Lake Michigan: State of the Lake '03
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Abstracts

The *Lake Michigan: State of the Lake '03* abstracts and posters are listed in alphabetical order by the first author. For presentations with multiple authors that are presented by one author, the presenting author is in italics. Abstracts and posters for the Great Lakes Beach Association are found in a separate document.

20th Century Changes in the Winter Hydrology of the Lake Michigan Basin: Potential Links to Climate Change

Breakout Session 7

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There are well-documented hemispheric changes in hydrology in the past 100 years with winter river discharge increases in many northern areas. Winter runoff has also increased noticeably into Lake Michigan-Huron, with total water input rising by 9.3 mm/decade between 1920 and 1995. Autumn also shows an increase in water input, which results from a rise in runoff (6.3 mm/decade) and precipitation (8.3 mm/decade). Surprisingly, spring runoff has decreased by 7.8 mm/decade for 1920-1995. This analysis indicates a shift in the seasonal hydrology of Lake Michigan-Huron with runoff increasing in the winter and autumn and decreasing markedly during the spring.

To better understand the changing state of winter hydrology we examined the volume and timing of runoff input to Lake Michigan-Huron. Monthly temperature, precipitation, and streamflow for 1945 to 2000 were analyzed for sub-basins of the Lake Michigan watershed. The northern portion of the basin records the largest shift in precipitation and in snow melt conditions for winter and during the winter-spring transition. In contrast, the southern sub-basins of Lake Michigan exhibit changes in precipitation primarily during summer. This integrated study of winter hydrology and climate variability provides new insights on changing hydrologic processes in Lake Michigan with implications for understanding effects of climate change predicted for the 21st century.

Evidence of Recovery from Phosphorus Enrichment in Lake Michigan
Breakout Session 5

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Tuchman, M.L., United States EPA Great Lakes National Program Office, Chicago, Illinois
Warren, G.J., United States EPA Great Lakes National Program Office, Chicago, Illinois
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During most of the last century, Lake Michigan has been subjected to substantial anthropogenic loadings of phosphorus. One unanticipated consequence of the increased phosphorus loads has been a corresponding decrease in the concentration of silica in the lake. Silica is a nutrient needed by diatoms, which have historically been the dominant type of phytoplankton in the lake. Increases in diatom production in response to increased phosphorus loading had resulted in increased silica sedimentation losses, and a consequent decline in the overall silica content of the lake. This also led to the development of silica limitation of diatoms during the summer, and a shift in summer communities to other types of phytoplankton. Thus the phosphorus-induced increases in diatom production lead to the somewhat paradoxical situation of increasing summer silica limitation and decreasing summer populations of diatoms, in effect concentrating diatom production in the spring.

With the signing of the Great Lakes Water Quality Agreement in 1972, the United States and Canada implemented an aggressive program of phosphorus abatement in the Great Lakes basin. The achievement of target phosphorus goals has been accompanied by dramatic improvements in water quality in Lake Erie, and substantial improvements in Lake Ontario. While phosphorus loads to Lake Michigan have also been successfully reduced, documenting improvements in in-lake water quality has proven elusive.

We hypothesized that a reduction in phosphorus loading to the lake would lead to an increase in silica concentrations in the lake and a shift in summer phytoplankton communities back towards the historic state of diatom dominance, i.e. a reversal of the trends outlined above. The EPA's Great Lakes National Program Office has been monitoring the chemical and biological status of Lake Michigan since 1983, and we utilized this unique dataset to test our hypotheses. We found that spring soluble silica concentrations, an indicator of total in-lake reserves, have risen steadily between 1983 and 2000, increasing from 1.1 $mg \cdot L^{-1}$ to 1.6 $mg \cdot L^{-1}$ during that time. Summer silica concentrations in the epilimnion have also increased during this period, as hypothesized, and this has allowed diatom populations to increase. The diatom response to increased silica was particularly apparent beginning in the early 1990s. It thus appears that the phytoplankton community has begun to shift back towards its historical condition of year-round diatom dominance. These results provide the first clear evidence that the Lake Michigan ecosystem is responding to the vigorous phosphorus abatement programs of the past thirty years.

About Digital Watershed
Breakout Session 4

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Shi, Y., Institute of Water Research, Michigan State University, East Lansing, Michigan
Asher, J., Institute of Water Research, Michigan State University, East Lansing, Michigan

The complexity and urgency of the world's environmental problems are going to be overwhelming if we don't do something effective to improve our collective abilities to deal with complex and rapid change of our environment. Here at the Institute of Water Research, we are building an environmental software system using the distributed computing technologies to build our collective abilities. To create a system to record patterns at different scales and understand different processes that shape these patterns is no easy task but it can be done if we aim high and act incrementally. This software will continue to grow with the ideal of once developed; new knowledge of our planet in the form of databases and models can be integrated into the system. We hope that this system will become part of our national environmental computing infrastructure and will also be able to answer questions about our environment based on information entered.

Since the watershed is considered to be the basic unit for the environment, we have developed online digital watershed website as our starting point. The digital watershed website is designed to provide both a centralized information repository and an online computing center for watersheds in the United States. This site is based on the comprehensive database of 8-digit watersheds for the whole continent of the United States, which is included in the EPA BASINS system. The database contains all regulated facilities, river network, DEM, state soil and other data layers. The digital watershed site is interconnected with Michigan's local level watershed information system by the scaling function. You can access the Michigan's local level watershed information system at http://www.hydra.iwr.msu.edu/water/.

With the advances in distributed computing technologies, online real time or quasi-real time environmental modeling has become a possibility. We believe that the online environmental modeling will become an essential part of our national environmental computing infrastructure. In Digital Watershed, we developed an online erosion and deposition modeling function as a demo for online environmental modeling to show the concept.

Lake Michigan Basin: New Challenges and Opportunties
Plenary Session

Beck, J., U.S. Environmental Protection Agency Lake Michigan Team Manager, Chicago. Illinois

The challenge of translating Lake Michigan scale watershed data and planning to local governments divided by political boundaries is being undertaken through the development of the Lake Michigan Watershed academy. In 2000 and 2002, the Lake Michigan Lakewide Management Plan highlighted the need to promote a series of dialogues with local decision makers about the status of their watersheds and their impact on Lake Michigan. Monitoring data and Geographic Information System presentations clearly show the interconnected aspects of the basin and the need to plan and cooperate across political boundaries in order to conserve habitat and sustain biodiversity. The basin is not only home to many local species but also provides resting and feeding grounds for several migratory species and approximately 26% of prime waterfowl habitat on the shores of the Great Lakes. Nearshore wetlands provide valuable spewing habitat for migratory aquatic species. The rare freshwater dunes, largest collection in the world, source water for 10 million residents to drink and key natural resources that fuel the national economy make the watershed prime human habitat as well.

The Academy will provide a vital communication link as it brings together nine regional planning councils from 4 states for the first time and foster better connections with the level of government that controls land use in the basin.

Microbial Influence on the Carbon Cycle in Southern Lake Michigan
Breakout Session 2

Biddanda, B.A., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI
Cotner, B.J., University of Minnesota, St. Paul, Minnesota

Respiration by planktonic microorganisms constitutes a major pathway for pelagic carbon flux in southern Lake Michigan. During a multi-year study, we found that the bulk of plankton respiration was due to heterotrophic bacteria, and that plankton respiration seasonally exceeded primary production. Drawdown of accumulated dissolved organic carbon in the water column ("money in the bank"), resuspended organic matter from the lake floor ("ghost of production past"), and riverine organic matter ("terrestrial subsidy") likely provided organic carbon to meet the additional respiratory demand of the plankton.

Dissolved organic carbon in the water column decreased between winter and summer and accounted for 20-50% of the carbon flowing through bacteria and 10-30% of plankton respiration. Carbon flux through the bacteria was maximized at elevated water temperatures due to decreased bacterial growth efficiency. Sediment resuspension events stimulated elevated heterotrophic bacterial activity while simultaneously decreasing autotrophic phytoplankton growth, and are likely important for the interannual variability in carbon dynamics within the lake. Rivers draining the surrounding landscape contain elevated dissolved organic carbon (5x) and dissolved phosphorus (10x) relative to Lake Michigan water, and may support 5-20% of the annual in-lake heterotrophy as well as autotrophy. It appears that inconspicuous planktonic microorganisms – both heterotrophs and autotrophs – link terrigenous organic matter and nutrients to aquatic secondary and primary productivity in southern Lake Michigan.

2002 Proposed LaMP Pollutant Identification Process and Comments
Breakout Session 5

Brauer, S.R., United States Environmental Protection Agency, Chicago, Illinois

In spring 2002, the U.S. EPA Region 5 published the Lake Michigan Lakewide Management Plan (LaMP) 2002. Appendix A to the LaMP contains a process and criteria for identifying critical pollutants, pollutants of concern, and a pollutant "watch list." The definitions of critical pollutant and pollutant of concern rely upon data collected for Clean Water Act programs, fish consumption advisories, pollutants causing the impairments listed in Annex 2 of GLWQA, and other action level exceedances. The LaMP proposes these criteria for placing a pollutant on the Watch List: potential to impact the Lake Michigan ecosystem; presence in the Lake Michigan watershed; and bioaccumulation potential, persistence in water or sediment, or toxicity singly or through synergistic effects. As sources of information to support placing a chemical on the watch list, the LaMP identifies IAGLR, the U.S. Geological Survey Toxics Program, EPA's GLNPO fish monitoring, and EPA programs implementing FQPA, FIFRA, SDWA, and TSCA, and the SOLEC indicators process. The purpose of this talk is to summarize comments received on the pollutant identification process and identification of candidate pollutants and the Agency's proposed response.

Windows to My Environment
Breakout Session 4

Brody, T., United States Environmental Protection Agency, Chicago, Illinois

Window To My Environment (WME) is a powerful new web-based tool that provides a wide range of federal, state, and local information about environmental conditions and features in an area of your choice. This application is provided by U.S. EPA in partnership with federal, state and local government and other organizations. After choosing your location, WME provides:

- An Interactive Map - showing the location of regulated facilities, monitoring sites, water bodies, population density, photographic and topographic views, and much more. Many of these features are hotlinked directly to state and federal information sources to describe and characterize these points of interest.

- Your Window - providing selected geographic statistics about your area of interest, including estimated population, county/urban area designations, local watersheds/waterbodies, etc.

- Your Environment - linking information from federal, state, and local partners on environmental issues like air and water quality, watershed health, Superfund sites, fish advisories, impaired waters, as well as local services working to protect the environment in your area.

We need your feedback and want your comments on this new tool! We would like to know what you think of the information presented here and what additional issues you would like to see addressed. To provide information or links, for use within WME, please contact Dave Catlin at 202-566-0694, or send an email to Catlin.Dave@epamail.epa.gov

Development of an Invertebrate Index of Biotic Integrity for Lake Michigan Drowned River Mouth Wetlands
Breakout Session 2

Burton, T.M., Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan
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Genet, J.A., Department of Zoology, Michigan State University, East Lansing, Michigan

Most rivers entering the eastern shore of Lake Michigan flow through drowned river mouth lakes. The hydrology of the extensive riverine wetlands that often occur upstream of the river mouth lakes is influenced by water levels in Lake Michigan and stream discharge. We are developing an invertebrate-based index of biotic integrity (IBI) for these wetlands. Three replicate invertebrate samples (150 invertebrates/replicate) were collected with dip nets from each inundated plant zone from 8-11 of the wetlands each year during June-August from 2000 through 2002 (14 wetlands were sampled one or more years; 4 were sampled all 3 years). Wetlands were selected to represent a gradient of disturbance. Disturbance was estimated from watershed land use/cover, chloride concentrations in the wetlands, and on-site observations. Invertebrates were sorted to lowest possible taxonomic unit, usually genus. More than 100 taxa were collected each year (e.g. 111 in 2000) but only 20-30/yr were common enough for potential use in an IBI. We identified 8 potential metrics by testing metrics used in our fringing wetland IBI developed for Lakes Huron and Michigan to see if any would work for drowned river mouth wetlands; 8 worked, 5 did not. An additional 4 metrics were identified using correspondence analyses followed by hypothesis testing for each potential metric using Mann-Whitney U tests. Only Nuphar, Typha and Sparghanium zones were common in enough wetlands during these low-water years to be included in an IBI. Nuphar zones were most consistently inundated, and metrics for Nuphar were most reliable. Metrics identified included decreases with disturbance of richness of Odonata, Crustacea plus Mollusca, Ephemeroptera plus Trichoptera plus Odonata and total genera; decreases in relative abundances of Odonata, Isopoda, Ephemeroptera, Coenagrionidae and Mesoveliidae; and decreased Shannon diversity and Evenness. These metrics, developed using 2000 and 2001 data, will be tested using 2002 data. We will use metrics that perform successfully in the test to develop an IBI for drowned river mouth wetlands.

A Model for Empowering Community Environmental Protection: Establishment of the White River Watershed Partnership
Breakout Session 1

Cabala, T., Lake Michigan Federation, Grand Haven, Michigan

The Lake Michigan Federation used innovative outreach techniques to understand citizens' interests and establish the White River Watershed Partnership in Michigan's Muskegon, Oceana, and Newaygo counties. With headquarters in Newaygo County, the White River flows for 120 miles before it discharges to Lake Michigan. Its watershed encompasses two coastal and one inland county. Primary uses in the rural watershed are mainly recreational, such as fishing, canoeing, and boating. The watershed is a diverse mix of riparian forest, wetlands and marshes, and inland lakes, with the river forming a freshwater estuary coupled with White Lake, a large drowned river mouth lake surrounded by sand dunes at its outlet to Lake Michigan.

