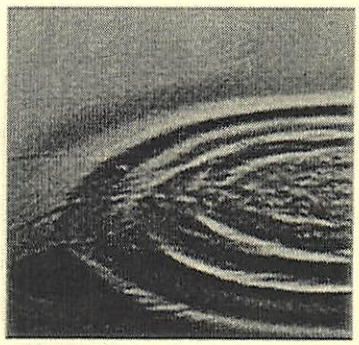
Sea Grant
MICHIGAN

BIENNIAL REPORT
MARCH 1997 - FEBRUARY 1999



MICHIGAN SEA GRANT COLLEGE PROGRAM

Michigan Sea Grant College Program
University of Michigan - Michigan State University
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TO:	The Office of Sea Grant NOAA, U.S. Department of Commerce
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Introduction

Michigan Sea Grant was founded in 1969 at the University of Michigan and joined by Michigan State University in 1977. The partnership with Michigan State University enabled the program to make full use of the Michigan State University Extension Service. With over twenty years of joint management, Michigan Sea Grant has honed the practice of collaboration to the point where this partnership serves as a model for other joint university partnership programs in Michigan.

During the 1997 and 1998 fiscal years, Michigan Sea Grant completed a series of transitions that reshaped and re-focused the program to better serve Michigan in the Twenty First Century. An Assistant Director, who also has overall responsibility for Communications, was hired and included on the Management Team. This change brought a stronger emphasis on coordination and collaboration between Communications and Extension. The review and selection process for research projects was changed to more closely follow national guidelines, assure prospective principal investigators that the process was fair and familiar, and to assure adequate reporting of research results. Michigan Sea Grant undertook a strategic planning process that included involvement from all staff, input from external stakeholders, and oversight from Michigan Sea Grant's Policy Committee.

Michigan Sea Grant's vision has remained unchanged, although the processes and personnel that strive to implement this vision have changed. Michigan Sea Grant is dedicated to providing research, education and technology transfer for the sustainable use of the Great Lakes. Michigan Sea Grant uses the best available academic and professional talent at the local and regional level to help address national, state and regional Sea Grant priorities.

During the 1997 and 1998 fiscal years Michigan Sea Grant outreach focused on four major programmatic areas: coastal community development, coastal business management, Great Lakes resource management, and education. Within these areas Michigan Sea Grant accomplished the following goals:

- Facilitated cooperation among municipalities, strengthened local leadership, and linked researchers to community needs to build sustainable coastal communities.
- Assisted coastal enterprises in identifying and advancing their business goals, while being involved in sustaining a healthy environment.
- Educated the public about aquatic nuisance species and how to control the spread and destructive impact of key exotic species.
- Provided leadership in lake basin, interstate, and international fishery management organizations.
- Educated Michigan citizens to become stewards of Great Lakes resources through educational youth programming, teacher training, and information dissemination.

During the 1997 and 1998 fiscal years, Michigan Sea Grant research focused on the following issues, which had considerable overlap with the outreach activities:

- Great Lakes Fishery Management
- Coastal Shoreline Protection
- Great Lakes Toxics
- Aquatic Nuisance Species
- Commercial Fishing Safety

Selected Accomplishments and Benefits
Outreach

Coastal Community Development

With 3,288 miles of shoreline, Michigan has a longer coastline than any other U.S. state except Alaska. Hundreds of small to large communities are scattered along Michigan's Great Lakes shoreline. Each year Michigan's coastal region provides an estimated 200 million person-days of recreation and tourism—the dominant coastal industry. In addition, waterfront development often provides a high quality of life that attracts and retains businesses not directly related to recreation or tourism. However, pollution problems, such as brownfields, provide barriers to revitalizing waterfronts. Additionally, tremendous development pressure can put environmentally-sensitive areas at risk.

One of the greatest challenges in coastal community development is overcoming the institutional and environmental barriers that exist to creating sustainable communities. At least 400 units of local government have jurisdiction over some part of Michigan's Great Lakes coastal zone. Michigan Sea Grant's unique contribution is the ability to bring together academic, government, business, and non-profit groups to develop solutions to community problems and to implement new visions. Michigan Sea Grant's efforts in sustainable coastal community development have resulted in redevelopment of waterfront areas that bring residents and visitors to the shore, protection and restoration of habitat, and economic development that complements environmental habitat.

