as "apparent toxaphene."

Apparent toxaphene was detected in Great Lakes fish as early as 1973. Michigan has analyzed apparent toxaphene in nearly 6,000 fish fillet samples since 1983 and concentrations have been detected in 17% of these samples. Apparent toxaphene is more prevalent in the Great Lakes and has been detected in 31% of the fish fillet samples, collected by Michigan, from the Great Lakes or Connecting Channels. Concentrations of apparent toxaphene exceeded the Food and Drug Administration action level of 5.0 mg/kg in one lake trout from Lake Michigan and 21 lake trout or cisco from Lake Superior. These elevated concentrations of apparent toxaphene, as well as elevated levels of total PCBs, mercury and total chlordane, prompted the Michigan Department of Community Health to issue a fish consumption advisory against eating cisco larger than 18 inches from Lake Superior. Also, apparent toxaphene concentrations were analyzed in fish collected from inland lakes treated with toxaphene during

the 1950s. However, apparent toxaphene was not detected in the fillet samples.

Existing data for the entire Great Lakes basin indicate that apparent toxaphene concentrations in whole lake trout samples have decreased about 3 fold since 1980-1982 in all of the Great Lakes, except Lake Superior. In addition, sediment data indicate that apparent toxaphene concentrations may have decreased in Lakes Superior, Michigan and Ontario since the 1970s. Insufficient data were available to draw conclusions for Lakes Huron and Erie.

Atmospheric deposition of apparent toxaphene to the Great Lakes is likely the most important pathway. Historically, other pathways such as tributaries may have been important. Some investigators believe that it is probable that local sources of apparent toxaphene other than long range atmospheric transport and deposition have been important to the Great Lakes basin.

In 1996, the EPA sponsored a workshop on toxaphene in the Great Lakes. The recommendations are as follows:

- Measure the concentration gradient of apparent toxaphene across the air-water interface and link with the atmospheric source profile to establish the seasonal and annual fluxes to and from Lakes Superior and Michigan.
- Collect additional sediment cores in Lakes Superior and Michigan to determine concentrations, accumulation rates, and inventories to help establish past dynamics of apparent toxaphene and assist in efforts to forecast future conditions in the Great Lakes.
- Quantify aquatic food web dynamics to establish how the food web influences spatial and temporal variations in concentrations of apparent toxaphene in biota.
- Measure the physical-chemical properties of apparent toxaphene homologs and congeners.

The EPA is considering several proposals to address these and other toxaphene related issues in the Great Lakes basin.

PCB Levels In The Blood Of An Avid Great Lakes Angler

by John L. Hesse

During my 28 years of employment by Michigan environmental and health agencies, I have witnessed dramatic improvements in the environmental quality of the Great Lakes and its tributary waters. Particularly gratifying has been the decline of several contaminants such as PCBs, DDT, and other chlorinated hydrocarbon chemicals in fish tissue. DDT and PCBs have dropped in some Great Lakes fish by as much as 90 percent since the 1970s. But what about contaminant levels in humans who eat Great Lakes fish?

Being the coordinator of Michigan's fish consumption advisory program for the Michigan Department of Public Health (now named the Department of Community Health) for more than a decade, I have had a special interest in learning more about human body burdens of PCBs and other contaminants related to Great Lakes fish consumption. I am also an avid angler who enjoys eating some of the fish I catch. Because of this interest, I have personally participated in some studies targeted at answering questions about the uptake and

retention of contaminants from fish. This report briefly presents some of those unpublished study findings.

In 1983, I was one of 16 state agency volunteers involved in a study by the Michigan Department of Public Health to evaluate human uptake of contaminants from a single meal of fish from Lake Michigan. Each participant ate a standardized volume (0.5 pound per 70 kilogram body weight) of either lake trout or chinook salmon with known contaminant levels. Concentrations of PCBs and other common contaminants were analyzed in blood samples immediately prior to the meal and at intervals over the following 7 days.

Figure 1 shows PCB concentrations in the blood of 4 volunteers who ate lake trout containing approximately 22 parts per million (ppm) of PCBs (more than 10 times the FDA Tolerance Level). For this group, skin and fatty deposits were purposely not removed prior to cooking. The top line represents my own blood levels of PCB prior to and following the meal. My background level prior to the meal was approximately 38 parts per billion (ppb). This level increased rapidly to 80 ppb only 6 hours after the meal. Within 48 hours, it had almost returned to the pre-meal level. Over the 15 years prior to the study, I had eaten Great Lakes salmon and trout regularly (but not more than 1 meal per week). The bottom line in Figure 1 represents 3 volunteers who were non-fisheaters. Their average uptake of PCBs and rate of decline in blood closely paralleled mine but their pre-meal background level was only approximately 5 ppb. Similar curves, but with lower amplitude, were observed for the other 12 volunteers who ate chinook salmon (skin-on and skin-off) or trimmed lake trout. The



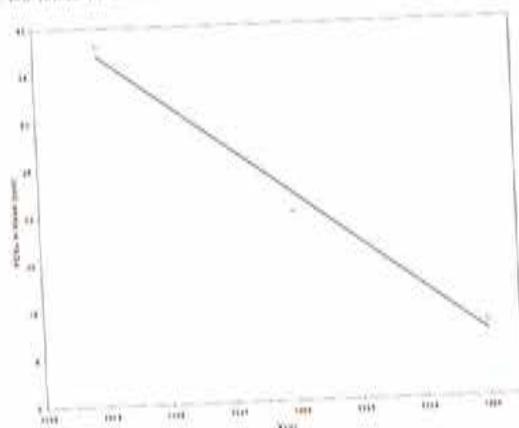
Are large Great Lakes fish like this steelhead safe to eat?

chinook salmon used for the study contained approximately 3 ppm. Skinning and trimming both fish species prior to cooking reduced the amount of uptake into the human blood stream.

Other studies by Michigan researchers had already showed that the longer a person has eaten contaminated fish, the higher the PCB level was in blood and fat tissues. Although the 1983 study suggests that the blood level from a single meal shows only a temporary spike, each meal is believed to add a small increment to a person's total body burden of PCBs. Some of the contaminants are being excreted continuously via urine and feces. If meals are adequately spaced and if contamination levels are decreasing, excretion may exceed the rate of uptake and storage.

The 1983 study was the first time I had my blood tested for PCBs. At that time, my background level of 38 parts per billion was about eight times higher than that of the general non-fish eating population in Michigan. Figure 2 shows what has happened to my PCB blood levels since 1983. The combination of declining contaminant concentrations in fish and my adherence to consumption advisories

Figure 2. PCB levels in the blood of the author vs. years, 1983-1995.