The process for establishing the watershed organization was officially undertaken with funds from the Fremont Area Community Foundation in September 2002 by the Lake Michigan Federation, supported by prior work done to stimulate and organize citizen interest supported by Howmet Corporation, its parent company foundation, the Alcoa Foundation, and the Community Foundation for Muskegon County. The goal was to work with local stakeholders in the three counties to establish a permanent support organization for the watershed. This work was based on earlier public outreach, school programs, and scientific study funded by Alcoa. The Alcoa supported effort showed considerable citizen interest in and support for maintenance and protection of the White River watershed. The logical next step was formation of an organization to capitalize on that interest and channel it into positive action. The Federation carried out a number of activities as part of establishing the new organization, from research and planning, sponsoring kayak/canoe trips, hosting public meetings, providing training in decision-making methods and leadership skills, to tightly focused and scheduled working group meetings of a citizen "organizing committee" that actually formed the new group. We facilitated a process whereby a diverse group of citizen leaders from all walks of life stepped forward from throughout the watershed, including sport fishing groups, riparian owners, educators, business owners, and conservation organizations. This group was assembled by the Federation to learn about the elements necessary in forming an organization, develop a mission and goals, file incorporation documents, and elect board members as leadership emerged from within the group. In addition, we instilled concepts of consensus building, financial accountability, and operating guidelines in the group. Under Federation guidance, the committee sought its first grant, coordinated public outreach activities for a watershed day, secured a Web address, and developed an organizational brochure. This is a tremendously promising beginning with a solid base of citizen support and awareness and a high potential for success. The White River effort is a model for its "bottom up" approach and its origins. The Federation proposes to use this model and lessons learned to inspire increased community watershed protection around the Great Lakes.

Watershed Hydrologic Modeling and Application in the Little Black Creek Basin
Breakout Session 7

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Steinman. A.D., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI
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Little Black Creek flows through the commercial and residential districts of Muskegon Heights and discharges into Mona Lake, which eventually drains into Lake Michigan. According to the MDEQ biological and chemical assessment, Little Black Creek has been contaminated with heavy metals and organic chemicals from superfund sites and industrial facilities. Sediment contamination and the consequent adverse impact on the ecosystem have become a critical issue in the area. Clearly, knowledge of hydrologic processes in the Little Black Creek basin is fundamental to better understand contaminated sediment transport and distribution, which in turn can be used to identify water-quality management strategies and environmental polices. Yet, little information is available concerning the quantity, variability, and original sources of both water and sediments that have been discharged into Mona Lake.

This study aimed to provide the fundamental information regarding hydrologic characteristics of the basin and erosion processes that dominated the fate and transport of sediments and pollutants. GIS-based watershed delineation and hydrologic modeling were conducted for the Little Black Creek basin by coupling WMS (Watershed Modeling System) and HEC-HMS (Hydrologic Modeling System). Simulation results indicated that about 70% of the stream water originated from base flow. This implied that loads of the contaminated sediments were primarily induced by direct runoff, generated by limited storms. Furthermore, an improved hydrologic model and watershed erosion model were proposed. A new modified Green-Ampt model was linked with a physically based drainage-redistribution model for continuous simulation of surface runoff, infiltration into layered soils, and soil water flow. Three erosion models (MUSLE, MUSS, and MUST) were incorporated into the modeling system to estimate the sediment yield. Eventually, the developed modeling system will be applied to the Little Black Creek basin to assess the loading potential of contaminated sediments and their impacts on the ecosystem.

Invertebrate Community Composition in Response to Chemical/Physical, Land-Use/Cover, and Vegetation Type within a Lake Michigan Drowned River Mouth Wetland
Breakout Session 2

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Burton, T.M., Departments of Zoology and Fisheries and Wildlife, Michigan State University, East Lansing, Michigan

The White River drains into the eastern shore of Lake Michigan. The combination of dune formation and the rise of Lake Michigan water levels formed White Lake and an expansive wetland upstream of the impoundment. The system receives a wide range of disturbance from agriculture to urbanization but also contains many areas with a relatively intact riparian zone. The system provided a unique opportunity to study intra-wetland variability in invertebrate communities due to anthropogenic disturbance. Invertebrate communities in Great Lakes coastal wetlands have been shown to respond predictably to anthropogenic disturbance and their use as indicators of biotic integrity continues to gain merit in these systems. We studied invertebrate communities from 19 sites, spanning 5 vegetation types, within the wetland. Sites were distributed along a gradient of anthropogenic disturbance from the less-impacted upper wetland to the more-impacted lower wetland. The relative importance of plant community type, water quality and surrounding land-use, in structuring invertebrate communities was then determined using correspondence analysis (CA) of biotic data and principle components analysis (PCA) of chemical/physical and land use/cover data. These two indirect gradient analyses were then compared to determine the factors most important in structuring invertebrate communities within the system. A significant correlation ($p<0.05$) between site scores of the CA and PCA showed that measured differences in water quality between sites were important factors in structuring invertebrate communities. Surrounding land-use correlated with differences in water quality and community composition and, hence, was shown to be a contributing factor in invertebrate community composition. The current research demonstrates that variability in invertebrate community composition due to anthropogenic disturbance can be significant at a within-system-scale and that this variability must be addressed in the development and use of invertebrate-based indices of biotic integrity for coastal wetlands.

Connecting Watersheds Through Learning: Policy Implications for Watershed Education
Breakout Session 1

Cotto, M., Northwestern Michigan College Great Lakes Water Studies Institute, Traverse City, Michigan in collaboration with Michigan State University Institute for Water Studies, East Lansing, Michigan

This session reports on the development of a joint venture to integrate watershed management concepts into science and social science K-12 curricula through (a) specialized coursework with locally relevant applications; (b) application of a learning community model to foster faculty professional development in watershed studies; (c) establishing convening points for community-based learning.

The presentation will address some of the key educational policy issues that must be resolved for effective and long-term watershed management education. Implications for design of teacher education programs, facilitation of watershed education for governmental and private sector professionals, and long-range potential for enhancing effectiveness of community-based educational efforts will be explored in various contexts.

Although much of the discussion regarding watershed education seems to center on articulation to state educational frameworks that provide standardization of content with measurable learning outcomes, the more challenging issues – and those that are arising with more frequency – relate to improving access to relevant research information; enhancing educational resources in areas underserved by traditional higher education; identification of shareable strategies that improve relevancy of learning resources; and extending the role of partnership and collaboration between researchers, educators and interested constituencies.

Healthy Watersheds – Our Responsibility; Our Legacy
Concluding Session

Cowles, F.E., Michigan Water Environment Association, Michigan Water Environment Association - Watershed Management Committee and Fishbeck Thompson Carr & Huber, Inc., Grand Rapids, Michigan

The Michigan Water Environment Association (MWEA), a member association of the Water Environment Federation, strives to be the recognized authority on and advocate for preserving, restoring and enhancing Michigan's water resources. To assist with this mission, the MWEA Watershed Management Committee has developed a "Healthy Watersheds" presentation as a tool to assist members, teachers and water professionals in educating our youth and the general public about watershed issues.

The Great Lakes Basin contains 20% of the world's fresh water and is the largest system of fresh, surface water on earth. The Great Lakes and its tributary watersheds provide water for industrial, agricultural, domestic, and recreational uses. Michigan is fortunate to be surrounded by Great Lakes. The state, however, is also burdened with a tremendous responsibility to protect this valuable resource. Protection begins at home and is watershed based. Everyone lives in, works in, plays in and impacts a watershed.

A healthy watershed cleanses the air, earth and water; sustains plants, wildlife and human inhabitants; creates natural balance and controls of invasive species and provides quality of life for its inhabitants.

Finally we ask "What makes a watershed healthy". And the answer is "We all can" through a "Top Ten Things We Can Do To Protect Our Watersheds (from Center for Watershed Protection)".

1. Always conserve and reuse water wisely.
2. Use natural systems to limit pesticide and fertilizer use.
3. Use native vegetation and eliminate turf grass.
4. Capture and reuse rainfall.
5. Dispose of pet waste properly.
6. Wash your car on the lawn – Not the driveway.
7. Maintain all vehicles – Eliminate leaks and spills.
8. Recycle and dispose of household chemicals properly.
9. Inspect and maintain septic systems and sewers.
10. Get active in our communities.

The Healthy Watersheds presentation is designed to help people recognize and remember that, in Michigan, we are all stewards of 20% of the Earth's usable, fresh water.

The Crystal Lake "Walkabout" – Education Through Observational Monitoring and Environmental Exploring
Breakout Session 1

Daniels, S. L., Crystal Lake Watershed Fund, Inc., Beulah, Michigan

The Crystal Lake ***"Walkabout"*** is intended to instill and nurture in young people and adults an awareness of their watershed environment through an interactive "hands-on" program of science education involving observational monitoring and environmental exploring. The ***"Walkabout"*** is designed for students, but its philosophy applies to property owners and visitors, and what all can do to preserve the integrity of the Crystal Lake Watershed by enhancing community awareness, providing educational experiences, and promoting future environmental improvements. The ***"Walkabout"*** is specific to the Crystal Lake Watershed located in northwest lower Michigan, but it can be extended to other watersheds.

The concept of the ***"Walkabout"*** is borrowed from the Australian Aborigines. Tribal members would take brief leave from their responsibilities of daily living. They would then "walk about" their environment and renew their fundamental spiritual associations. It can be imagined that Henry David Thoreau, the noted naturalist, might have used the same approach in his sojourn at Walden Pond. A modern-day context of the ***"Walkabout"*** is applied in this innovative educational program.

Crystal Lake, the ninth largest inland lake in Michigan (Benzie County), contains ~ ¼ trillion gallons (740,000 Acre-feet) of high-quality fresh water. This 9,854-Acre Lake, with a maximum depth of 165 feet, is surrounded by high ridges about twice as high as the Lake is deep. The ***"Walkabout"*** participants visit eight Interpretive Sites within the Crystal Lake Watershed, encompassing 28,145 Acres (43.67 square miles) of a wooded environment and neighboring watersheds. Each Site represents a unique environmental segment: Crystal Lake, its tributaries, wetlands, high ridges, dunes, Betsie Bay, and Lake Michigan. Hydrology is the unifying theme - how a drop of water might enter, linger, and then pass through the Watershed.

The ***"Walkabout"*** expressly targets students, but anyone young of heart and open of mind is welcome to participate in a group or to ponder its philosophy individually. Environmental awareness is developed during a "walk about" the Interpretive Sites, or personally in one's special place or mind's eye. At various times in their lives, each participant will become involved in making informed choices on water quality, land use, zoning, septic tanks, green belts, sustainable development, education, and watershed management.

The 30-page Interpretive Manual is both An Educational Primer for Students and A Reference Handbook for Property Owners and Visitors. Containing Watershed facts, Watershed history, a detailed GIS map of the Watershed, descriptions of the eight Interpretive Sites, a section on Watershed management, and a list of Concerns for Property Owners and Visitors, it is intended to inspire participants to look at their Watershed from several points of view. Supplemental publications ("How to Protect Your Watershed" (WEF), "Watersheds: Where We Live" (USGS), and "Your Lake and You" (ML&SA) describe the importance of living in a watershed and steps that can be taken to protect it.

Four Interpretive Sites, selected on a biennial basis, are interpreted by environmental professionals selected from thirteen cosponsoring organizations. The ***"Walkabout"*** is presented in four, one-hour sessions: in the Fall to 8th grade students, in the Spring to 6th grade students, and in the Summer to

the general public. Each participant receives a colorful Tee-shirt with the multicolor GIS map of the Crystal Lake Watershed and a copy of the ***"Walkabout"*** Interpretive Manual

Initiated in 1993, the Crystal Lake ***"Walkabout"*** has been offered to more than 1,600 students, residents, and visitors. The prime sponsor is the Crystal Lake Watershed Fund (www.CLWF.org), a nonprofit 501(c)(3) organization, that supports citizen initiatives for water quality monitoring, septic system control, sustainable development, and land conservancy through education, for watershed management.

The Mega-Recovery of America's Lake
Plenary Session

Davis, C., Lake Michigan Federation, Chicago, Illinois and Grand Haven, Michigan.

For decades the Great Lakes have suffered from the effects of industrial pollution, habitat loss, invasive species, poorly planned land use development, pathogens, and wasteful water use, among other ecological challenges. These are the easy problems to solve.

The more difficult challenge is understanding how we must address them in a way that ties local rehabilitation efforts together to result in the dramatic, holistic healing of the Great Lakes. Fortunately, forces are gathering to confront problems in an organized, prioritized manner, regional pride in the Great Lakes is emerging, and political leadership in Washington, D.C. is crystallizing, all a the same time. The alignment of these elements could represent the greatest opportunity since the settlement of the region to restore the Great Lakes to health, perhaps even starting with Lake Michigan. Or they could mean the greatest opportunity lost if we fail to act.

Pressing for a Lake Michigan mega-recovery effort will require a number of ingredients:

- Stop planning and start prioritizing. Federal, state, and municipal governments have spent millions of dollars in planning efforts over the decades, including the Lakewide Management Plan for Lake Michigan, Great Lakes Strategy 2002, Michigan's Great Lakes Senate Task Force Report, various International Joint Commission reports, and many, many others. We've had enough strategic planning. Now it's time for strategic doing.
- Shoot for new policy stars. Federal and state environmental protections seek to attain the minimization of harm to the Great Lakes. If our health depends on Great Lakes health, this is equivalent to failing to improve our health, but instead going through life trying not to get hurt. A new Great Lakes Charter Annex for the first time in the region if not the world shoots for our policy goal to be the "restoration" of Great Lakes health, not just the protection of what's left.
- Culturally, the region is viewed as consisting of people who have a strong ethic of conservation and stewardship. Take the issue of Michigan's proposal in 2001 to open Lake Michigan and Huron shorelines to new oil and gas drilling. After initial support for the proposal, state legislators quickly began to understand that a vast majority of the public, while understanding the possibility of oil and gas leaks may be minimal, felt strongly that the Great Lakes were not worth the risk. Within months, a full reversal of opinion in the legislature kicked in and drilling was banned. The values underpinning this example can translate into political power as candidates in upcoming elections seek to appeal to those of us who live, work, and play here.