Michigan Sea Grant Leadership Results in New Partnerships and Funding to Revitalize the Detroit River Waterfront

Michigan Sea Grant led the development of the Detroit Greenways Partnership, a cooperative association of more than 40 businesses, community organizations and municipal agencies that brings together coastal community redevelopment, economic revitalization, and ecology interests in the Detroit area. The Greenways Partnership developed a vision for revitalizing the 32 mile long Detroit River waterfront. In 1997, an expanded partnership spearheaded the development of an application for designation of the Detroit River as an American Heritage River (AHR) by President Clinton. A Michigan Sea Grant Extension Agent co-chaired a 40 member Canadian and U.S. team that obtained over 175 letters of support from governments, citizen groups, businesses, researchers, and citizens.

President Clinton named the Detroit River as one of 14 American Heritage Rivers from a field of 126 applicants. Resulting from these efforts, a federally-appointed liaison professional called a "river navigator" will help waterfront communities secure technical and financial assistance from federal programs. The Greenways Partnership blended with a newly formed American Heritage River Steering Committee to function as the implementation committee of the AHR initiative. In recognition of Sea Grant's integral role in these efforts, a Michigan Sea Grant Extension Agent was appointed Chair of the AHR Steering Committee by the Mayor of Detroit, the Wayne County Executive and the Downriver Community Conference.

New Publications and Workshops Educate Citizens on Stewardship of Michigan's Coastal Areas

Two new publications on coastal ecosystems, *Discovering Great Lakes Dunes* and *A Field Guide to Great Lakes Coastal Wetlands*, written for coastal visitors, have reached more than 700 teachers, resource

managers, and Great Lakes residents with information on how to identify and protect key coastal land forms. Michigan Sea Grant Extension conducted various workshops for coastal residents and community leaders on coastal erosion, water quality, and nonpoint pollution control, reaching more than 2,000 individuals in 26 venues.

Michigan Sea Grant-Sponsored Research and Community Leadership Result in Nine Underwater Preserves in Michigan

In the early 1980's Michigan Sea Grant produced a series of research reports on several aspects of underwater resources. Based on this research, the Michigan legislature adopted a law to allow the designation of underwater preserves in areas of geological and historical significance. Michigan Sea Grant provided assistance and support to communities wishing to designate underwater preserves, ultimately leading to the development of the Michigan Underwater Preserves Council, an autonomous, self-supporting organization with a strategic plan for underwater preserve development. Michigan now has nine fully designated bottomland preserves: Alger, Whitefish Point, Marquette, and Keweenaw in Lake Superior; the Straits of Mackinac in Lakes Michigan and Huron; Thunder Bay, Thumb Area and Sanilac Shores in Lake Huron; and Manitou Passage in Lake Michigan. Currently, Michigan Sea Grant is working with a committee in South Haven, MI to designate a preserve in southern Lake Michigan.

Economic development has already spun off these efforts. In 1997, Michigan Sea Grant assisted in the development of several charter dive and glass-bottom boat businesses by acquiring buoys from federal and state surplus to mark shipwrecks, and through the development of business plans. Michigan Sea Grant also assisted in the sinking of the historic tug *Selvick* in the Alger preserve, and worked with the Great Lakes Shipwreck Historical Society to archive video of the 1989 dive to the *Edmund Fitzgerald.* The tape is available to the public and researchers in the MSU audiovisual library.

Coastal Business Management

Of the tens of thousands of coastal-related businesses in Michigan, many are family-owned and most are small-to-medium sized. Collectively, however, their impact on the economies of coastal communities is sizable. Businesses dependent on the Great Lakes coast include marinas, recreational fishing enterprises, commercial fishing, aquaculture and fish processing operations.

To compete effectively in today's rapidly changing business climate, water-related enterprises need to continually improve their business planning, decision-making and management skills. They can also benefit from learning about new technologies and marketing strategies for their products, and from learning about resource management issues that their businesses affect and that likewise affect them.

Michigan Sea Grant is a leader in facilitating sustainable coastal businesses. Through our efforts coastal enterprises have identified and clarified their business goals, have taken advantage of new technology and developed additional markets, and have maximized and demonstrated their economic impact on the community, while being involved in developing and sustaining a healthy environment.