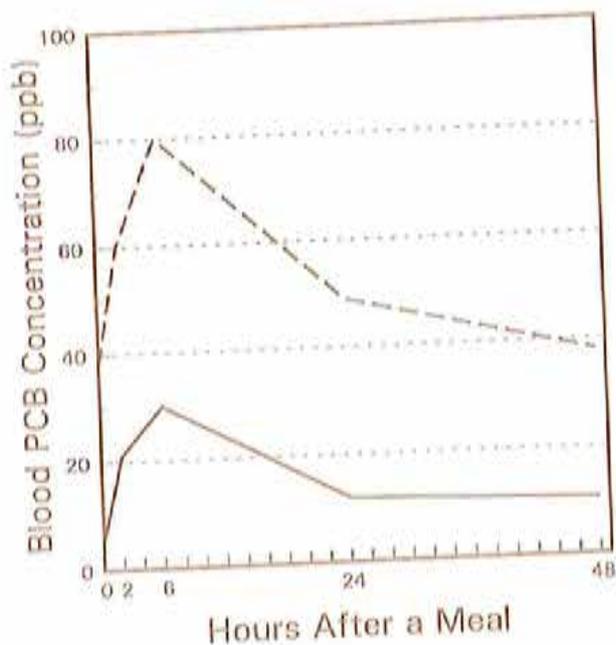


resulted in a 50 percent decline by 1989. The level had decreased to 12 parts per billion in 1993 and 8 parts per billion in 1995. My blood level is now essentially the same as the background level in Michigan residents who do not eat sport caught fish. Of great importance is the fact that this decline was achieved while I continued to enjoy reasonably frequent meals of sport fish from the Great Lakes and inland waters.

These data support other evidence that contaminant levels are declining in the environment and that following fish consumption advisories can be an effective way of reducing one's exposure to contaminants. I always skin and trim my fish as recommended by each of the Great Lakes jurisdictions' in their fish consumption advisory documents. Surveys show that the majority of Great Lakes anglers now follow the recommended trimming and cooking advice. Coupled with information in the advisories on which fish have the highest contaminant levels, anglers can minimize their risks and continue to enjoy the health benefits of regular fish consumption.

John L. Hesse works in the Environmental Epidemiology Division of the Michigan Department of Community Health and coordinates Michigan's Fish Consumption Advisory Program.

FISHEATERS EXPOSURE LEVEL AFTER A MEAL



Societal Benefits Grow On Trees In The Lake States: A Continuing Regional Resource Renaissance

by Dr. Henry Webster

The forests of the Lake States (Michigan, Minnesota, and Wisconsin) a century or more ago provided both raw material and financial capital for development of a major part of midcontinental United States. William Cronon, author of *Nature's Metropolis: Chicago and the Great West*, describes how Chicago and a large hinterland from the Appalachians to the Rockies interacted with each other. Three resource-based commodities (timber, grain, and meat) were the developmental underpinning, and they linked together at the junction of the Great Lakes and the western and eastern railroads.

Original harvest of Lake States forests, as Cronon demonstrates, made sense in the context of a developing country that the U.S. then was. Two less fortunate — neither permanent, nor fatal — events followed. One was punishing wildfires. In addition to loss of human life (as in Peshtigo in 1871, Hinskey in 1894, Cloquet in 1918, and several others in Michigan), these fires considerably reduced organic matter in soils of considerable parts of the Lake States. The second was the attempt, with great human effort, to farm areas that were not fertile enough to provide an adequate and decent living.

Recovery began some seventy-five years ago. Both passage of time, and deliberate efforts, have played mutually reinforcing parts. Deliberate efforts include: progressively better wildland fire control beginning in the 1920s; institutional changes in landownership, concentrated in the 1930s, which have given the Lake States the largest amount of state and county owned and managed forests in the contiguous forty-eight states; and a series of concentrated efforts in improved forest resource management that range from the 1930s to the present.

Rebound of the Lake States forests is continuing and is strongly reflected in recent

statewide resource inventories in all three states. Forest area increased somewhat from the 1970s to 1990s with reversion of additional marginal agricultural land to forest, accompanied by increases in

wildlife species. Between 1980 and 1993 the volume of trees growing on forest land in Michigan increased by essentially the *entire* volume growing there in 1950.

Lake States forests are in generally good and improving health. Careful monitoring shows that threats of disease and decline are highly place-specific and *not* general. Occasional drought is the stressor most likely to affect forest cover over any widespread area.

Forest products industries in the Lake States have also expanded significantly. During the 1980s, major firms invested \$4.5 billion in new and expanded plants in both pulp and paper and building products sectors. A significant number of expansions continue with the three states sharing about equally over the most recent fifteen years. These expansions are a result of major economic forces and resource trends, and the combined efforts of business development and forest resource units in the three states, with encouragement from the respective governors.

Resource-based activities in tourism and forest products are a major support for the fabric of society in the Lake States. The two sectors together provide 280 thousand jobs directly paying wages of \$7.6 billion, with sales and expenditures of \$26 billion. The forest products sector is substantially the larger of the two, as well as the more rapidly expanding. Careful examination of a number of specific areas of the Lake States shows that



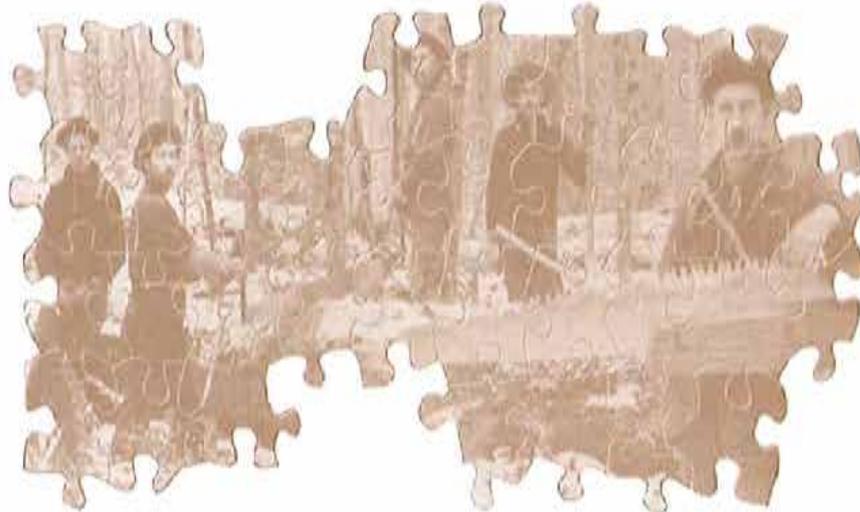
communities with substantial activity in *both* tourism and forest products are better in employment and community terms than are communities more concentrated in one or the other.

Recovery and growth based on forest resources in the Lake States will benefit the nation as well as the region itself. A first consideration is some evident shift in the resource geography of North America that is in progress. Half of the lumber consumed in the U.S. comes from the Pacific Northwest and British Columbia, but substantial reductions in production are occurring in these regions. Southern forests are essentially producing at capacity. The one place in North America that there is resource capacity for a significant increase in output is the drainage basin of the Great Lakes and St. Lawrence River in both the United States and Canada. The Lake States are the major U.S. forested portion of this large drainage basin.