Protecting what's left is no longer enough. It is time to build and re-build a healthy Great Lakes so that it will provide drinking water, recreation, jobs, and an unparalleled quality of life for the region.

Great Lakes Restoration Planning: Identifying Regional Priorities
Plenary Session

Donahue, M.J., Great Lakes Commission, Ann Arbor, Michigan
Macdonagh-Dumler, J., Great Lakes Commission, Ann Arbor, Michigan

The ecological and economic importance of the Great Lakes basin, coupled with its size, multiple use and multi-jurisdictional characteristics, has fostered the development of a rather complex set of institutional arrangements for its management. Policymaking and management authority is shared by two federal governments, eight states, two provinces, a multitude of First Nations/tribal authorities, several regional agencies, and literally hundreds of sub-state/provincial governments. Inter-agency agreements and cooperative arrangements are a common feature on the governance landscape, and there is growing recognition that an ecosystem-based, partnership-oriented approach is a fundamental component of successful basin governance.

Institutional complexity, and the multitude of "players" in the governance process, have historically led to some confusion among elected officials, other policy makers and the general public. Commonly asked questions have included, "What are the roles and responsibilities of the various Great Lakes agencies? "Who speaks for the Great Lakes?" And, "Is there a shared vision for the Great Lakes and a plan, or blueprint, to achieve it?"

In the mid-1990s, the Great Lakes Commission coordinated a response to the latter question with the development of "An Ecosystem Charter for the Great Lakes-St. Lawrence Basin." That document, which consisted of a vision statement, set of principles and a series of goals, objectives and strategic actions, was the product of a large binational "drafting committee" comprised of federal, state and provincial officials, and representatives of business/industry interests, citizen organizations, user groups and academia. The intent was to highlight fundamental resource management principles that enjoyed broad support. In essence, the Ecosystem Charter was an affirmation that the members of the Great Lakes community were generally "in the same boat and rowing in the same direction." Once completed, the Ecosystem Charter garnered the signatures of approximately 175 agencies, organizations and other entities.

While initiatives such as the *Ecosystem Charter* speak to the long standing interest in the *Great Lakes Restoration Plan* concept, the heightened awareness of this need is largely attributable to several recent developments. Congressional support for the "Comprehensive Everglades Restoration Plan," a multi-year, multi-billion dollar initiative, emphasized the benefits to be realized if all players in a given region pulled together and supported a single plan. It also prompted many in the Great Lakes basin to wonder if this region – historically the leader in institutional innovation and collaboration – might be "losing its edge." Also, the Great Lakes Commission heightened regional interest in a comprehensive, consensus-based plan when it released (in March 2001) its annual U.S. federal legislative and appropriations priorities in the form of *The Great Lakes Program to Ensure Environmental and Economic Prosperity*. And, a multitude of other public agencies with Great Lakes responsibilities – particularly U.S. federal agencies – have recently launched comprehensive strategic planning initiatives that speak – to varying degrees – to the ecosystem restoration concept. The Congressional Great Lakes Task Force reaffirmed the desirability of a region-wide, consensus-based plan that could help inform and direct its legislative/appropriations efforts, and invited the Great Lakes governors (in a letter dated March 1, 2001) to help coordinate contributions to that effort. In making that request, it was emphasized that the plan needs to originate in the region and garner broad-based support among the range of regional interests. Further, in recent months, members of the

Great Lakes Congressional Delegation have introduced legislation, in both houses, that calls for a large scale restoration planning and funding effort.

Advancing the development, funding and implementation of ecosystem restoration initiatives – from the local to regional levels – is a mandated responsibility of the Great Lakes Commission per the Great Lakes Basin Compact. Toward that end, the Commission is partnering with the National Sea Grant Program, and its Great Lakes state programs, to conduct a series of restoration workshops to solicit public input on restoration needs and assist the Great Lakes governors in realizing their restoration priorities and formulating an associated plan or strategy in concert with the larger Great Lakes community. An initial workshop was held September 17 in Ann Arbor, with many more to follow in the coming year.

This presentation will discuss the importance of ecosystem restoration planning in the Great Lakes basin; the role and responsibility of the Great Lakes Commission; "building blocks" already available; the current Great Lakes Commission/Sea Grant project; and the Commission's view on key elements for a restoration planning process.

Regional Data Access and Indexing through the Great Lakes Information Network
Breakout Session 6

Eddy, S.H., Great Lakes Commission, Ann Arbor, Michigan

The Great Lakes Information Network has long been a central Internet clearinghouse for news and information related to the Great Lakes region. Work currently underway at the Great Lakes Commission is also enhancing Internet access to regional map data. Data compatible with geographic information systems is indexed by state and province, watershed, and county. Two search options, a graphical representation of the Great Lakes region and a text-based query tool, are linked to metadata for approximately 2000 data sets specific to the Great Lakes region. Data source agencies will be able to update the metadata index as appropriate, and a download service incorporated into this site allows a number of reference data sets to be obtained directly through the GLIN Data Access Portal. As Great Lakes regional data sharing and decision support services grow, so will the value and sophistication of this set of tools.

Basinwide Mapping and the Internet: The Lake Michigan Basin Online Atlas
Breakout Session 6

Eddy, S.H., Great Lakes Commission, Ann Arbor, Michigan

The Great Lakes Commission and US EPA Region 5 have been working to place information, maps and data relevant to the Lake Michigan basin online at a central location. As a result, the Great Lakes Information Network now hosts an online mapping interface that allows users to explore the geography of the Lake Michigan basin and access information on regional topics. Data sharing and coordination among regional, state and local agencies has been a crucial component in the development of this project, and it is hoped that the project will have a long-term impact on continued data sharing, enhancements to the data development process itself, and broad participation in regional issues. The presenter will describe the tools and technology involved in this project, some of the issues encountered, and possible next steps for such regional projects.

Application of Advance Informatics for Improved Efficiency in Management of Lake Michigan Watersheds – Activities of the Great Lakes Environmental and Molecular Sciences Center (GLEAMS)
Breakout Session 6

Edson, R.W., Altarum Institute, Ann Arbor, Michigan
Shuchman, R.A., Altarum Institute, Ann Arbor, Michigan
Savage S., Altarum Institute, Ann Arbor, Michigan
Piper, B.K.S., Altarum Institute, Ann Arbor, Michigan
Caldwell, E.J., Altarum Institute, Ann Arbor, Michigan
Ide, C., Western Michigan University, Kalamazoo, Michigan
Means, J., Western Michigan University, Kalamazoo, Michigan
Wygant, B., Western Michigan University, Kalamazoo, Michigan
Kahmark, K.A., Western Michigan University, Kalamazoo, Michigan

Informatics is the science concerned with the gathering, manipulation, classification, storage and retrieval of recorded knowledge. In the context of environmental assessments, advanced Informatics includes:

- Geographic Information Systems;
- State-of-the-art Environmental Process and Risk Assessment Models;
- Online collaborative workspaces and Internet Portals; and
- Data mining and knowledge generation tools.

Most importantly, advanced informatics is the combination of all of the above into an integrated system for decision support (Dynamic Decision Support System).

The Great Lakes Environmental and Molecular Science Center (GLEAMS) is an EPA funded partnership between Western Michigan University and Altarum Institute (formerly ERIM). A major goal of the center is to construct a comprehensive geospatially based dynamic decision support system (DDSS) that utilizes hydrodynamic fate and transport models combined with novel automated genetic analysis techniques, food chain relationships and epidemiological statistics estimates to assess contaminant affects on the watershed ecosystem including the human health consequences.

The GLEAMS team is constructing the DDSS in partnership with federal, state and local parties. It is hosted on a web/portal, which facilitates its use by the local, county, state, and federal stakeholders. Since the DDSS is geographic information system (GIS) based, watershed environmental characterization and monitoring data are housed at the web/portal site, facilitating a “one stop” approach for all interested parties. The use of a GIS for contaminant sampling as well as the framework for the DDSS has already improved efficiencies in the watershed studies.

Kalamazoo River is being used as the watershed test case. The methodology, food chain, and GIS specific watershed tools, fate, transport and epidemiological models, as well as the DDSS will be applicable to other watersheds throughout the Great Lakes basin.

Long-Term Hydrologic Impact Assessment (L-THIA)
Breakout Session 4

Engel, B., Agricultural and Biological Engineering, Purdue University, W. Lafayette, Indiana

Land use changes can significantly impact groundwater recharge, stormwater drainage, and water pollution. The Long-Term Hydrologic Impact Assessment (L-THIA) model was developed as an accessible WWW-based tool to assess the water quality impacts of land use change. Based on community-specific climate data, L-THIA estimates changes in runoff and nonpoint source pollution resulting from past or proposed development. As a quick and easy-to-use approach, L-THIA's results can be used to generate community awareness of potential long-term problems and to support planning aimed at minimizing disturbance of critical areas. L-THIA is an ideal tool to assist in the evaluation of potential effects of land use change and to identify the best location of a particular land use so as to have minimum impact on a community's natural environment. The WWW-based L-THIA is accessible at http://www.ecn.purdue.edu/runoff/lthianew. A WWW-based GIS L-THIA and a desktop GIS L-THIA are accessible at http://pasture.ecn.purdue.edu/~watergen.

Bioindicators for Environmental Risk Assessment: Molecular Markers for Carp (*Cyprinus carpio*) Exposed to Polychlorinated Biphenyls
Breakout Session 2

Fisher, M.A., Western Michigan University, Great Lakes Center for Environmental and Molecular Sciences, Kalamazoo, Michigan
Ide, C.F., Western Michigan University, Great Lakes Center for Environmental and Molecular Sciences, Kalamazoo, Michigan
Means, J.C., Western Michigan University, Great Lakes Center for Environmental and Molecular Sciences, Kalamazoo, Michigan

The Kalamazoo River superfund site (MI, USA) is contaminated with polychlorinated biphenyls (PCBs) and serves as a major source of PCB contamination to Lake Michigan. The health impacts of PCBs on organisms in the Kalamazoo River are not well defined. Whether contamination of these organisms poses a significant health risk is unknown. Applying new biotechnology based tools that define health impacts of PCBs could be instrumental in improving ecosystem based health risk assessment related to setting clean-up priorities for contaminated watersheds in the Great Lakes Basin.

This work focuses on defining health effects induced by PCBs in the common carp *Cyprinus carpio*. Carp are found throughout the Kalamazoo River and feed benthically in heavily PCB-contaminated sediment. Laboratory experiments were carried out on hatchery-raised carp fed a diet containing the PCB mixture Aroclor 1242, the mixture most commonly found in the Kalamazoo River. In additional field studies, carp caught from PCB contaminated Kalamazoo River sites were compared to carp caught from upstream uncontaminated Kalamazoo River sites. We examined exposure-related health effects of PCBs by using real time RT-PCR (reverse transcriptase- polymerase chain reaction) to quantify mRNA expression levels in carp liver (hepatopancreas). Real-time PCR is increasingly used in molecular medicine and biotechnology to characterize gene expression patterns by comparing mRNA levels. Using this technique, we quantified mRNA expression levels of an exposure indicator gene (cytochrome P450 1A1 (CYP 1A1)), two metabolism genes (phosphoenolpyruvate carboxykinase (PEPCK) and nucleolin), and two oxidative stress genes (gamma-glutamylcysteine synthetase (g-gcs) and manganese superoxide dismutase (mnsod)) in PCB exposed and control carp. CYP 1A1 mRNA expression was significantly increased in laboratory PCB treated carp compared to controls ($p=0.0012$), and significantly increased in Kalamazoo River carp in PCB contaminated sites compared to carp caught from control sites ($p=0.0302$). PEPCK and nucleolin mRNA expression levels were not different among PCB exposed and control laboratory and field carp. In pilot studies, mnsod and g-gcs, have not shown differences among laboratory exposed versus control carp groups.

These molecular data relating to fish health status indicate that carp exposed to environmental levels of PCBs show changes in CYP 1A1 gene expression that may underlie health effects. However, gene expression of additional health indicator genes have not shown significant differences among PCB exposed and control groups thus far. These data, in conjunction with additional gene expression analyses, may provide new, more precise data concerning contaminant effects on organisms in Great Lakes ecosystems, and may be useful in risk assessment analysis related to prioritizing clean up of the Kalamazoo River and similarly contaminated sites.

Microbial Plankton and Metabolic Mysteries in Two West Michigan Streams
Poster Session

Gamble, S.J., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI
Biddanda, B.A., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI

This study examines some basic metabolic processes in two adjacent streams in Muskegon County: Black Creek and Cedar Creek. We examined photosynthesis and respiration in aquatic plankton and bacterial growth and respiration. Photosynthesis (ranging from -0.4 to 1.8 $\mu M O_2$/hr) and respiration rates (-0.49 to 2.07 $\mu M O_2$/hr) were determined by measuring changes in the dissolved oxygen concentrations within the light and dark bottle samples using the Winkler Titration method. Bacterial growth rates were determined by tracking the change in bacterial abundance in dilution cultures under an epiflorescence microscope. We found rate differences between the impacted Black creek and the relatively pristine Cedar Creek in most studied variables. The surprise and mystery of this study occurs with some of the respiration and photosynthesis measurements—primarily in the short-term experiments. In those cases we found that oxygen was being produced in the respiration (dark) bottles and oxygen was consumed in the photosynthesis bottles (light); both cases are the opposite of typical results. These cases, though not unheard of, are greatly underrepresented in scientific literature. Further investigation will be required to better understand the processes at work in these shallow aquatic ecosystems.