MarinaNet Develops Consensus on Research Needs and Priorities for Boating Industry

MarinaNet, a national network of Sea Grant programs, government agencies, and boating and marina associations has successfully bridged a gap between research, regulation and business. Michigan Sea Grant partnered with other Sea Grant programs to co-sponsor a national and a Great Lakes MarinaNet research collegium (a meeting of equals), which developed consensus on industry research needs for the future. Specific outcomes of these meetings include: identification of research priorities, development of research proposals, and industry action plans. Other MarinaNet activities included producing an issue of the national MarinaNet newsletter, producing proceedings of the Great Lakes collegial meeting, and providing media coverage for Clean Boating Week in partnership with the Michigan Boating Industry Association. The Sea Grant network is working with industry leaders to fund and lead ongoing MarinaNet efforts.

CoastWatch Web-Site Improves Recreational Charter Fishing Business

Using data from NOAA's Great Lakes Environmental Research Laboratory, Michigan Sea Grant partnered with the Michigan State University Institute of Water Resources and four Great Lakes Sea Grant programs to create an interactive web site that provides up-to-date surface water temperatures, available as isothermic maps. These maps, updated four times per day, help anglers and charter boat captains save fuel by pinpointing likely areas for fishing. Associated data also helps fishers to assess if the weather is safe for boating. In 1997 the web site was expanded to include regional maps and port views for all the Great Lakes. An average of 2,000 temperature maps per week were downloaded in 1997 and 15,000 per week in 1998. The CoastWatch team won the Michigan State University Extension John Hannah Award, and the Sea Grant Network Program Leaders' Outstanding Program award in 1998.

Unique Tribal Community Position Provides Links Between State and Tribal Commercial Fishers

Filled in 1992, the first-ever Native American Sea Grant Extension Agent position was jointly funded and supervised with the Chippewa-Ottawa Treaty Fishery Management Authority (COTFMA). This unique position used traditional Extension and Sea Grant information to develop business plans and marketing expertise to tribal fishers, while bringing understanding of Michigan's Native American culture and knowledge of treaty rights to state and regional fisheries stakeholders. An extensive net-setting safety program was developed that reduced conflict by helping state-licensed commercial fishers and recreational anglers avoid tribal fish nets. In 1998, COTFMA began fully supporting this position and staffing it with a tribal member.

Michigan Sea Grant Improves Safety of Great Lakes Fish Products Through HACCP Training

The National Sea Grant Program drew together partners from government, industry and academia to implement a federal seafood safety mandate. The U.S. Food and Drug Administration mandated that all fish processors develop and implement Hazard Analysis and Critical Control Points (HACCP) plans by December 31, 1997. These plans are to assure that potential hazards are identified and controlled throughout the entire processing continuum, from receiving ingredients to distribution and use of the final product. The National Seafood HACCP Alliance developed a uniform national HACCP education, training, and technical assistance program. Michigan Sea Grant led training and technical assistance efforts in the Great Lakes region. Through workshops, development of model plans, and site visits, Michigan Sea Grant Extension staff assisted 90% of the fish processors in the Great Lakes region to design and implement HACCP plans.

In a unique spin-off from the national effort, Michigan Sea Grant partnered with Minnesota Sea Grant and baitfish producers to develop HACCP-like plans for the baitfish segment of the aquaculture industry to prevent the introduction and spread of exotic species. Michigan Sea Grant Extension agents worked side by side with bait producers and dealers gaining first-hand knowledge of the industry. They coupled this understanding with Sea Grant research on aquatic nuisance species to develop HACCP-like protocols with industry partners. The model safety protocols are being used to train bait producers and dealers to minimize the risk of inadvertently spreading exotic species, such as zebra mussels, ruffe and gobies, through their transportation and distribution operations.

Great Lakes Resources Management

Michigan is the only state to be situated entirely within the Great Lakes basin. Because of this unique geography, the health of the Great Lakes ecosystem dominates environmental concerns. Critical environmental issues include resource planning, water quality, the unintentional introduction of aquatic nuisance species, and fishery management. Sustainably managing the multiple uses of Great Lakes resources requires an interdisciplinary, integrated approach of research, assistance, and education.

Michigan Sea Grant is a leader in bringing timely, relevant information to bear on Great Lakes resource challenges, providing leadership in lake basin, interstate, and international Great Lakes management organizations, as well as research and outreach on significant Great Lakes issues. Michigan Sea Grant's programs have improved water quality and habitat.