A second consideration is the extremely high U.S. consumption of resource commodities in comparison with parts of the world at an equivalent stage of societal development. For example, U.S. per capita consumption of paper and paperboard is 48 percent higher than that of Canada, and 93 percent higher than that of western Europe. Other resource-based commodities, for example gasoline, show a similar pattern. No doubt we could live satisfactorily with less consumption; Canadians and western Europeans do. But saying that, and actually somehow reducing U.S. consumption, are two quite different things. Materials to meet continuing high levels of U.S. consumption do have to come from somewhere.

It is important that a reasonable proportion come from domestic sources. This is so for reasons of trade balance, societal prosperity, and environmental effects otherwise exported to other parts of the world via our imports of resource commodities. With imported lumber now comprising about double its historic share of total U.S. consumption, there is evident need of improvement from this national perspective.

This major rebound is very different from some publicly expressed views that many natural resource matters are in a very bad way. The contrast between *fact* and *expressed views* is so great as to call for an effort to explain the underlying reasons. A good point of departure is Oxford historian, Michael Williams, and his book, *Americans and Their Forests: A Historical Geography*. He concludes that over a long history there has consistently been more public



Lumbermen in Kalkaska County in 1899.

attention to factors diminishing forests than to factors augmenting them, even when the latter are distinctly stronger. There may be a very simple but important one-eyed public view. Tree growth, and re-establishment of forests on areas once

farmed is very gradual but persistent. Removal of forest at any given place, in contrast, is usually rather abrupt. This amounts to a gradually rising tide contrasted with the abruptness of surgery. Things that happen suddenly attract the eye. But the point to remember is the tide is steadily rising in the Lake States.

Dr. Henry Webster is Project Director for the Lake States Regional Forest Resources Assessment for The Lake States Forestry Alliance. He was formerly State Forester for the State of Michigan.

The Future Of Our Great Lakes Forest

by Anne Worwode

Michigan residents can be proud that the Upper Great Lakes forests were the birthplace of the modern conservation movement. At the beginning of the 20th century this remarkable movement rose like a phoenix from the stumps and ashes of the one of most ecologically destructive eras in history. The conservation challenges in the 21st century, however, will be even greater than those faced in the last hundred years. The protection, restoration and perpetuation of native forest ecosystems is the difficult but essential next step toward reclaiming the majesty of the Great Lakes forests, for our well-being as individuals and for society as a whole.

The last eighty years have been marked by the success of efforts to bring back marketable trees and huntable species, but even these triumphs were only the first steps toward recovery of the region's native forest ecosystems. Paradoxically these very successes have presented some of the biggest hurdles to the restoration of native forest ecosystems.

The emphasis on restoring the region's timber and game resources has produced wildly out of balance forest ecosystems throughout the Upper Great Lakes. More than a few well-intentioned efforts have turned out to be ecological calamities in hindsight. From red pine plantations that are virtual biological deserts, to the over abundant white tailed deer herd which is stripping native vegetation across the landscape, the ecology of Michigan, Wisconsin and Minnesota forests continues to show the effects of management practices that hinder restoration of healthy, balanced forests ecosystems.

To achieve an ecologically sound, sustainable forest system for the 21st century two indispensable ingredients are needed: the scientific and technical capability to achieve these goals; and the societal will to make it happen. Already, scientists are documenting the problems and

developing techniques to restore the woods.

A classic example of the adverse effect of current management practices is the troubling decline of neotropical migratory songbirds. This category of birds includes many warblers, tanagers and thrushes found throughout the forests of the Great Lakes region. Like many examples from the natural world, it is not a single cause but a collection of impacts that are suspected in the decline of these bird species. Neotropical migrants move north each spring from their wintering grounds in South and Central America, following insect hatches all the way north, allowing them to feed easily while migrating. Midges hatching on the Great Lakes provide abundant food when the birds arrive here, and the birds long ago learned how to best take advantage of the feast. As these tiny insects hatch in the spring, they are blown into the dense white cedar groves along the lakeshore. The birds find a virtual midge buffet in the cedars, and are able to easily consume a large amount of food, building up their energy stores so they are ready to move inland for the critical task of nesting.

But during the last forty years, white cedar has virtually stopped reproducing throughout the Great Lakes forests. A major reason is believed to be the overabundant deer populations everywhere in the region. Deer crowd into the dense cedar stands for cover and food in the winter months, and as population numbers grow the cedar swamps have been increasingly hard hit by the hungry deer.

The loss of cedar has an impact on the deer themselves by reducing the quality and quantity of winter yarding areas. But the impact on other species, especially neotropical migratory birds, is increasingly linked to the decline of cedar as well.

This alone would raise concerns about the status of these birds, but another management outcome is equally troubling. As the birds move inland to nest, they settle



into wooded areas as they have since time immemorial. Hundreds of years ago, those forests were relatively unfragmented, and the birds were able to reproduce in effective numbers simply by playing the odds. Nests built near forest openings caused by blow downs or fire were vulnerable to predation by edge species such as raccoons, while birds nesting farther into the interior of the forests would be relatively safe from these threats. Modern forestry and wildlife management practices, as well as development and farming impacts, have changed the forest matrix dramatically. Instead of large blocks of uninterrupted forest with few, natural openings, the forests and wildlife management has favored more and larger intensive management activities that create much more forest edge and much more vulnerability to predators. While a lot of forested areas still remain and neotropical migrants continue to nest in them, the number of unsuccessful nests rises dramatically as the birds become increasingly vulnerable to predators.

Some changes proposed by scientists to address these problems are remarkably simple, while others will be understandable only to experts and will take time to refine and apply. For example, scientists are calling for forest and wildlife management techniques to be implemented today that leave very large blocks of contiguous forest tied together by corridors. By concentrating management activities in other parts of the landscape, both production of forest products and protection of critical ecosystems may well be achieved.