Response of Aquatic Invertebrates to a Stream Restoration in Northern Indiana
Poster Session

Gerard, K.J., Department of Biological Sciences, University of Notre Dame, Notre Dame, Indiana
Hellenthal. R.A., Department of Biological Sciences, University of Notre Dame, Notre Dame, Indiana

Although stream habitat restoration is performed commonly as part of stream improvement and mitigation projects, the long term effectiveness of these efforts is poorly documented. Macroinvertebrate species richness and population densities, sediment deposition, and habitat quality were compared in restored and unrestored reaches of Juday Creek, a 3rd order cold water tributary of the St. Joseph River, in St. Joseph County, Indiana, from 1997 through 2002. The restoration included the relocation of two 320 m reaches of the stream into newly constructed channels, and the construction and maintenance of a sediment trap to protect the restored reaches. Between 1980 and 1992, stream invertebrate populations seriously deteriorated as a result of high rates of sedimentation due to changing land use and riparian management practices. The sediment trap has been effective at reducing levels of deposited sediments in downstream reaches, with maintenance activities having little impact on downstream conditions. Macroinvertebrate populations showed significantly higher densities and diversities in restored versus control stream reaches that have been sustained for 5 years following the restoration.

Development of a Rapid Response Plan for Great Lakes Aquatic Invasions
Breakout Session 8

Glassner-Shwayder, K., Great Lakes Commission, Ann Arbor, Michigan.
Walters, K., Great Lakes Commission, Ann Arbor, Michigan.
Whitney, S., Great Lakes Commission, Ann Arbor, Michigan.

Approximately 160 nonindigenous aquatic nuisance species (ANS) have become established in the Great Lakes system since the middle of the 19th century. Once established, controlling the spread of these species is both technically difficult and expensive. Control efforts for purple loosestrife, zebra mussels and sea lamprey alone have been assessed at $365 million per year on a national scale. Eradication/control of ANS populations has a higher likelihood of success if nuisance species are detected soon after introduction, at which point the number of individuals in the ANS population is low and eradication/control measures can be applied quickly and in a targeted manner.

Currently, the infrastructure for early detection and rapid response has not been established to control ANS introduction and spread in the Great Lakes region. The Great Lakes Commission, in consultation with the Great Lakes Panel on Aquatic Nuisance Species, has undertaken the development of guidelines and recommendations for early detection and monitoring in Lake Michigan and development of a model rapid response plan for the region.

A number of questions must be answered in order to develop usable guidelines for early detection and rapid response including: How should monitoring for early detection be conducted? How can baseline data be utilized to reflect disturbances caused by ANS impacts? How should rapid response plans be structured to respond to ANS introductions and spread in a time frame that can maximize the possibility for eradication/control? How can rapid response plans be structured to avoid institutional/jurisdictional obstacles that might impede action within a reasonable time frame?

The recommendations for early detection and monitoring will focus on development of a coordinated system to detect new invasions of nonindigenous aquatic species in the Lake Michigan basin. Guidelines will be targeted toward the Lake Michigan basin to build upon the monitoring inventory efforts developed by the Lake Michigan Monitoring Coordination Council in conjunction with the Great Lakes Commission, and may also provide the basis for a comprehensive regional early detection and monitoring system in the Great Lakes-St. Lawrence ecosystem. The guidelines and recommendations will be developed based on an assessment of existing monitoring coverage in the basin, and a determination of the capacity of existing monitoring efforts to discover new ANS introductions and track the spread of current ANS.

Early detection and monitoring are essential for both prevention and eradication. The development of recommendations for early detection and monitoring in Lake Michigan will be coordinated with a larger regional effort to develop a model rapid response plan for Great Lakes invasions. The development of the model plan was begun with a thorough review of relevant literature. The literature review, as well as discussion with the Great Lakes Panel, helped outline a framework for the model and identify its components. Once consensus was reach on the components, a mid-project workshop was held to develop and fill out each component. The next step is for the model plan to be made operational. A test case, where a new species is found in a specific location, will be conducted based on the model plan to determine gaps and unmet needs as well as identifying redundancies in the plan.

Application of Invertebrate-Based Metrics of Wetland Function to Lake Michigan Drowned River Mouth Wetlands
Poster Session

Hool, M.M., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI
Uzarski, D.G., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI
Burton, T. M., Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan
Cooper, M.J., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI

Development of indicators of "ecosystem health" for the Great Lakes was the emphasis of the State-of-the-Lakes Ecosystem Conferences held in 1998 and 2000. Among the indicators listed by the task force were macroinvertebrate indices of biotic integrity. A collaborative team of researchers from GVSU, MSU, MNFI, and USGS has been developing metrics for these systems since the mid-1990s. However, the applicability of metrics developed in other regions has received little attention. A suite of metrics to determine wetland function was developed on the Kissimmee River Marsh along a disturbance gradient. The Kissimmee Marsh was similar in structure to the Michigan wetlands. We therefore hypothesized that these metrics should rank our Michigan sites according to disturbance. We applied Kissimmee metrics to invertebrate data collected in 2002 from 11 drowned river mouth wetlands along the eastern shore of Lake Michigan. Chemical/physical and land use/cover data were used to establish a gradient of disturbance. Invertebrates were identified to the lowest operational taxonomic unit and classified into functional feeding and habit groups. The results of the classification were then subjected to the functional metrics. Resulting metric values did not rank our drowned river mouth wetlands according to our established gradient of anthropogenic disturbance. Possible explanations for the inconsistency include habitat and sampling differences between the Michigan and Kissimmee studies, as well as limited resources for classifying the Michigan invertebrates by function. Continued modification of the functional metrics is necessary before using them to accurately categorize Michigan drowned river mouths according to anthropogenic disturbance.

The Use of Geographic Information Systems and Other Information Tools to Improve Watershed Management in West Michigan
Breakout Session 6

Koches, J. K., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI
Denning, R., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI
Thompson, K.M., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI

The Annis Water Resources Institute (AWRI) of Grand Valley State University is working as a partner with Michigan State University, the University of Michigan, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, and other public and private interests on three projects in the Muskegon River watershed. The first is the *Mega Model Project* funded by the Great Lakes Fishery Trust and involves the use of various hydrologic, ecologic, and land use models with the intention of providing useful tools for area decision-makers. The second is the *Sustainable Future Project* funded by The Wege Foundation with additional support from the Fremont Area Community Foundation. The *Sustainable Future Project* allows for the comprehensive inventory of land use and land cover, the comparison of 1978 and 1998 land use statistics, the development of land use change models, and a workshop series that instructs local decision-makers on how to incorporate these tools for better land use management. The third project is the Clean Water Act Section 319 Project funded by the U.S. EPA and the Michigan Department of Environmental Quality. This third project makes possible the creation of a Watershed Management Plan to deal specifically with nonpoint source pollution.

Each of these projects involves AWRI in the continued development of a comprehensive Geographic Information System (GIS) and other information tools specific for the Muskegon River watershed. This GIS and the tools thus far created help AWRI to communicate with other researcher scientist, public officials, property owners, and area decision-makers. The GIS and various map atlases, web servers, data bases, handbooks, etc. have become vital and essential components in the overall management of land use throughout the Muskegon River watershed.

Lake Michigan Mass Balance Study: Prognosis for PCBs
Breakout Session 5

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Gerstner, G.J., Welso Federal Services LLC, Grosse Ile, Michigan
Endicott, D.D., Great Lakes Environmental Center, Traverse City, Michigan
Warren, G., U.S. U.S. EPA Great Lakes National Program Office, Chicago, Illinois
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Zhang, X., Welso Federal Services LLC, Grosse Ile, Michigan
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Melendez, W., Computer Sciences Corporation, Grosse Ile, Michigan

The Lake Michigan Mass Balance Study was conducted to measure and model nutrients, atrazine, PCBs, trans-nonachlor, and mercury to gain a better understanding of the transport and fate of these substances within the system and to aid managers in the environmental decision-making process. Modeling results for PCBs will be presented based upon the screening level model, MICHTOX, one of three PCB models being applied in the study. Results of the system mass balance show that the greatest, external gross input of PCBs to the system is atmospheric vapor phase absorption; followed by tributary inputs and atmospheric deposition, respectively. The greatest gross losses from the system are volatilization and deep burial in sediments. Internal PCB loading from sediment resuspension is substantial. Gross PCB inputs to, losses from, and cycling processes within the system each typically exceed 1000 kg/yr or greater. Tributary inputs and atmospheric deposition are approximately 375 and 236 kg/yr, respectively. Results indicate that during the mass balance field collection years of 1994-95, the Fox, Grand Calumet, and the Kalamazoo Rivers had the largest tributary loads of PCBs to Lake Michigan. When all gross input and output fluxes are summed, the system exhibits a net loss of approximately 3000 kg/yr. The mass balance results demonstrate the importance of contaminant cycling and the dynamic interactions between air, water, and sediments. These interactions, with present PCB inventories already in the lake, will continue to control PCB concentrations in the system.

The MICHTOX model was also used to forecast future concentrations of PCBs in lake trout at Saugatuck, MI, under different loading scenarios. Scenarios included no further remedial action, virtual elimination, and various combinations of reduced atmospheric and tributary loadings. Forecasts predicted that PCB concentrations in lake trout will continue to decrease. The target level for the unrestricted consumption of fish was forecasted to be achieved for 5/6-year old lake trout between the years 2020 and 2030 in all load reduction scenarios. The narrow forecast range for scenarios, past actions, the long-term decrease in loads, and decreasing PCB concentrations in the system indicate that PCB concentrations are presently controlled by dynamic interactions among media and PCBs presently in the system. MICHTOX results will be compared to higher-resolution models in the future for agreement. It is anticipated that the higher resolution models will further delineate nearshore processes, interactions with tributary inputs, and will allow a more resolute assessment of PCBs in lake trout populations. This abstract does not necessarily reflect EPA policy. Lake Michigan Mass Balance Study:

Sunlight Alterations of Carbon in West Michigan Watersheds: Rapid Decay of Colored Organic Matter
Poster Session

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Biddanda, B.A., Annis Water Resources Institute, Grand Valley State University, Muskegon, MI

The aim of this research project was to explore the sunlight initiated chemical changes in dissolved organic carbon (DOC) and colored dissolved organic matter (CDOM) in Black Creek and Cedar Creek watersheds in the greater Muskegon area. The relatively pristine Cedar Creek was compared to Black Creek, which is heavily impacted by agricultural and urban use.

The water obtained was characterized for DOC concentration, UV-visible spectrum absorbance, dissolved oxygen (DO) concentration, and bacterial growth assays over a two-week period. Samples of 0.2 μm filtered water were exposed to ambient sunlight in either Whirlpack plastic bags or quartz vials. Sunlight-exposed samples were compared to dark, aluminum foil wrapped controls. Absorbance changes in samples over the range of 250-650 nm correlate to the decay of the CDOM; light samples retained 54% and 80% absorbance at 350 nm relative to dark samples in Black Creek and Cedar Creek waters respectively. Additionally, water was sampled from the series of sunlight exposed water samples for DOC following CDOM decay. In unfiltered water from both creeks, DOC increased at a rate of 1.41 and 1.25 μmol carbon/hr, while DO decreased at a rate of 0.19 and 0.16 μmol O_2/hr for Black Creek and Cedar Creek respectively. While the decline in DO is easily explained by respiration, the increasing DOC defies explanation. From these results, CDOM appeared to decay rapidly by photoactivation within two weeks, thereby accounting for one of the most reactive components of the DOC pool in Western Michigan watersheds.

Eurasian Ruffe, Round Gobies, and Zebra Mussels: An 'Exotic Triad' of Lake Michigan Invaders
Breakout Session 2

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Bauer, C.R., United States Environmental Protection Agency, Chicago, Illinois
Berg, M.B., Department of Biology, Loyola University of Chicago, Chicago, Illinois

Eurasian ruffe (*Gymnocephalus cernuus*), round gobies (*Neogobius melanostomus*), and zebra mussels (*Dreissena polymorpha*) are recent invaders of Lake Michigan, where they can attain high densities in nearshore environments. The goal of our study was to determine the potential interactions among these invaders and their effects on native yellow perch (*Perca flavescens*). Laboratory experiments were used to investigate the (1) effect of zebra mussels on fish growth, (2) strength of interspecific competition among perch, gobies, and ruffe, (3) relative vulnerability of these fishes to predation, and (4) food and habitat preferences of perch, gobies, and ruffe. We predicted that (1) fish growth would decline in mussel habitats because of increased habitat heterogeneity, (2) gobies would have a competitive advantage over perch and ruffe in the presence of live mussels because gobies consume mussels, (3) gobies would be the preferred prey of piscivorous fish, thereby reducing their potential effects on perch and ruffe, and (4) perch, gobies, and ruffe would overlap in food use, but habitat use would differ. Fish growth in laboratory experiments was generally unaffected by the presence of mussels, except that goby growth tended to be positively affected by mussels. Overall, fish growth declined at low food levels representative of intense competition during invasion, but ruffe growth declined more than did goby growth when the species co-occurred (sympatry). Perch growth was similar to goby growth when sympatric, but declined at low food levels in the presence of all three invaders. Smallmouth bass (*Micropterus dolomieui*) consumed fewer gobies than either perch or ruffe. Thus, piscivores could exacerbate the negative effects of the 'exotic triad' on perch through sustained predation pressure. Laboratory experiments and field observations suggest that perch can co-occur with gobies and ruffe in macrophyte and sand habitats where their ranges overlap, and that they consume similar soft-bodied benthic invertebrate prey. As gobies and ruffe spread in Lake Michigan, they may increasingly compete with yellow perch for food and habitat, thereby reducing perch growth rates in zebra mussel-colonized nearshore areas. Thus, yellow perch populations may be sustained only by stocking, decreased fishing pressure, and control of nonindigenous species. Improved understanding of the interactions among invasive and native organisms will better inform fisheries management decisions for Lake Michigan.

Developing Tools for Assessing the Impacts of Water Withdrawals in the Great Lakes-St. Lawrence Basin
Breakout Session 6

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Redder, T.M., Limno-Tech, Inc. (LTI), Ann Arbor, Michigan
DePinto, J.V., Limno-Tech, Inc. (LTI), Ann Arbor, Michigan

The Great Lakes Charter Annex, signed in 2001, seeks to develop water resource management practices in the Great Lakes-St. Lawrence Basin that guarantee the long-term sustainability of the basin's water resources. One of the main tenets of any water resource management approach with this goal is to prevent human withdrawal and use of the waters of the basin from having adverse ecological impacts on the Great Lakes ecosystem. In specifying its concern about preventing adverse ecological impacts of water withdrawals in the Great Lakes, Directive #3 of the Great Lakes Charter Annex invokes the establishment of a new decision-making standard that the States and Provinces will use to evaluate proposals related to establishing new water withdrawals, or increasing existing water withdrawals from the Great Lakes Basin. Implementation of such a decision-making standard in a fair and equitable way requires a quantitative understanding of the relationship between water withdrawals and human uses, and the cumulative ecological response of the system. Over the past few years, several research efforts have focused on the development of technical and policy tools to address these management questions.

Technical tools currently under development in support of the Great Lakes Charter Annex range from relatively simple evaluations to more complex model applications. The application of mathematical models provides the potential for evaluating water withdrawal impacts at the full range of spatial and temporal scales to address management issues. However, existing models generally address only part of the overall problem, such as watershed hydrologic response, channel hydraulics, sediment transport, water quality, or ecological effects. No existing model by itself directly links a water withdrawal to ecological endpoints, or addresses the broad range of potential ecological responses resulting from water withdrawal scenarios. To address the need for a decision support tool, we developed a prototype-modeling framework that permits direct evaluation of how hydrologic changes associated with water withdrawals affect important ecological aspects of a river-based watershed. The modeling framework links the Hydrologic Simulation Program (HSPF) model to a series of habitat-based ecosystem sub-models developed based on existing standalone ecosystem models. The prototype model is being field-tested on the Muskegon River watershed in Michigan. Water withdrawals in this watershed can potentially impact flow regime and water temperature in mainstream and tributary reaches, thus affecting the habitat of brown trout and other important fish species in the system.

The utility of the technical tools developed through this and other efforts will be considered for use by parties responsible for making decisions concerning new water withdrawal applications in the context of the Great Lakes Charter Annex. It is envisioned that these approaches as implemented in a specific watershed could be used as an adaptive management tool by incorporating results of ongoing monitoring, thereby providing a synthesis tool and a methodology for assessing cumulative impacts of multiple flow modifications. In addition, models for individual watersheds could potentially be linked to form a larger Great Lakes Basin assessment tool.

CoastWatch Program Update: Lake Michigan – 2003
Breakout Session 6

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Liu, S., NOAA/Great Lakes Environmental Research Laboratory and CILER, Ann Arbor, Michigan

CoastWatch, a nationwide National Oceanic and Atmospheric Administration (NOAA) program, started as the result of an occurrence of Red Tide off the North Carolina coast in 1988. Within this program, the Great Lakes Environmental Research Laboratory (GLERL) functions as the CoastWatch Great Lakes regional node. In this capacity, GLERL obtains, produces, and delivers environmental data and products for near real-time monitoring of the Great Lakes to support environmental science, decision-making, and supporting research. This is achieved by providing Internet access to near real-time and retrospective satellite observations, in-situ Great Lakes data, and derived products to Federal, state, and local agencies, academic institutions, and the public via the CoastWatch Great Lakes web site (http://coastwatch.glerl.noaa.gov). The goals and objectives of the CoastWatch Great Lakes Program directly support agency statutory responsibilities in estuarine and marine science, living marine resource protection, and ecosystem monitoring and management. New data file formats enhance the accessibility and utility of CoastWatch data for monitoring Lake Michigan and use in GIS databases. Plans include enhancing the present product suite with new near real-time products such as satellite derived wind fields, ice type mapping, turbidity and chlorophyll images.

Wisconsin User Feedback
Breakout Session 4

Lucero, D., Wisconsin Department of Natural Resources, Madison, Wisconsin
Murrell, M., Wisconsin Department of Natural Resources, Madison, Wisconsin

Decision support tools that integrate geographic and spatially explicit information can enhance local, state, and federal decision-making and foster better environmental results. This session will outline recent efforts to evaluate and promote decision support systems in Wisconsin. In the spring of 2003, planning professionals and technical assistance providers were asked to review and provide expert opinion on the usefulness, cost-effectiveness, and applicability of seven impact assessment tools. A similar audience will review seven additional tools at a second workshop in early 2004. Results from the workshops will be used to develop statewide outreach efforts that seek to improve the quality of local land use decisions. The structure of the workshops, preliminary results collected through tool evaluations, and future efforts will be described. Attendees at this session will be asked to apply the evaluation to three decision support tools introduced in subsequent presentations.

Distribution and Fluxes of Combustion and Petroleum Source PAH in Kalamazoo River Sediments Discharging into Lake Michigan
Breakout Session 5

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Polycyclic aromatic hydrocarbons (PAH) are discharged into the Great Lakes environment from combustion sources (pyrogenic) and from petroleum (petrogenic) spills. These classes of compounds both have been associated with a variety of adverse effects on ecosystem and human health, including immune system suppression, increased mutation rates and tumor formation. In the present study, the distribution of 85 specific parent, alkylated and heterocyclic aromatic hydrocarbons were measured in sediments of the Kalamazoo River, which ultimately discharges into Lake Michigan. Regulatory agencies typically only require the analysis and reporting of the levels of 16 parent PAH compounds. Sediments in the Saugatuck Harbor and Kalamazoo Lake portions of the lower Kalamazoo River immediately discharging into Lake Michigan as well as in the sediment of upstream impoundments such as Lake Allegan were collected using a cylindrical coring device. Suspended sediments were also collected in the water column at these same sites on three different collection cruises. Current measurements were made using free-floating grog buoys equipped with GPS position recording devices. Both bedded and suspended sediments at these sites were found to contain significant quantities of petrogenic PAH relative to parent pyrogenic PAH. The Fossil Fuel Pollution Index (FFPI) values calculated for these sediments ranged from 0.4 to 0.6 indicating that 40 to 60% of the total PAH being transported from this tributary into Lake Michigan are from petroleum sources. Fluxes of PAH into Lake Michigan during three seasons of the year were calculated utilizing current data, suspended sediment data and the concentrations of the PAHs. This measurements and calculations suggest that PAH loading to Lake Michigan from this and potentially other tributaries may be underestimated since the alkylated and heterocyclic PAH are not measured in most studies.

Great Lakes Charter Annex Stakeholder Conflict Resolution Project
Breakout Session 1

Mendoza, C., Lake Michigan Federation, Grand Haven, Michigan

The Great Lakes governors and Ontario and Quebec premiers signed an Annex to the Great Lakes Charter on June 18, 2001, also known as Annex 2001, making a commitment to develop and implement a new, common, resource-based, conservation standard to apply to new water withdrawal proposals to protect the Great Lakes basin against harmful water withdrawals. State, national, and international laws and treaties currently may not be strong enough to prevent such withdrawals. By basing the Annex on ecosystem protection and restoration it will provide a strong legal defense to withdrawal proposals that could endanger Great Lakes ecology, according to legal analysis requested by Great Lakes governors.

According to the Annex, the new decision making standard will be based on these principles:

- "Preventing or minimizing basin water loss through return flow and implementation of environmentally sound and economically feasible water conservation measures; and
- No significant adverse individual or cumulative impacts to the quantity or quality of the waters and water-dependant natural resources of the Great Lakes basin; and
- An improvement to the waters and water-dependant natural resources of the Great Lakes basin; and
- Compliance with the applicable state, provincial, federal, and international laws and treaties."

Fulfilling the Great Lakes Charter Annex 2001 Resource Improvement Concept and successfully permitting new or increased water withdrawals within the Great Lakes Basin will depend on common agreement and general understanding of the scope of this provision.

The Lake Michigan Federation participated in a project funded by the Great Lakes Protection Fund entitled "Netting Benefits for the Great Lakes Ecosystem". The project assembled a multi-stakeholder team including representatives from the environmental, legal, industrial, and municipal communities to represent the diverse interests in the Great Lakes Basin and produced case studies that analyzed the application of improvement factors to increased water demand cases likely to confront Great Lakes water authorities in the coming decade.

The recognition of controversy was intentionally built into the project. The team designed the project to reveal conflicts, different interests, value judgments, and potential tensions over the state of scientific knowledge. The case studies, or scenarios, themselves did not gloss over or ignore these persistent conflicts, but instead presented opportunities for the multiple interests to identify, engage, and where possible resolve conflicts. The value of this exercise was to forthrightly address the likelihood of continuing controversy, and to promote exchange among the numerous interests that are, in reality, integral to the success of Annex 2001.

The Great Lakes States and Provinces need to be aware of conflicts between the different interest groups of the basin in order to move Annex 2001 forward. This project identified such conflicts, sought a means of preventing them, and created definable steps to resolve differences between the diverse interests. The identification of irresolvable points of controversy will facilitate the development of a legally sustainable and socially attentive governance structure that will develop policies that account for these differences, reflect the principles of Annex 2001, and satisfy the needs of Basin citizens.

Land-Use Effects on Stream Habitat, Water Chemistry and Fish Communities in the Kalamazoo River Basin, Michigan
Breakout Session 1

Moerke, A.H., Department of Biological Sciences, University of Notre Dame, Notre Dame, Indiana
Lamberti, G.A., Department of Biological Sciences, University of Notre Dame, Notre Dame, Indiana

Land-use activities such as agriculture and urbanization have drastically modified the structure and function of streams throughout the midwestern U.S., including the Lake Michigan watershed, where changes in land use have contributed to extensive water pollution and channel degradation. Although we understand the general effects of land use change on aquatic ecosystems, only recently have we begun to understand how impacts vary among different types of land use. We determined the relative effects of different land-use types on stream physico-chemical variables and fish community structure within the Kalamazoo River basin, Michigan. To address the natural variability among streams, we selected 22 subwatersheds within the same basin and ecoregion, which were similar in surficial geology and topography, but differed in watershed land use (i.e., forested, urban, agricultural with buffer, agricultural without buffer). Our objectives were to: 1) quantify the effects of different land uses on stream habitat, water chemistry, and fish communities within the watershed, and 2) determine if distinct fish communities were associated with specific land-use types. Landscape and buffer metrics were quantified using ArcView GIS. Riparian and in-stream habitat, water quality, dissolved nutrients, and fish community structure were assessed *in situ*. We used a combination of univariate and multivariate statistical approaches to compare physical, chemical, and biological responses to varying land uses. Some geomorphic (e.g., width-to-depth ratios), instream habitat (e.g., LWD volume), and water quality (e.g., turbidity) characteristics differed significantly across land-use types, whereas many physico-chemical variables (e.g., habitat index, dissolved oxygen) were similar among land uses. Dissolved nutrient concentrations and fish metrics (e.g., density, IBI, % intolerants) differed significantly between agricultural watersheds lacking buffers and forested watersheds, while metrics for urban and agricultural watersheds with buffers were intermediate to the other land uses. Fish species composition also varied among sites and was related to the type of watershed land use. For example, fishes typical of cool-water streams were most related to the % forest in a watershed, whereas tolerant fishes were most related to the % wetlands in a watershed. In general, physico-chemical and fish community parameters showed a gradient of responses to land-use types, from forested (least degraded) to urban and agricultural with buffers (intermediate) and finally agricultural (most degraded) streams.

Current Trends in Benthic Macroinvertebrate Populations in Lake Michigan with Emphasis on Diporeia (amphipod) and Dreissena (zebra and quagga mussel)
Breakout Session 2

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Ruberg, S. A., Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, Michigan

Recent trends in the major macroinvertebrate groups in southern and central Lake Michigan will be examined. Declines in *Diporeia*, first noted in 1992, are continuing. Between 2000 and 2002, densities declined 40-76 % at 45-m sites in the central basin off Port Washington, Sheyboygan, Ludington, and Little Sable Point. In the southern basin, this amphipod is now completely gone to depths of 70 m between Chicago and Grand Haven. Trends in oligochaetes and sphaeriids were documented through 1999. Densities of the former group have appeared to stabilize in the 1990s after declining in the 1980s, while densities of the latter group are continuing to decline. Densities of zebra mussels do not appear to have changed since the late 1990s, but densities of quagga mussels are increasing at a rapid rate. Although not found in the southern basin in 2000, quagga mussels were nearly as abundant as zebra mussels at many sites in 2002. Because of patchy distribution patterns, true densities of zebra and quagga mussels are difficult to assess using standard benthic sampling devices (grab samplers). We will present results of acoustic and video observations of zebra/quaqqa beds in the central basin and define approaches to better estimate distributions.