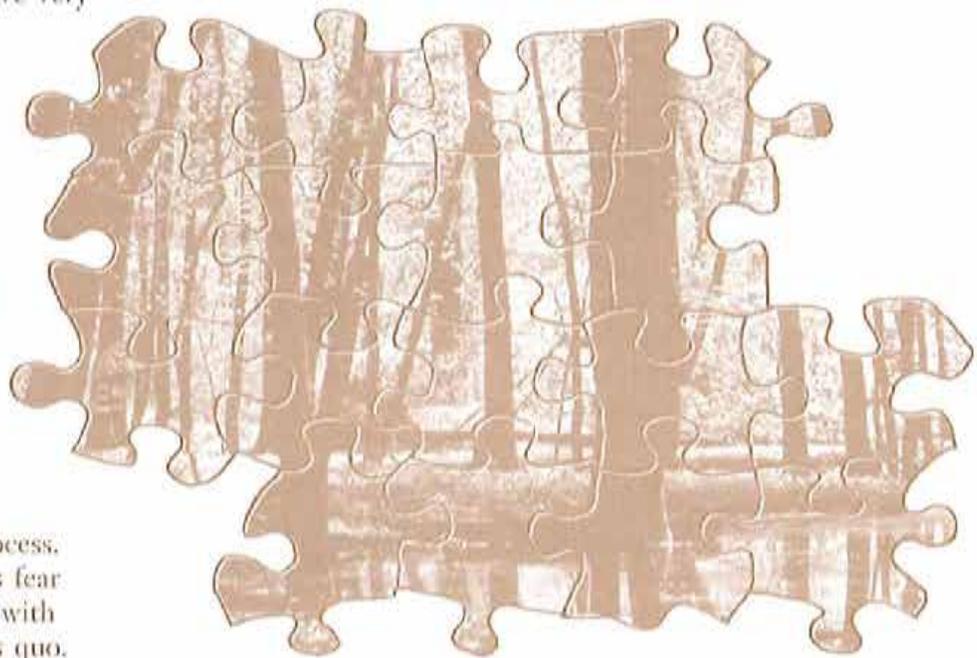
The biggest impediment is really not the lack of know-how, but instead the lack of will to commit to a restoration process. On the other hand, there is fear and reticence among many with personal stakes in the status quo. Narrow and short term interests,

tied primarily to today's outputs from the forest, are at odds with the need to create sustainable forest ecosystems with the long term, diverse values they provide.

There is also ignorance, or in some cases deliberate misrepresentation, about the issues at stake. Today, for example, we have more wood growing in Michigan than we are harvesting, a fact often cited to argue that current management practices are sound. But this is only one of the measurements that must be taken to determine the status of our forests.

The successes of the original conservation movement took years, and in some cases decades to come to fruition. The shortsightedness of today's leaders in failing to set the long term course for our forests may in the end be the greatest threat to the success of restoration efforts. For the first time anywhere, the people of the Upper Great Lakes region can consciously choose the direction we would like to take in managing the future of our forests.

Anne Woiwode is Program Director for Sierra Club's Michigan Forest Biodiversity Program.



Great Lakes forests provide diverse habitat for a wide range of wildlife.

Great Migrations And The Great Lakes

by Dr. David Ewert and Dr. Michael Hamas

Around the globe, the seasonal movements of animals are both spectacular to witness and mysterious even to science. Perhaps the most noticed, diverse and spectacular of these seasonal patterns are those of migrating songbirds. From our own backyards, we can witness the spring and fall flights of the songbirds who live and breed here in the Great Lakes basin during the food-rich spring and summer months, but retreat southward during winter when food is much less available. Most Michigan bird species are migratory, and fully half of our songbird species migrate to the tropics each winter. The species that breed here in Michigan, winter in places that range from Mexico and the Bahamas through the Caribbean islands, Central America and even further south to Argentina.

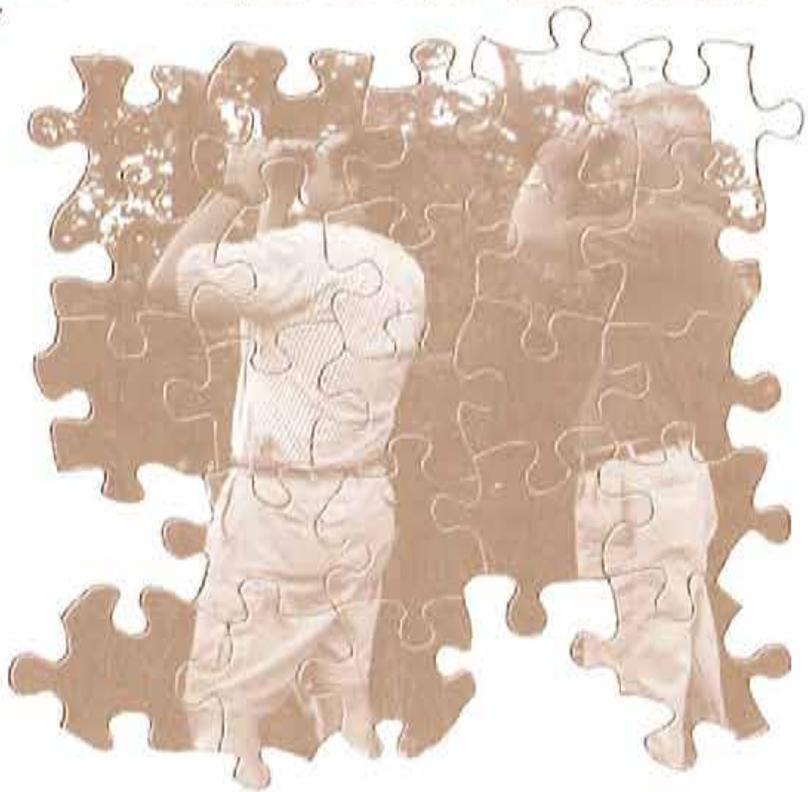
Twice each year of its life, the songbird prepares for such a journey. It goes on a feeding binge, accumulating fat and increasing its weight by as much as half. This fat will be burned during long, nocturnal migratory flights. Leaving shortly after sunset, migrants navigate using stars, magnetic fields, and other cues. Some nights the sky may be full of migrants whose call notes — single, subtle chirps — punctuate the silence. The birds stop the next morning to rest and feed. Migration continues when they have replenished their fat reserves and with favorable winds and weather. Finally, the migrants reach the tropics for the winter. As in the summers up north, many migrants return to the same site each year, while others wander more widely.

The Great Lakes present formidable barriers to migrating landbirds. Migrating birds will “pile up” on a shoreline, feeding, resting and waiting for weather and wind conditions favorable for further flight. Incredible numbers of birds (and birdwatchers) can be seen on Great

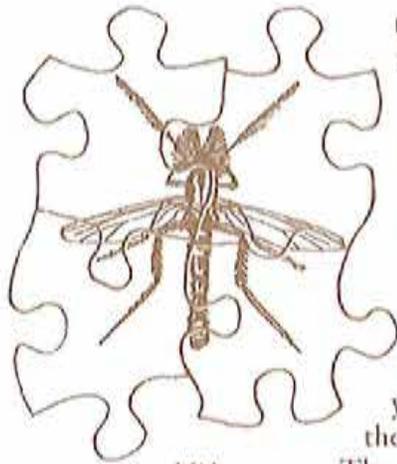
Lakes shorelines during migration, as along the Gulf of Mexico or Atlantic Ocean. Point Pelee and Long Point, Ontario; Whitefish Point, Michigan; Hawk Ridge, Minnesota; and Ottawa National Wildlife Refuge in Ohio are only a few spots where birders and migrants meet in large numbers at barriers’ edges.

A few years ago, The Nature Conservancy launched a research project aimed at understanding the ways that migrating songbirds depend on our shorelines each spring and fall. Dr. Michael Hamas of Central Michigan University and the Conservancy’s David Ewert collaborated on a research design focused on neotropical migratory songbirds passing through the eastern end of the Upper Peninsula, along the northern shore of Lake Huron. The Conservancy has a long-term land conservation project underway along this shore, and manages five nature preserves here.

We know that some species of migrant songbirds feed only on insects; we also know



Dr. Michael Hamas (left) and Dr. David Ewert at work in the field.



Midge

that most springs, these birds arrive on our northern shores before leaves have opened.

Caterpillars, a favorite food of many migrating warblers, have yet to appear; they need leaves.

The research undertaken by the

Conservancy and Central Michigan University posed a hypothesis that the migrating songbirds would quickly move from the shoreline — where leaf development is retarded by cool winds off the lake — into the forests, where leaves are better developed.

The findings of the two-year study surprised the researchers: the birds tended to stay on the shore. Emerging from the Great Lakes (and nearby interdunal swales), at least along the northern shore of Lake Huron, are hordes of small non-biting flies, midges. The water-borne midges congregate in huge numbers on trees and shrubs within a half-mile of the shoreline. The midges and the shoreline itself are vital to the warblers as they make their way northward to summer breeding grounds.

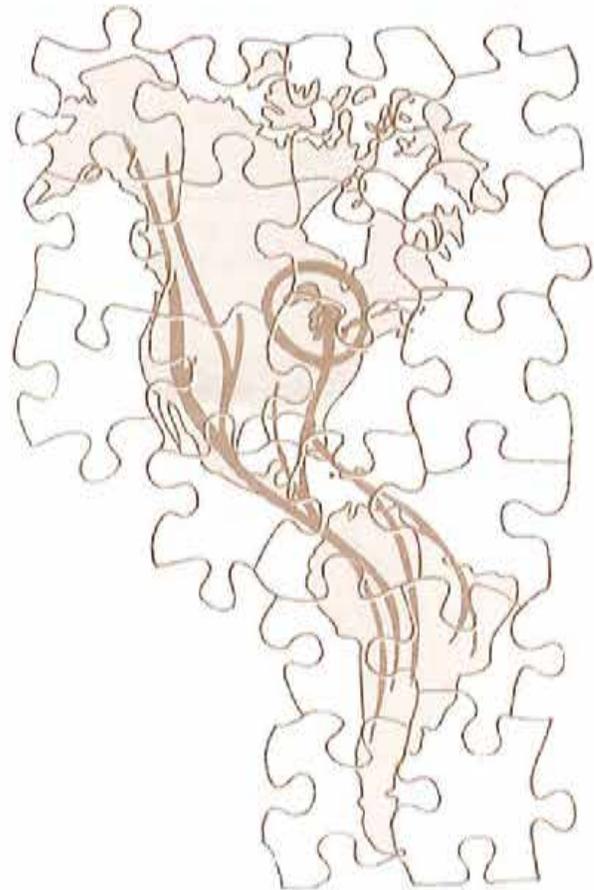
It appears to be different in autumn. Southward migration begins in August when leaves are still out; caterpillars and other large insects feed on the leaves where warblers and other sharp-eyed migrants devour them. The tiny midges at the water's edge are largely ignored.

A conservation lesson is revealed for the northern Lake Huron region: The stretches of shoreline that we treasure for their views and inspiration are important biological assets as well. As stopover sites for migratory landbirds, they provide critically important shelter and, in spring, essential food supplies. The birds' food supply is also an important food source, in larval stages underwater, to yellow perch.

The Nature Conservancy has since launched further research into these near-shore

ecological systems. Its Great Lakes marsh research project brings together teams from Michigan State University, the University of Michigan, Central Michigan University, the Michigan Natural Features Inventory and the National Biological Service to develop a clear picture of how these nearshore systems work, to understand what it might take to keep midges abundant and perch and migrating birds well fed. The tiny midge is an unsuspected, important ecological connection between land and water, between migrating and resident animals, and thus helps sharpen our conservation focus.

Dr. David Ewert is Chapter Director of Science and Stewardship for the Michigan Chapter of The Nature Conservancy. Dr. Michael Hannas is with Central Michigan University.



Trans-Continental Bird Migration Routes (generalized)

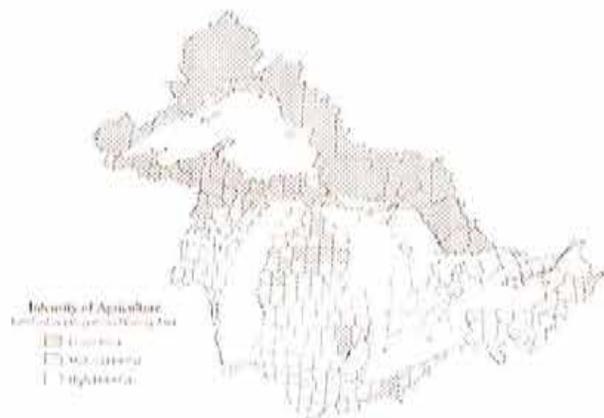
Profiling Agriculture In The Great Lakes Basin

by Dr. Jon Bartholic

The vast expanse of the Great Lakes basin holds bountiful natural resources and fresh water to support agricultural production and human development. Yet, our natural resources are finite and demands on resources, particularly water with its multiple uses and needs are increasing. As agriculture thrives (generating nearly \$40 billion in economic activity in Michigan) and adjusts to extensive changes, the associated stresses extend to the urban-rural fringe, international competition and ecological integrate. The effects of concentrated animal feedlots, as well as nutrient and pesticide management, need to be studied along with urban sprawl and nonpoint source discharges.

Farm Operations

The Great Lakes Protection Fund supported through the Great Lakes Commission recently completed the Great Lakes Basin Agricultural Profile, "Characteristics and Trends in Production, Land-Use, and Environmental Impacts." The results of that study indicate that the numbers of animals and acres harvested have not changed significantly over the last decade. However, the basin has undergone a downward trend in the separation of integrated crop and livestock farming. Also, the size of farm operations has increased, particularly the concentration of animal production in confined areas.



Farm managers profit by expanding their operations, often by increasing the number of animals being raised in a confined area. This increases the problems associated with effectively utilizing the nutrients in the animal wastes. In recent years animal manure has created ten times more nutrient waste than all of the human population in the basin. More attention must be devoted to the storage, utilization, distribution, and handling of animal manure. The nutrients can be utilized more effectively as a resource in agricultural crop production.