Long Range Transport of Toxic Substances to the Great Lakes
Breakout Session 5

Nettesheim, T., United States Environmental Protection Agency, Chicago, Illinois
Venkatesh, S., Meteorological Services of Canada, Environment Canada

For some time, it has been recognized that the atmosphere is a pathway of persistent toxic pollutants to the Great Lakes. More recently, however, there has been increasing evidence that these substances can be transported to the Great Lakes on a continental, and in some cases, a global scale. The Great Lakes Binational Toxics Strategy (GLBTS) challenges Environment Canada (EC) and the U.S. EPA to evaluate the contribution and significance of long-range transport of these substances from worldwide sources to the Great Lakes.

In response to this challenge and the growing evidence of long-range transport, EC and the U.S. EPA, with support from the Commission for Environmental Cooperation (CEC) and the International Joint Commission (IJC), held a workshop in Ann Arbor, Michigan, on September 16-17, 2003, as a further step, under the GLBTS, to work with international experts to characterize and ultimately reduce releases of such substances.

Drawing on both a commissioned background paper and the expertise of several distinguished North American and European scientists, the workshop reviewed pertinent information, identified critical knowledge gaps, and provided recommendations on future activities necessary to adequately address long-range transport. A final report is currently being produced to characterize the current state of knowledge regarding long-range transport to the Great Lakes, recommending future research needs, and identifying possible management opportunities.

Metallic Mineral Mining in Upper Michigan
Poster Session

Nitkowski, M., Front 40 Environmental Fight (*Citizens dedicated to preserving the Menominee River watershed*), Stephenson, Michigan
Nitkowski, J., Front 40 Environmental Fight (*Citizens dedicated to preserving the Menominee River watershed*), Stephenson, Michigan

The Menominee River runs directly into Lake Michigan and then into the other Great Lakes. The Great Lakes not only affords many pristine areas to its many citizens (Upper Michigan being the greatest description of the word 'pristine'), but drinking water for 28,000,000 people. It also constitutes 20 percent of the fresh water on the globe. We feel strongly that this is a resource that must be protected. When issues are identified and the high risk is obvious, we as citizens of Lake Michigan must protect the water for this generation and those that will follow.

Menominee County, the Menominee River and Lake Michigan are facing a known polluter. An exploratory drilling company has found metallic minerals - gold, lead, silver, copper, nickel and more. The citizens of Menominee County have formed a group, Front 40 Environmental Fight, attempting to preserve the watersheds of the Menominee River, Lake Michigan, the chain of Shakey Lakes. We fear for our water and the water of our children. Menominee County is also dependent on the recreational activities, hunting and tourism this pristine area of Michigan affords.

We have met with our state's environmental agencies and have found items of great concern:

1) State mineral mining laws were changed in the late 1990's to favor permitting of mineral mines
2) Permitting on private land is not required for exploratory drilling because we are in the 'Precambrian rock' area of the state. Therefore the drilling company has done drilling within 75', down 1000+ feet at the River's bank without state permits.
3) The state DNR is leasing our state land and mineral rights (some state mineral rights are private surface land owned) without public input.
4) Our state environmental agencies admit they do not have experience in this type of mineral mining or knowledge of what effects the use of cyanide leaching will have on the environment. They have publicly stated: "It is our mission to provide an opportunity for mining".

Acid mine drainage (AMD) is the mineral mining industry's greatest environmental problem and its greatest liability, especially to waterways. An acid-generating mine has the potential for long-term, devastating impacts on rivers, streams and aquatic life, becoming in effect a "perpetual pollution machine". The gap between the theoretical tests and the real world dynamics of AMD provides reason for caution when mines are assessed or permitted. If the state of Michigan does not educate itself on metallic mineral mining the answers to these and many more will be measured by our children in the health of our water and fish.

Muskegon Lake and Estuary Emergent Vegetation Restoration Demonstration (Wild Rice) Project
Breakout Session 2

Nobes, G., Muskegon River Watershed Assembly through a United States Fish and Wildlife Service grant, Big Rapids, Michigan.

Wild rice stands have been drastically reduced in the majority of its natural range in the Muskegon River Watershed. In the lower Watershed area, this has been due to impacts from development, loss of habitat, exotic species, historic logging and farming practices, industrial pollution and recreational use of near-shore habitats. The majority of wild rice and bulrush beds in Muskegon Lake were eliminated by the logging practices of the late 1800s. Industrial impacts that followed through the 1900s prevented any reestablishment of the plants.

The purpose of this project is to reestablish the wild rice stands, soft stem and hardstem bulrush and other aquatic emergent plant species for fish and wildlife habitat in the Muskegon Lake AOC and lower river estuary. The MRWA and partners have identified the Muskegon Lake and Estuary Emergent Vegetation Restoration Demonstration project to address the following needs:

1. enhancement of fish and wildlife habitat
2. delisting of Muskegon Lake as an Area of Concern (AOC)
3. education of restoration processes and techniques
4. meeting the spiritual and cultural needs of Native American people within the Muskegon River Watershed.

The first planting of emergents was done in November 2002, and wild rice and other emergents were reported growing on the May 10, 2003, “Scouting Day”. Even though the project is in its early stages, there has been measurable success.

Local Planning for Sustainable Development in Coastal Michigan
Breakout Session 1

Norton, R.K., Urban & Regional Planning Program, University of Michigan, Ann Arbor, Michigan
Brabec, E.A., School of Natural Resources and the Environment, University of Michigan, Ann Arbor, Michigan

Local communities in coastal Michigan and elsewhere increasingly struggle to make land-use related policy decisions that promote environmental, social, and economic sustainability, while federal agencies, state agencies, and non-governmental entities endeavor to assist them in a variety of ways. Despite these attempts, the technical complexities of the natural and built environments and the policy-making processes involved frequently overwhelm local officials in their efforts to make well-informed decisions. In response, a common prescription is to provide more education and outreach for local officials. The expectation is that this kind of intervention will lead to local plans and related land management policies that better promote sustainability, and that it will increase local officials' commitment to the implementation of those plans. Despite the appeal of this approach, however, no systematic studies exist on the effectiveness of such education and outreach efforts.

This presentation will provide preliminary results from an initial evaluation of local planning efforts by selected counties, townships, and municipalities in coastal Michigan. We are in the process of establishing a baseline of current planning and policy-making efforts, as well as current outreach and education programs for local officials, for localities in several coastal regions of the state, including several counties bordering Lake Michigan (Leelanau, Benzie, Ottawa, and Berrien). As part of this work, we have been or will shortly be conducting assessments of web-based outreach and education efforts directed to local officials, content evaluations of local plans for jurisdictions within these counties, and telephone surveys of local officials. The primary substantive focus of this work is to evaluate the extent to which local planning efforts in these coastal localities advance sustainable development and the extent to which education programs for local officials appear to improve those local planning efforts. We will be able to provide a more detailed description of the findings to be presented for the conference by mid September.

Lake Michigan Academy Regional Workshops
Breakout Session 1

Novato, J., Northeastern Illinois Planning Commission, Chicago, Illinois
Ward, B., The Cadmus Group, Chicago, Illinois
Walter, M., Bay-Lake Regional Planning Commission, Green Bay, Wisconsin
Pierce, A. Bay-Lake Regional Planning Commission, Green Bay, Wisconsin

In March of 2003, representatives of nine regional planning councils from throughout the Lake Michigan watershed met at Western Michigan University in Kalamazoo, Michigan as part of the Lake Michigan Academy initiative. The intent of this event was to provide watershed and water quality management professionals and land use decision-makers with information regarding the state of Lake Michigan, watershed planning, and tools for improving Lake Michigan watershed resources. Attendees included policy makers and practitioners at the state, regional and local level, as well as grassroots watershed organization leaders. The ultimate goal of the Lake Michigan Academy project is to build a network for information sharing and to match the needs of watershed management leaders and professionals with resources to move forward with watershed improvement strategies. Other objectives for attendees included:

- Learn about the state of Lake Michigan as a valuable resource and ecosystem and the vision and goals of the Lake Michigan Lakewide Management Plan (LaMP).
- Learn why local decision-making and land use is essential to healthy watersheds.
- Learn the key players, roles and activities needed at the local level to sustain effective stewardship of the lake and watershed.
- Learn how the USEPA and regional planning councils are working together to bring watershed management tools and resources to those who need it at the local level.
- Learn how to use the watershed management cycle.
- Become part of a network and forum for exchanging information and resources.
- Hear case studies of effective watershed management activities.

As a follow-up to this event six of the regional councils are holding regional workshops in each of their respective regions to transfer the knowledge gained at the Kalamazoo event to watershed leaders at the local level. These workshops are intended for local government officials, staff, regional water quality agencies, water quality advocates, and other professionals, and will be tailored to local needs and opportunities of each region. A number of these regional workshops will be held in August and September of 2003.

For the Lake Michigan State of the Lake ’03 Conference, we propose a panel discussion including representatives from the regional planning councils from those regions holding workshops prior to the conference on October 21-22. These representatives will present the results of their workshops including:

- Regional issues concerning the state of Lake Michigan.
- The location in the watershed planning process of particular Lake Michigan subwatersheds.
- The needs of local watershed groups, in terms of information and tools, to improve watershed resources.
- Broad, locally oriented action strategies for moving forward with Lake Michigan planning and improvement.

Local Government Tools for Resource Protection
Breakout Session 1

Ogilvie, E.W., Fishbeck, Thompson, Carr & Huber, Inc., Grand Rapids, Michigan

Case studies from communities in Michigan are used to present evaluation tools and procedures that are available to assess rules and regulations relating to resource protection. Comprehensive and coordinated land use planning was a desire of these communities, which are focusing more on preventive measures through improved planning and design rather than treatment control practices to address impairments. Local governments need options for preserving and restoring their resources and also need to understand the connections between their plans and ordinances. Many model ordinances exist that have proven effective in protecting water quality and other natural resources. Some communities have adopted these ordinances, which can either directly protect natural resources or restrict certain land uses that have negative effects on natural resources. Lack of knowledge in other communities has created a gap in the adoption of these ordinances. This paper presents methods of the evaluations used in the following case studies. One method, developed by the Center for Watershed Protection in Maryland, uses a Code and Ordinance Worksheet (COW), which asks questions based on 22 development principles focusing on imperviousness requirements for transportation, land use requirements for housing, and preservation requirements for natural resources. Another method, developed through the Dowagiac River Watershed project in Cass County, Michigan, provides a more simple analysis of a communities' rules through identifying the communities' resource concerns, then documenting how the Master Plan and the zoning ordinances supported those concerns. One community developed their own evaluation method using a combination of the COW, the Workbook for Local Governments developed by the Southeast Michigan Council of Governments, and ideas and concerns brought forth from a Policy Committee formed under a local watershed-planning project. Background information about the importance of planning, Michigan planning laws and regulations, and an overview of the connections between Master Plans, land use maps, and zoning ordinances is also included in the paper. The paper concludes with the results of those evaluations and the follow-up that the communities have conducted in changing their development rules to further protect natural resources

CASE STUDIES:

Galien River Watershed - Community Planning Workshop: The Galien River Watershed Communities have been working together for the past 2 years to develop the Galien River Watershed Management Plan. A Community Planning Workshop was organized with officials and planners from the townships and villages within the Galien River Watershed to review their development and land use regulations. The participants evaluated their ordinances, storm water criteria, design specifications and standards, building codes, and any other documents that shape how development happens in their community using the COW and the Dowagiac River Watershed analysis method.

Eastern Sanilac Coastal Tributary Watersheds - Policy Committee: Communities in eastern Sanilac County formed a Policy Committee, as part of the Eastern Sanilac Coastal Tributary Watersheds planning project, to ensure that the watershed planning process resulted in recommendations that were consistent with the County's Master Plan that is currently being updated. The Policy Committee created their own evaluation process using the various methods available.

City of Midland - Policy Review Document: The City of Midland participated in the Sturgeon Creek Watershed Project by reviewing their ordinances and regulations in terms of watershed protection. An analysis was performed using the COW method and the results were presented to the City of Midland in a Policy Review Document.

Assessment of Soil Erosion and Sediment Load from Agricultual Cropland in the Great Lakes Basin
Breakout Session 7

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Bartholic, J., Institute of Water Research, Michigan State University, East Lansing, Michigan
Selegean, J., Institute of Water Research, Michigan State University, East Lansing, Michigan

Soil erosion and sedimentation causes substantial waterway damages and water quality degradation, and remains as one of the main environmental concerns in the Great Lakes Basin. It is also costly. According to the US Army Corp of Engineers, there are approximately 35 projects dredged in the Great Lakes each year. That involves 3.8 million cubic yards of sediment, which costs $20.6 million. Information is needed for identifying and prioritizing high potential sediment contributing areas / watersheds. Sediment transport models are being developed to assist State and local resource agencies in reducing sediment / pollutants loading to navigation channels and Areas of Concerns (AOCs), and thus in reducing the costs for navigation maintenance and sediment remediation.

Use of models in identifying areas with high sediment yield that can be of dredging concern and controlling sediment loads requires knowledge and quantitative assessment of soil erosion and the sediment transport process. A number of factors such as drainage area size, basin slope, climate, land use/land cover affect sediment delivery processes. As monitored sediment data is not readily available in many cases, modeling of erosion and sediment delivery ratios is an important and effective approach to estimate sediment loading. Using Geographical Information System (GIS) technology and GIS data layers such as digital elevation model (DEM), land use/cover and soils, models can be efficiently used to simulate soil erosion, sediment delivery and loading for identifying high contributing areas in a large basin. This study uses GIS-based models to estimate soil erosion and sediment load in the 8-digit watersheds in the Great Lakes Basin. The results help prioritize the modeling efforts and BMP implementations in the region.