Loss of Farm Land

The loss of farm land was highlighted in Michigan's Trend Future Michigan Society of Planning Officials Report, "Patterns on the Land: Our Choices - Our Future." Between 1982 and 1992 the loss was 854,000 acres. This 7.8% decrease raises important concerns. Currently, this land conversion is driven by citizens' desire to own homes with larger lots as well as by a modest population expansion. Land used for agriculture may have less negative impacts overall than urban uses. Frequently more toxic substances are contained in urban runoff. Also, urbanization increases the intensity of runoff because impervious surfaces such as roofs, roads, and parking lots channel more water quickly into streams and rivers.

Externalities of Agricultural Use of Pesticides

The agriculture community is aggressively striving to achieve safe and effective pesticide use and management. New pesticides are being introduced that are more targeted and require

less active ingredients per acre. In addition, farm operators are increasingly utilizing Integrated Pest Management Practices, the Extension Service, and specialized crop consultants to reduce the use of pesticides. However, concerns continue regarding the potential danger of even extremely low quantities of mixes of pesticides to humans and the ecosystem.

The 1996 USDA Farm Bill

This bill has generated major changes in American agricultural support programs. The Environmental Quality Incentives Program (EQIP) authorized \$1.3 billion over a seven year period which will not only improve conservation practices, but also increase net farm income. In addition, society benefits as long-term productivity maintains the resource base while, non-point source pollution is reduced, and wildlife habitats are enhanced. EQIP will emphasize areas designated as natural resources at risk. A state technical committee of more than 30 individuals from state and federal agencies, private industries, farm organizations, farmers, and citizens' groups are helping to implement EQIP. Also, the Michigan Farm Bureau has established a Environmental Quality Department, reflecting not only their concern but also support from farmers who recognize the direct environmental connection with most farm operations.

Effluent Allowance Trading: A New Tool in Watershed Management

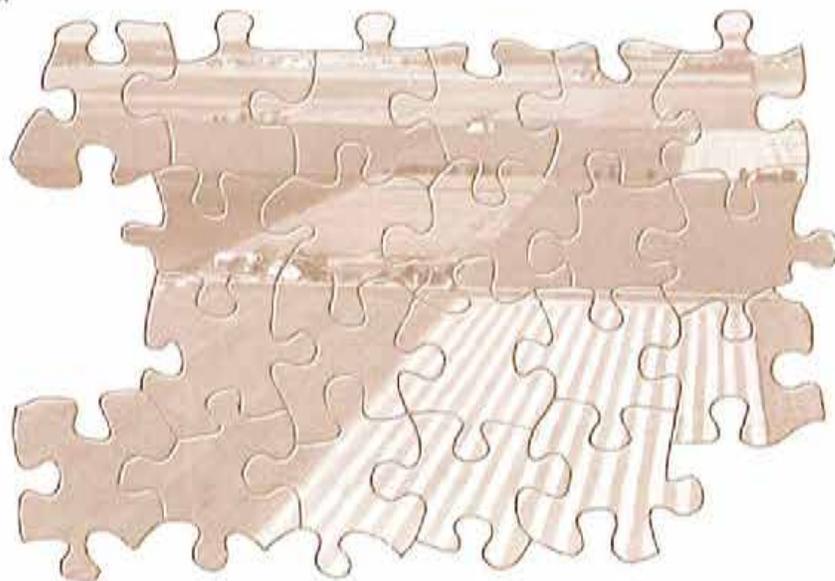
From a watershed perspective, citizens are mainly concerned with the negative impacts of pollution on their drinking water supplies and the environment. With regard to the nonpoint source problems of sediment and nutrient delivery to water courses, funds potentially may be traded or reallocated to optimize the reduction of negative impacts within the watershed. For example, the U.S. Army Corps of Engineers spends millions of dollars

each year to remove sediments from our rivers and streams. Studies indicate that if some of those dollars were reallocated to best management practices, sediment input could be reduced from further upstream where the agricultural/urban sediment loading begins. Studies of this concept are underway in Michigan, and pilot efforts have been initiated in the Maumee River and the River Raisin watersheds.

Decision Support From The Information Age

With access to digital data, world markets, etc., over the World Wide Web, the information age makes it increasingly possible to utilize diverse yet combined economic and environmental information in decision making with the potential of integrated online information systems. Farmers can make wise economic decisions as they weigh options to minimize risk to the environment. At the same time, planners on a regional watershed scale can develop more effective compromises for all citizens, assuring sustainability of our finite land and water resources, while preserving the integrity of the Great Lakes system.

Dr. Jon Bartholic is Director of The Institute of Water Research, Michigan State University.



*A sustainable agricultural economy is vital to the future
of the Great Lakes region.*

Tightening the Faucet: Beginning The Era of Ballast Management Technology

by Dr. James T. Carlton

Sometime in the 1890s, a vessel from China arrived in western Europe, released its ballast water (which had only been in common international use for about two decades) and unknowingly entered history by inoculating the Atlantic Ocean with a Pacific Ocean diatom — one of the first (if not the first) documented ballast water-mediated invasion.

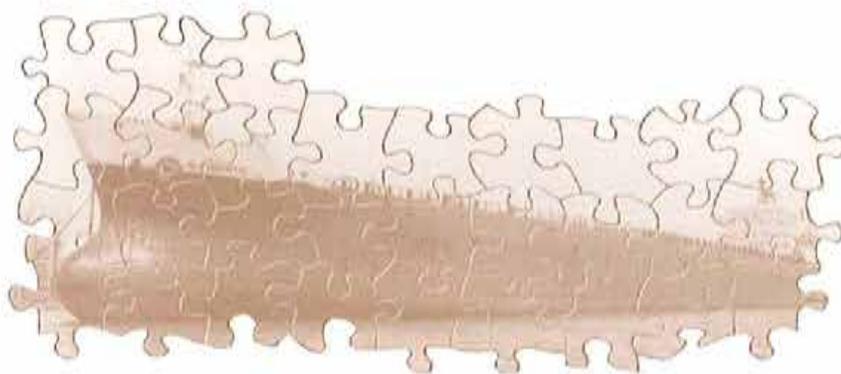
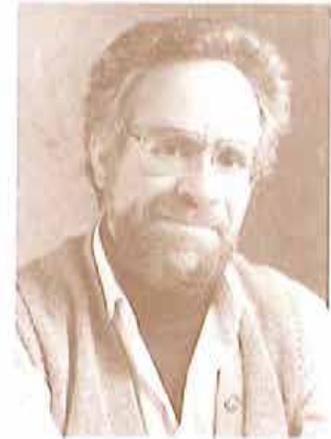
One hundred years and untold invasions later, the world has now started down the winding road of considering how to modify the biological contents of ballast water and ballast sediments. Since two species of European mussel-looking clams of the genus *Dreissena*, zebra mussels, were first found by researchers in 1987 in the Great Lakes, more than 50 suggestions have been put forward relative to “what to do about ballast water.” Many of these suggestions have been prefaced by the three-word phrase, “Why not just...,” implying that a plethora of reticulate complexities — spanning a dizzying variety of vessels and ballast systems, which to a biologist would comprise many different orders, families, genera, and species — can be simplified to a one-or two-step (and perhaps universal) procedure.

Among these 50 ideas, a half-dozen have floated to the top of several independent studies. These half-dozen survivors include both ballast handling practices: open-sea exchange, which means deballasting and reballasting

ballast water on the high seas, or micromanagement of exactly when and where ballast water is loaded; and ballast treatment practices: heating the water, filtering the water, and passing the water through ultraviolet light.

While investigators in Australia pursue thermal ballast treatment experiments, North American researchers have now launched a detailed experimental test to filter ballast water. The endeavor, known as the “Ballast Technology Demonstration Project” (BTDP) and based in the Great Lakes and adjacent waters, is led by biologist Allegra Cangelosi of the Northeast-Midwest Institute (Washington, D.C.) and shipping engineer Richard Harkins of the Lake Carriers’ Association (Cleveland, Ohio). BTDP is funded in large part by a \$1 million grant from the Great Lakes Protection Fund, with additional contributions from a number of federal and state agencies. The BTDP includes research teams from industry and academia. A steering committee composed of scientists and government and industry officials helps to oversee the project’s progress.

Ships have used a form of filtration as a primary means of ballast water treatment for most of the 20th century. However, this technology has been restricted to the use of coarse screens — grates, strainers, and cover plates — placed over the sea chest intakes that lead to the ballast pumps. These screens, when intact, are effective in preventing the intake of “larger particles” (such as wood debris, aquatic plants, plastic, and larger fish) into floodable cargo holds and ballast tanks. Such



The ship Algonorth has been selected for research on ballast water technology.

screens, however, appear to play no role in reducing the intake of very small organisms such as zooplankton (animal plankton, including the temporarily planktonic larvae of benthic organisms, such as zebra mussels), phytoplankton (such as diatoms and toxic dinoflagellates), bacterioplankton (bacteria and blue-green algae) or viroplankton (viruses). The desire to control the intake of these smaller organisms sets the stage for experimental fine filtration technology.

The vessel selected for testing in the BTDP is the Algonorth, a 730 foot long dry bulk carrier owned by Algoma Central Marine in Sault Saint Marie, Ontario, and operated by Seaway Bulk Carriers of Winnipeg. The Algonorth typically carries iron ore into and grain out of the Great Lakes. Given these voyage patterns, the Algonorth has occasion to use both salt water ballast, when in the Gulf of St. Lawrence, and fresh water ballast, when in the Great Lakes. Testing in both fresh and salt water environments is an important component of the research.

The experimental design is rigorous and consists of replicate samples of ballast water and, where appropriate, sediments at a number of possible points along the potential transport pathway of a given organism. Thus, water can be sampled outside the vessel before ballasting, inside the vessel after ballasting, after having passed through the ship's own normal ballast pumps, and after the water has been pumped again (using the project's specially installed pumps) into control (pre-filter) and experimental (post-filter) tanks. Physical, chemical and biological samples will be taken, including measuring the water's salinity, temperature, oxygen, pH, and other parameters, particle loads, and the water's biological content.

Installation of experimental equipment began in November of 1996. Work continued through the winter 1996-1997 vessel lay-up, and field testing commenced in April 1997.

How does this experiment fit into international interests in ballast water management? The management of ballast water to reduce the introduction of alien species has risen to the top of the agenda of the United Nations International Maritime Organization



One of the filters installed aboard the Algonorth.

(IMO) in London as one of the most serious environmental challenges facing the global shipping industry in the 21st century. To this end, the IMO has formed a dedicated ballast water working group, composed of participants from many countries.

Thus, any large-scale and rigorous project aimed at demonstrating potential control technologies that would reduce the role of ballast water in exotic species invasions will attract profound attention from around the world. That this work could contribute significantly to the reduction of the release of potentially invasive species is clear. But, as we have found, filtration will likely be one of several robust tools in the ballast management tool box of the future.

With some 48 months left in the 20th century, the initiation of the BTDP represents a significant "state change" in the way that many stakeholders now view the issue of ballast water. Critical and profound changes in how we move and manage ballast water around the world clearly lie ahead for the next century.

Dr. James T. Carlton is Director of the Department of Maritime Studies at Williams College - Mystic Seaport.

Protecting the Great Lakes Through Education

Each year as the ice and snow begins to melt, Michigan vessel-based Great Lakes education programs start to bustle with activity as the captains, crews, volunteers, teachers, and thousands of students begin preparations for another busy season of learning while afloat on the Great Lakes. During the past 10 years over 75,000 individuals of all ages have experienced learning on the Great Lakes and adjoining waters through a number of Great Lakes vessel-based education programs offered in Michigan.

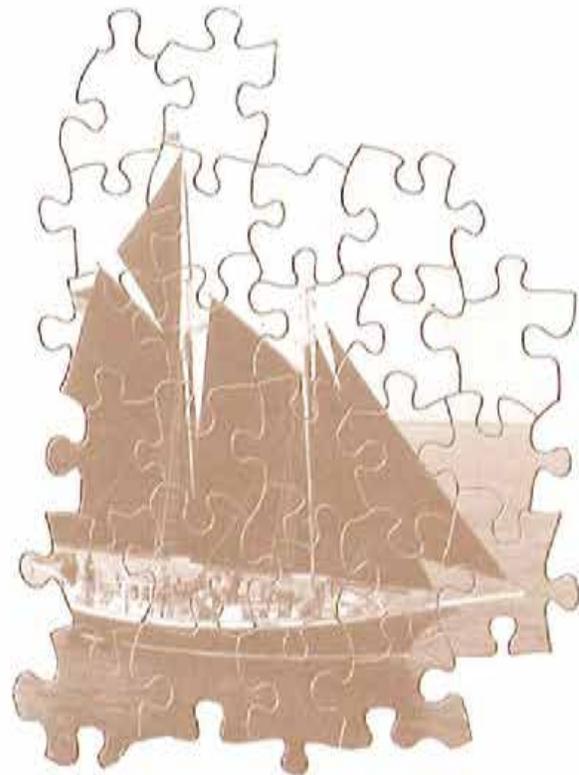
From May to October, the floating classrooms provide a unique hands-on learning activity that can be customized for any age. But, no matter who the target audience is, or the diversity in type and size of boats, and the varied lengths of the trips, one thing that remains constant is the overall goal of the experience, which is protecting the Great Lakes through education.