Assessing Watershed Stewardship: Connections to the Lake Michigan Basin
Breakout Session 1

Pater, J.E., Delta Institute, Chicago, Illinois
Abel, T.D., University of Wisconsin, Green Bay, Wisconsin
Brown, T.H., Delta Institute, Chicago, Illinois
Baba, R.K., University of Wisconsin, Green Bay, Wisconsin
Holsen, T.J., Delta Institute, Chicago, Illinois

"The overall status of the Lake Michigan ecosystem is derived from an assessment of the health of the ecological systems in conjunction with the degree to which humans act sustainably to protect the services and resources provided by the ecosystem." (Lake Michigan LaMP 2000) Many studies have been conducted to evaluate the first of these two criteria, but no studies have examined the level of stewardship within the Lake Michigan basin that would be required to ensure long-term environmental protection. A better understanding of the relationship between human activity and environmental protection will enable more informed decisions about the most industrious and efficient uses of resources to improve the environmental quality of Lake Michigan.

Local, community-based stewardship is fundamental to understanding these human affects on the natural resources of each watershed in the basin and the environmental quality of all of Lake Michigan. Thus, the Lake Michigan Forum developed a process to rapidly evaluate the level of that stewardship in any watershed, as compared to a best-case stewardship scenario. Based on input from local leaders and citizens, as well as a panel of experts, the process reveals a collection of opportunities within the watershed where enhanced stewardship could help protect and improve environmental quality. Local community members can use these recommendations as a guide for designing and implementing programs that will protect and improve the condition of the watershed. At the same time, policy makers can use the recommendations to craft policies for increasing the stewardship capacity of local communities throughout the Lake Michigan basin.

Using this process, the Lake Michigan Forum conducted a pilot assessment in the Mona Lake watershed in western Michigan with the assistance of local partners. The findings of this study and an overview of the assessment process will be presented at the conference.

Cercopagis pengoi and *Bythotrephes longimanus* in Lake Michigan

Breakout Session 2

Pichlova, R., CILER, University of Michigan/GLERL, NOAA, Ann Arbor, Michigan
Vanderploeg, H.A., CILER, University of Michigan/GLERL, NOAA, Ann Arbor, Michigan

Invasion of invertebrate predators *Cercopagis pengoi* and *Bythotrephes longimanus* in the Laurentian Great Lakes are hypothesized being a threat to existing food webs through negative impact on fish recruitment. In this paper, we want to summarize our current understanding of impacts of these two invasive species, based on experience with both field and experimental research conducted on these predators on Lake Michigan. This covers four years of sampling (2000-2003) at a nearshore-offshore transect at Muskegon and Muskegon Lake, a drowned river mouth lake connected to Lake Michigan and predation experiments with *Cercopagis* and *Bythotrephes* both on natural zooplankton assemblage and one prey species treatments. While *Bythotrephes* became well established in Lake Michigan, it seems that *Cercopagis* abundance declined since 2000 through 2002. We do not know yet whether it is an effect of fish predation, lack of food and/or competition with other invertebrate predators and larval fish. We are beginning to get clues about the population changes from analysis of brood count, size, biomass and body/spine ratio.

Aquatic Nuisance Species Update
Breakout Session 8

Pistis, C., Michigan Sea Grant, Grand Haven, Michigan
Kinnunen, R., Michigan Sea Grant, Marquette, Michigan

More than 165 exotic species now exist in the Great Lakes Basin. Each year there are new threats identified. Invasive species are causing profound change to the Great Lakes ecosystem .Our understanding of the mechanisms of change brought about by exotic species is also increasing. Once exotics enter the Great Lakes, they are difficult to control and they spread rapidly. Emphasis should be placed on preventative action. One promising technique now utilized to prevent the spread is ANS **HAACP** (Hazard Analysis Critical Control Point). Through this methodology, Sea Grant partners with Federal, State and private aquaculture facilities will identify potential introduction points inherent in day-to-day operational practices. The concept has received widespread acceptance throughout the US and can be adaptable to other industries.

Preliminary Investigation of Sediment Contamination in Muskegon Lake, Michigan
Breakout Session 5

Rediske, R.R., Annis Water Research Institute, Grand Valley State University, Muskegon, MI
Gabrosek, J.G., Annis Water Research Institute, Grand Valley State University, Muskegon, MI
Thompson, K.M., Annis Water Research Institute, Grand Valley State University, Muskegon, MI
Carter, G.C., Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan

A preliminary investigation of the nature and extent of sediment contamination in Muskegon Lake was performed using Sediment Quality Triad methodology. Sediment chemistry, solid-phase toxicity, and benthic macroinvertebrates were examined at 15 locations. High levels of cadmium, copper, chromium, lead, and mercury were found in the Division Street Outfall area. These levels exceeded the Probable Effect Concentrations (PECs) for current sediment quality guidelines. High concentrations of PAH compounds were found at a lakeshore industrial area formerly occupied by a manufactured gas facility. These levels also exceeded PEC guidelines. Sediment toxicity was observed at two stations in the Division Street Outfall area and at the lakeshore industrial site. These locations had the highest concentrations of metals and PAH compounds respectively. Benthic macroinvertebrate communities throughout Muskegon Lake were found to be indicative of organically enriched conditions. The locations in the Division Street Outfall area were significantly different than reference sites with respect to fewer numbers and a smaller population of detritivores. Sediment Quality Triad diagrams were prepared and significant correlations were obtained between chemistry and toxicity and chemistry and diversity ($p < .01$).

Spatial and Temporal Variability of the Grand River Plume in Lake Michigan During the Summers of 2001 and 2002
Breakout Session 7

Riemersma, P.E., Department of Geology, Grand Valley State University, Allendale, Michigan
Vanderwerp, M.A., Department of Geology, Grand Valley State University, Allendale, Michigan
Gensler, A.A., Department of Geology, Grand Valley State University, Allendale, Michigan

The Grand River is the largest tributary flowing directly into Lake Michigan, and is estimated to contribute a large fraction of the chemical load. The plume of turbid river water that extends into the lake may adversely impact local lake water quality. The objectives of our investigation were to examine the temporal changes in the spatial and chemical configuration of the Grand River plume where it discharges into Lake Michigan in the vicinity of Grand Haven, Michigan.

Over twenty cruises aboard the GVSU-AWRI *R/V* D.J. Angus were conducted during the summers of 2001 and 2002. During each cruise from 12 - 40 locations were sampled within and at the edge of the plume. At each location, a Sea-Bird Seacat SBE 19-03 was used to measure in detail the variation with depth of temperature, conductivity, irradiance (a measure of turbidity), chlorophyll concentration and light transmission. Selected water samples were analyzed for nitrate concentration.

By producing detailed snapshots of the plume at different times and under varying conditions, we examined the relative influence of variable river discharge, wind velocity, wind direction and water temperature on the resulting plume shape and composition. We also documented the effect of thermal bar formation and wind-induced upwelling events on the plume configuration.

Effects of Water Levels on Bluff Recession
Breakout Session 7

Ross, P., United States Army Corps of Engineers, Detroit, Michigan
Strum, M., United States Army Corps of Engineers, Detroit, Michigan

Final results from the Lake Michigan Potential Damages Study (LMPDS) modeling effort for five (5) prototype counties have been recently obtained. The modeling effort required the development and utilization of The Flood and Erosion Prediction System (FEPS). The FEPS was developed to estimate future shoreline positions at 20, 35, and 50-year intervals for three lake level scenarios to help quantify economic damages due to shoreline erosion.

In addition to future shoreline mapping for the LMPDS, the FEPS modeling results have provided valuable insight into regional coastal zone management issues for the Great Lakes Basin. The main findings of the analyses are:

1) For cohesive shore types, over the 50-year modeling period, accelerated bluff recession rates were predicted for the Wet Scenario, while conversely, slower bluff recession rates were predicted for the Dry Scenario. Shoreline retreat for the Base Scenario was generally similar to long-term historic rates established from air photo analyses;
2) Sandy shore types were found to be sensitive to both high and low lake levels or, more importantly, lake level cycles rather than absolute water level elevations. Specifically, cross-shore adjustments of the sandy profile occur in response to relative changes in lake levels and are greatest during periods of rising and falling lake levels, not simply high and low lake levels. Modeling at sandy reaches in Ottawa and Allegan Counties predicted more recession for the Dry Scenario than for the Base-case Scenario. This is a different response than was found in the cohesive shore type modeling
3) Shore protection structures tended to cause an increase in recession rates downdrift from the structures. Furthermore, modeling results indicate that hardening of sandy shore types increases recession rates downdrift to a greater extent than hardening of cohesive shore types. Modeling of various shoreline armoring scenarios of sandy shore types in Ottawa county produced noticeably higher rates of recession, while similar modeling scenarios for the cohesive shore types in Allegan County resulted in only slight rises in rates of recession downdrift of the structure.
4) Bathymetric surveys at or near harbor structures were compared over a 53-year period (1948-2001) to determine if sediment was being deflected offshore. Comparisons showed no significant profile changes over the 53-year period suggesting that sand could be bypassing the structures investigated.
5) Based on the modeling results for the sandy and cohesive shore types, it was hypothesized that if the 50 year Wet and Dry Scenarios were run indefinitely, the beach profile would eventually reach a new equilibrium form based on the existing wave climate for the new mean water level. Then the recession rates would converge to the rates for the Base-case Scenario since the driving forces associated with the wave climate are identical.

Preliminary results of this hypothesis were obtained by modeling the three scenarios for a 200-year period. This was accomplished by combining wave data with the first 20 years of the water levels from the Wet and Dry Scenarios and repeating the model runs 10 times. Through this method, it was found that recession rates for the two scenarios converged on the Base-case Scenario recession rates in roughly 100 years

Further support of this investigation can also be extrapolated from results obtained from a recent investigation into erosional impacts due to federal structures at Saugatuck, MI. In the Saugatuck Section 111 Study, sediment budget analyses were conducted over the life of the federal structures. It was found that over a 95-year period, the adjacent accretion fillets seem to have adjusted to the placement of these structures and have reached a state of dynamic equilibrium. This also seems to indicate that sand bypassing may now be occurring.

Great Lakes Regional Sediment Management
Breakout Session 7

Ross, P., United States Army Corps of Engineers, Detroit, Michigan
Zager, N., United States Army Corps of Engineers, Detroit, Michigan

The Great Lakes Regional Sediment Management Demonstration Program was initiated by the Corps of Engineers, Detroit District in FY 2001 in conjunction with the Coastal and Hydraulics Laboratory in Vicksburg, Mississippi under the authority of Section 516, WRDA 1996. By gaining state and local government support for policies that help protect the unique Great Lakes environment, Regional Sediment Management will strive to address weaknesses in current coastal management practices. Regional Sediment Management (RSM) refers to the management of nearshore, estuarine, and riverine sediment within physical, not political, boundaries where sediment exchange occurs naturally. A "region" may include a variety of beaches, bluffs, inlets, rivers, estuaries, bays, and communities. Implementation of RSM recognizes that a coastal system is made up of many interconnected ecosystems. Affecting one ecosystem can alter how the rest of the coastal system functions.

The Great Lakes RSM Demonstration Site being studied is from Ludington, Michigan at the north end, to Burns Waterway, Indiana at the south. This 186-mile region contains 12 Federal structures and 1 private jetty system at Port Sheldon, Michigan. The region is the focus of an array of coastal issues including erosion and bluff recession, coastal structure impacts, navigational structure impacts, dredging projects, beneficial use of dredge material, and nearshore placement of sandy material. By identifying key stakeholders, forming partnerships with state and local agencies, linking projects and obtaining available coastal data, the Corps of Engineers will gain a better understanding of regional and local processes while approaching efficient sediment management.

Under the RSM program, the Detroit District is attempting to address nearshore issues near Michigan City Harbor in Indiana. The issues concerning this area include; 1) shoaling problems at the mouth of the harbor, 2) nourishment requirements downdrift of the harbor, 3) protection of a critical dune area, 3) protection of critical wetlands, 4) reduction of dredging at the Michigan City Marina, 5) protection of a breakwater just east of the harbor, and 5) maintaining a safe swim area at the local state park. In order to address these issues, partnerships need to be developed with a number of stakeholders including state regulatory offices, the local port authority, the local park service, and adjacent U.S. Army Corps of Engineer District (Chicago). Meetings and workshops will be developed and held to define each agencies interests and concerns and highlight readily available data sources to support studies for development of a 20 year Dredge Material Management Plan (DMMP).

Fish Monitoring in Muskegon Lake: Preliminary Results
Breakout Session 2

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We plan to assess the short-term and long-term trends in fish abundance and composition in Muskegon Lake by sampling fish in shallow-water areas (< 1 m) along the margins of the lake during spring, summer, and fall. We initiated this study by sampling fish at three sites in Muskegon Lake during May 2003. The catch from the May sampling event consisted of six species. Round gobies (*Neogobius melanostomus*) and rock bass (*Amploplites rupestris*) were most abundant. In July, we performed an experiment to examine within site variation in catch, and how catch varied among fyke nets that were set parallel versus perpendicular to shore. The results from this experiment will help us to refine our sampling design and better allocate our sampling effort. Ultimately, we hope that the data we collect on the long-term dynamics of fish abundance and composition will help to provide base-line information that will be necessary for restoration of Muskegon Lake, which is currently designated as an Area of Concern by the Environmental Protection Agency.