Grand Valley State University's Water Resources Institute offers K-12 classes and other interested organizations hands-on investigative science experiences onboard their research vessels, the D.J. Angus and W.G. Jackson. Instructors guide participants in the use of instruments and the collection and analysis of water quality data on lakes and rivers. Discussions integrate the collected data with topics such as fisheries, shoreline erosion, transportation, and pollution prevention.

Thousands of middle and high school students have sailed into Great Lakes education on the Inland Seas, an 80-foot schooner outfitted with the latest scientific equipment to enable students to study the Great Lakes ecosystem. Inland Seas is a floating classroom owned by Inland Seas Education Association (ISEA), which was established in 1989 to provide aquatic science, environmental awareness and sail training classes for students of all ages. Classes are conducted aboard the tall ship to complement traditional classroom studies in ecology, history, geography, geology, biology, chemistry and meteorology. Students learn through demonstrations, questioning and hands-on-participation.

The Great Lakes Education Program (GLEP) has reached more than 10,000 students, parents and teachers since 1991. The program provides hands-on experience in learning about the land, water, life and people of the Clinton River and Lake St. Clair as an introduction to the Great Lakes. The goal of the program is to enhance the effectiveness of classroom and experiential aquatic education for students in Macomb county, and ultimately throughout Michigan and the Great Lakes region. The program complements the Michigan educational model's emphasis on the Great Lakes at the fourth grade level.

GLEP offers classroom-based curricula that are used by participant teachers, prior to the water experience, designed to engage students in an exploration of the physical, biological and cultural dimensions of the Clinton River and Lake St. Clair. After the boat experience, participants select from a variety of activities designed to reinforce their learning experience at the school, household, and community levels.



The Inland Seas

Lake Michigan Water Diversion Limits Successfully Mediated

by John G. Bickerman

Last October, governors of the eight Great Lakes States and the Acting Solicitor General of the United States signed an agreement to resolve a dispute over the use of Lake Michigan's historic waters at Chicago.¹ In March 1995, the State of Michigan indicated its intention to reopen the matter before the United States Supreme Court. In a letter to the Court, Michigan's Attorney General contended that the State of Illinois, the City of Chicago, and the Metropolitan Water Reclamation District of Chicago had been diverting more water than the 3,200 cubic feet per second allowed by the Court's most recent decree of 1980.

Under the U.S. Constitution, disputes between states are litigated before the Supreme Court. In practice, when states sue each other, the Court appoints a special master who hears testimony, issues a report, and makes recommendations to the Justices, which the court usually adopts. The process is lengthy and extremely expensive. Moreover, as the four previous trips to the Supreme Court had shown, the Court's decrees have not created a lasting peace.

Initially, several parties expressed skepticism that a non-binding, voluntary mediation process would produce a durable solution to a problem that had previously defied resolution. Nonetheless, they all agreed to try. In less than a year they produced a framework to permanently settle the dispute. The solution they devised affirms Illinois' right to use Lake Michigan water, but within bounds acceptable to the other Great Lakes States. The Memorandum of Understanding agreed to by the parties includes the following terms:

- Illinois affirms its obligation to comply with earlier Court decrees limiting the amount of water it can divert from Lake Michigan. Illinois further agrees to restore water back to Lake Michigan that it has taken in excess of what previous Court decrees had allowed.

- The system for measuring diversion will be moved to the Chicago lakefront, allowing for almost instantaneous estimates. The parties agreed to fix for measurement purposes the amount of stormwater runoff that leaves the basin and grant Illinois a credit for the amount of water consumed by users of Lake Michigan water.
- Illinois will reduce the amount of water diverted to the Chicago Sanitary and Ship Canal, repair leaks in the Chicago River Controlling Works, construct a wall across the Chicago River Turning Basin to prevent leakage, and install pumps at the lakefront to return water to Lake Michigan; and
- The U.S. Army Corps of Engineers (subject to Congressional direction and funding) will repair the lock system at the mouth of the Chicago River.

The States also agreed to a three year transition period during which time no litigation will be commenced. If Illinois makes demonstrable progress toward fulfilling its obligations and an independent technical panel accepts the lakefront measurement system, the parties will urge the Supreme Court to incorporate the terms of their agreement in a final decree.

John G. Bickerman was the mediator for the Chicago Diversion Settlement. He is associated with Bickerman & Associates, Washington, DC.

¹ For an overview of the dispute, see "Watershed Approaches: Chicago Water Diversion," on page 45, *State of the Great Lakes 1994 Annual Report*, Office of the Great Lakes, Department of Natural Resources, 1995.



Growing Permanent Community Endowment Funds To Help The Environment

by Robert S. Collier

The fastest growing form of organized philanthropy in Michigan is the community foundation. Every county is now served by a community foundation, a collection of permanent endowment funds that can benefit a variety of needs depending on the interests of donors to those funds. The funds are permanent because only the interest is used for annual grants. Community foundations have funds dealing with issues such as education, the arts, and economic development.

The Bay Area Community Foundation was one of the first Michigan community foundations to establish an Environmental Education Endowment Fund. We are pleased to report that there has been new activity by Michigan's community foundations to create permanent endowment funds to deal with the environment.

The Kalamazoo Foundation, the state's largest community foundation, has added the environment as its fifth focus area. With support from the Upjohn Company, now Pharmacia & Upjohn, a permanent endowment fund, the Sustainable Community Watershed Fund, has been established for activities related to environmental matters involving water issues.

The Community Foundation of the Holland/Zeeland Area was formed in 1996 by the merger of the community foundations serving these two neighboring communities. To celebrate the merger, the combined Board of Trustees of the new Foundation decided to create a Greenway and Natural Resources Fund. The Fund has an initial goal of a \$500,000 endowment and initial plans are to use earnings for matching grants. Creation of the Fund will help ensure that existing open spaces and green landmarks are accompanied by additional parks and woodlands to serve a growing population in the years ahead.

The five county Grand Traverse Regional Community Foundation has joined with the Traverse City Area Chamber of Commerce to promote New Designs for Growth — a land use

program aimed at fitting more people into the area while strengthening the economy and minimizing harm to the environment.

The Regional Community Foundation has established a permanent endowment fund that will be able to support continuation of the educational workshops started by New Designs for Growth.

The Great Lakes Protection Fund along with the Charles Stewart Mott Foundation recognize the potential that community foundations offer for supporting environmental stewardship efforts of the Great Lakes basin. Through the Council of Michigan Foundations (CMF), these two grantmakers are supporting the development of permanent environmental endowment funds at 20 of the 39 shoreline community foundations in the Great Lakes basin — 10 of which are in Michigan.

Individuals, families, non-profit organizations, local governments and businesses taking action as consumers, recyclers, neighborhood stewards and health promoters are learning that their community foundation can be an important tool to serve current needs and future plans.

Robert S. Collier is Vice President of the Council of Michigan Foundations.



Water quality, land use, and habitat preservation are the focus of new community foundation partnerships.

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