Great Lakes Education for Understanding and Action: Connect. Explore. Investigate
Concluding Session

Smith, S. Lake Michigan Federation, Chicago, Illinois
Morton, J., Lake Michigan Federation, Grand Haven, Michigan

The Lake Michigan Federation is committed to creating a wave of Great Lakes enthusiasm in formal and non-formal education so that students of all ages better understand and care about the watershed we share. Lake Michigan Federation programs educate students of all ages about the vital role the Great Lakes play in our lives by focusing on sense of place education. Our approach, which inspires care and uses a problem-solving approach, aims to enhance critical thinking and responsible decision-making with regard to the Great Lakes. The Lake Michigan Federation has developed programs for schools and community groups that raise awareness of the importance of the Great Lakes' rich and diverse ecosystems. These programs focus on developmentally appropriate subject matter for participants and aspire to create positive change in the watershed. In theory and practice, these programs explore a model in which future generations and communities are a key part of Great Lakes protection.

The Lake Michigan Federation adopts a fresh approach to learning about environmental issues that encompasses three levels of understanding: Connect, Explore and Investigate.

- *Connect:* Participants explore their personal connection to the plants, animals and landscape/lakescape that surround them. To understand the place that we live inspires a lifetime of learning, and a continued ethic of care.
- *Explore:* Participants expand their knowledge of their communities and the Great Lakes. By exploring local issues students gain knowledge about Great Lakes ecological significance and the rich natural and human history of the Great Lakes watershed.
- *Investigate:* Participants investigate issues that impact the future of their Great Lakes, as well as solutions that can alleviate these problems. As problem-solvers of local (as opposed to global) issues, participants become more invested in the future of the region and engage in local decision-making.

These concepts are demonstrated in the following educational programs:

- *Adopt-a-Beach:* A program that enables schools, individuals, and community groups to play a "hands on" role at their local beaches year-round. Adopters are involved in litter monitoring, water quality testing, and action projects that can make a real difference at local beaches.
- *Great Lakes In My World K-8 curriculum*: The Federation is creating a curriculum that connects the lakes through "real world" learning.
- *Great Lakes In My World* consists of 6 units: Lake Ecology, Sand Dune Ecology, Wetland Ecology, Geology, Human Communities, and History. Teachers in schools throughout the Lake Michigan basin have piloted these units to ensure that the activities engage students.

An Ecological Assessment of the Mona Lake Watershed
Breakout Session 2

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The Mona Lake Watershed is relatively small in area (ca. 200 km^2) but faces a large number of social and environmental challenges, including toxic sediments, cultural eutrophication, invasive species, and habitat alteration. An ecological assessment was conducted to evaluate the status of the two main tributaries in the watershed, both of which are considered impaired by the MDEQ, as well as the status of Mona Lake itself, which is a relatively small (2.8 km^2) drowned river mouth draining into Lake Michigan.

A demographic analysis revealed major differences between the two cities in the watershed, with one (Norton Shores) being largely white and affluent, whereas the other (Muskegon Heights) was largely African-American with a median household income less than half of that in Norton Shores. Land use/land cover change in the past 20 years indicates an increase in low-density residential land cover at the expense of agriculture. Monthly sampling of all inflows into Mona Lake suggests that the majority (>75%) of the flow and nutrient load come from Black Creek. Total coliform numbers often exceeded state guidelines. Simulations from a watershed-based hydrologic model reveal that storm events may alter the percent contribution of flow from the subbasins, but this change is short-lived. In addition, sediments in Little Black Creek had concentrations of several contaminants that exceeded Probable Effect Concentration thresholds, with some of the highest cadmium concentrations measured in the Great Lakes.

A combined observational and experimental study was initiated to assess the current ecological status of the lake. Mean chlorophyll concentrations in the lake ranged from 6.1 to 53.74 µg/L, with lowest amounts generally found at the station closest to Lake Michigan. This compares to a mean chlorophyll value of 30.5 µg/L reported from 1972-1975. During periods of stratification and DO depletion, TP concentrations were up to 2-3 orders of magnitude greater near the bottom of the water column compared to the top (e.g. 400 vs. 8 µg/L, respectively), suggesting iron-mediated anoxic release of phosphorus. Phosphorus and nitrogen concentrations have declined dramatically over the past 30 years, but internal loading appears to be a significant source of phosphorus within Mona Lake. A nutrient bioassay experiment conducted in May 2003 resulted in significant increases in mean chlorophyll levels in the N+P treatment, suggesting co-limitation. Plankton metabolism results were equivocal.

This preliminary analysis revealed significant ecological impairment in this watershed. Recommendations for future research include toxicity studies with contaminated sediments, laboratory-based phosphorus flux experiments to examine internal P loading and an associated comparison of internal vs. external phosphorus loading, more detailed flow sampling to capture the load contribution of storm events, and continued monitoring to evaluate the effectiveness of proposed best management practices in the watershed.

Internal Phosphorus Loading in Spring Lake, Michigan
Breakout Session 5

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Spring Lake is a 5.25 km^2 drowned river mouth lake that is located in Muskegon and Ottawa Counties of west Michigan. The lake drains into the Grand River just before the River enters Lake Michigan. Phosphorus and chlorophyll concentration measurements from recent summers indicate that Spring Lake is eutrophic to hypereutrophic. The Spring Lake – lake board is considering the application of alum to reduce the amount of phosphorus entering the water column from the sediments. In order to determine whether this treatment is appropriate, experiments were conducted to determine: 1) the apparent internal loading rate of phosphorus in Spring Lake; and 2) the effectiveness of alum in reducing the apparent internal loading rate.

Four sites in Spring Lake, representing a downlake gradient, were sampled in summer, 2003. Twelve cores were collected from each site; in the laboratory, cores were subjected to one of four treatments (3 replicates per treatment): 1) aerobic with alum; 2) aerobic without alum; 3) anaerobic with alum; and 4) anaerobic without alum. Cores were placed in an environmental growth chamber in the dark and at ambient temperature during collection (15°C). Both SRP and TP were sampled from the water column at regular intervals after incubation.

Data are available from sites 1 and 2, closest to the Grand River; diffusive flux measurements revealed extremely low release rates (<0.1 $mg/m^2/d$) of phosphorus in the alum treatments (both with and without oxygen) and also in the aerobic/no alum treatment. Diffusive flux rates from the anaerobic/no alum treatment ranged from 10.3 to 23.9 $mg/m^2/d$ for SRP and from 14.8 to 33.8 $mg/m^2/d$ at Site 1 for TP. At Site 2, diffusive flux rates ranged from 2.2 to 32.1 $mg/m^2/d$ for SRP and from 1.6 to 26.4 $mg/m^2/d$ for TP. These rates, when extrapolated for the entire lake and year (no weighting by season or location), translated into internal loads average 29.5 tons/yr for SRP and 42.3 tons/yr for TP. This compares to an external load average of 3.3 tons/yr based on previous work. Even after taking into account that the external loads are likely overestimates (anoxia, no disturbance to alum layer, warm temperatures) and that the internals are likely underestimates (minimal storm event sampling), it is clear that internal loading is an important source of phosphorus in Spring Lake. Attempts to reduce in-lake phosphorus concentrations must focus on both external and internal load sources.

The International Association of Great Lakes and St. Lawrence Mayors: An Organization for the Right Reasons
Plenary Session

Thorp, S. J., Great Lakes Commission, Ann Arbor, Michigan

In 1987 mayors of Great Lakes and St. Lawrence River shoreline communities agreed to organize for the purpose of adding their voice to the regional policy process. There was widespread acknowledgment that policy discussions about the use and protection of the region's preeminent freshwater resource had not fully engaged local government. These U.S. and Canadian mayors, who have many water-related problems and opportunities in common, decided that local government needed a place at the policy table. Their reasoning was that local government with its close connection to residents and duty of responsiveness should be more involved in decision-making that would have a direct impact on their communities.

The mayors initially set up an annual conference schedule with host cities providing staff support. In 1991 a part-time bilingual secretariat was established and a more formal organizational structure with bylaws and dues followed. Actions of the International Association of Great Lakes and St. Lawrence Mayors are usually in the form of resolutions adopted at the annual meeting with appropriate follow-up by staff. More recently, mayors and, in particular, board members, have taken the initiative to lobby on behalf of the Association in diverse venues ranging from their home communities to federal and state/provincial capitals. The Mayors Association is cooperating with other organizations such as the Great Lakes Commission and Council of Great Lakes Governors so as to broaden its impact and benefit from information exchange. Over the years the mayors' agenda has been shaped by contemporary events but long-standing environmental concerns such as inter-basin diversions and aquatic nuisances species are addressed regularly. Waterfront development and Great Lakes-St. Lawrence transportation are also topics that have become mainstay interests.

Status and Trends of Bird and Anuran Abundance and Occurrence and Habitat Components Throughout Great Lakes Basin Marshes: A View From the Marsh Monitoring Program
Poster Session

Timmermans, S.T.A., Bird Studies Canada, Port Rowan, Ontario
Craigie, G.E.L., Bird Studies Canada, Port Rowan, Ontario

Volunteer participants engaged in the Marsh Monitoring Program have been collecting data on relative abundance of marsh birds, relative occurrence of anurans, and approximations of habitat components in surveyed stations from 1995 through 2002, inclusively. Recent analyses of these data indicate that there are several bird and anuran species whose annual abundance and/or occurrence indices have undergone temporal declines, and few whose respective indices have been increasing. Some bird and anuran species that are common and well distributed throughout Laurentian Great Lakes basin marshes such as American toad (*Bufo americanus*), chorus frog (*Acris crepitans*) and Black Tern (*Chlidonias niger*), have incurred steady year-to-year declines. Net declines in other species' indices were driven by a more recent decline that coincides with a recent period of steady decline in water levels of Great Lakes basin water bodies. Status and trends of several marsh birds species, anuran species and components of their associated marsh habitats are presented. These are discussed in context of their use as indicators of change in marsh faunal communities, and for potential use in evaluating biotic and abiotic changes that affect marsh environments of the Laurentian Great Lakes basin.

Environmental Benefits of Biodiesel in Marine Applications
Poster Session

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The exhaust gases from commercial and recreational marine diesel engines contribute to greenhouse gases, degrade water quality, and expose crews and passengers to variety of air pollutants. Biodiesel, chemically described as a mono alkyl ester, is recognized by the Environmental Protection Agency as an alternative fuel and has demonstrated significant reductions in harmful exhaust emissions. Annis Water Resources Institute has researched the use of diesel fuel in commercial and recreational boats in the West Michigan area and the potential for biodiesel to reduce the impact on the environment.

Great Lakes Cities Initiative
Plenary Session

Ullrich, D., Great Lakes Cities Initiative, Chicago, Illinois

Overview

The Great Lakes Cities Initiative, created by mayors, seeks to strengthen the collective voice and enhance the role of local leaders in Great Lakes decision-making. It is a project of the Northeast Midwest Institute and is chaired by Chicago Mayor Richard M. Daley. Mayor Daley convened the Initiative's initial meeting in November 2002. Through support from the Joyce Foundation, the office of the Great Lakes Cities Initiative officially opened in Chicago in July 2003. Dave Ullrich, who recently completed a 30-year career with the U.S. Environmental Protection Agency, serves as the Initiative's Executive Director.

Objectives - Enhanced role for Mayors

Mayors want full partnership with other stakeholders in Great Lakes decision-making. Local officials all around the Basin have a major stake in the future of the resource, as their citizens rely on the Great Lakes for their economic well being and quality of life. Residents most often turn to local officials to provide clean and safe drinking water, preserve open space and recreational opportunities, and manage stormwater.

Advocate for Great Lakes Protection and Restoration

Mayors are major advocates for Great Lakes restoration. Over the years, progress has been made on improving the resource, but much more needs to be done. Great Lakes legislation was introduced in the House and Senate during the Summer of 2003. Mayors plan to play an active role in advocating for passage of the best possible legislation that will benefit the Great Lakes and the cities in its basin. Included in both current bills is a provision for a Great Lakes Advisory Board, which would include mayors as full partners with federal, state, and other officials.

Share Best Practices

The Great Lakes Cities Initiative will showcase and share best practices from cities around the Great Lakes. Much creative work is being done by cities. However, to date there has not been an effective means of sharing this experience and expertise. The Initiative will collect this information from the cities, make sure that others are aware of it, and provide recognition for accomplishments.

Unique Perspective of Mayors

The region's mayors will bring a new sense of urgency and innovation to problem solving in the Great Lakes. Because of their proximity to the resource, they have the benefit of first-hand experience with both the problems and the solutions. This experience will be shared with other cities, as well as state and federal representatives. The initial focus will be on such issues as swimming bans at beaches, shore land and habitat protection, invasive species, and contaminated sediments.

The Great Lakes – as a source of fresh water, a means of transportation, a resource for economic development, an environment for a wide and diverse community of plants and animals, as well as home for over 40 million people – deserves nothing short of our collective best efforts to restore and protect it long into the future. The mayors stand ready to do their part to carry out this mission.

Long Term Trends in Lake Michigan Chemistry
Breakout Session 5

Warren, G.J., United States Environmental Protection Agency, Great Lakes National Program Office, Chicago, Illinois
Horvatin, P.J., United States Environmental Protection Agency, Great Lakes National Program Office, Chicago, Illinois

Lake Michigan has responded to reductions in loads of nutrients and toxic contaminants. The success of control efforts on the waters of the Lake is evident for phosphorus, the primary indicator of eutrophication, as well as for banned pesticides and industrial chemicals, particularly DDT and PCBs. These chemicals appear to be approaching lower asymptotic values in the water column. Recent evidence, based on phosphorus, silica and phytoplankton species analyses indicate that the lake is recovering from eutrophication. However, while water column concentrations of phosphorus have decreased, other measures of anthropogenic influence on the lake have not. Nitrogen, measured as nitrate plus nitrite, chloride and conductivity have consistently increased over our monitored period. Both atmospheric (nitrate) and tributary (nitrate, chloride, conductivity) pathways are important routes for materials into Lake Michigan. Data on long term trends in nutrients and contaminants, and where possible the importance of each input route will be presented.