Water Quality Improves through Innovative Citizen Monitoring Programs and Watershed Initiatives

Three citizen monitoring programs developed by Michigan Sea Grant created a strong network of volunteers that have taken direct stewardship of both Great Lakes and inland lake ecosystems. These programs include, Superior Lakewatch; three inland Lakewatch programs in southeastern Michigan, and a statewide Zebra Mussel Watch program that monitors for zebra mussel veligers in inland lakes. A steadily increasing number of volunteers took secchi disk readings for water clarity and measured the surface water temperature of the lakes or collected samples for detecting zebra mussel veligers. Property owners are responding to enhanced water quality awareness by requesting information on minimizing the use of lawn fertilizers and applying beneficial landscape techniques to shoreline property. The zebra mussel monitoring program instructional manual, video and monitoring kit won a "Teddy" award from the Michigan Outdoor Writers Association.

Grand Traverse Bay in northern Lake Michigan is a unique ecosystem that draws many residents and visitors to the region each year. To help coordinate water quality efforts in this watershed, which spans five county boundaries, Michigan Sea Grant helped create the Grand Traverse Bay Watershed Initiative (GTBWI). Early efforts were led by a Michigan Sea Grant Extension Agent to instill a coordinated ecosystem approach to resource and land-use management in the watershed. The GTBWI is now an independent organization. However, Michigan Sea Grant continues to provide funding, administrative and communications support. In 1997 and 1998 Michigan Sea Grant secured funding for water quality testing and assisted in the production of the first *State of the Bay* report.

Diving Safety Program Tackles New Diving Techniques

Michigan Sea Grant has been a national leader in diving safety since 1969. Diving safety protocols developed by Michigan Sea Grant's diving expert have been used to train thousands of divers in Michigan and nationwide. In the last few years, new mixed-gas technologies have allowed divers to reach very deep waters, which poses increased safety challenges. These advanced diving techniques are beginning to become popular among recreational divers. However, most diving standards and manuals do not address the new technology nor the increased safety challenges. Michigan Sea Grant's diving specialist applied relevant research to update standards and develop educational materials. He presented workshops to address technical, mixed-gas diving safety issues for recreational divers. These standards and training materials were adapted for use by the U.S. Navy's Experimental Diving Unit, the U.S. Secret Service in Washington, and university research diving units. Also, as chairperson for the Michigan OSHA Diving Standards Advisory Committee, Michigan Sea Grant's diving safety expert led national efforts to combine three diving standards (health, construction, and general industry) into a single more workable, readable and applicable standard.

Aquatic Nuisance Species Education Programs Improve Control Technologies and Prevent the Spread of Exotic Species

Michigan Sea Grant spearheaded the first outreach effort on exotic species in Michigan with a conference on zebra mussels that brought together water users and researchers. Michigan Sea Grant has continued educating water users on control methods every year. In 1997 Michigan Sea Grant also sponsored the first International Conference on the Biology and Control of Ruffe. In the last biennium, these conferences have educated more than 200 water users, resource managers, and researchers about the latest in control and prevention technology and research.

An informed public has played an increasingly vital role in control of aquatic nuisance species. Sightings by a knowledgeable public help scientists track the spread of nonnative species—a process that may shed light on methods of introduction and effective methods of control. As evidence of the importance of this work, young anglers on two separate occasions last summer correctly identified round gobies (from public information pieces) and took specimens to their nearest Department of Natural Resources (DNR) offices for confirmation. Michigan Sea Grant's Great Lakes Exotic Species Graphics Library has played a significant role in educating the public by providing photographs, illustrations, and fact sheets for use in publications, news coverage, and educational programs. Supplying graphics to the news media, alone, has resulted in reaching over 4 million people per year. Also, more than 11,000 fact sheets per year have been distributed to teachers, the media, resource managers and residents.

Biological Control of Purple Loosestrife: Education with an Impact

Purple loosestrife was once planted as an ornamental plant. This beautiful, yet aggressive wetland plant is now present in almost every major watershed in Michigan and is crowding out native wetland plants that wildlife depend on for food and shelter. Michigan Sea Grant partnered with entomologists at Michigan State University and state agencies to develop an innovative program to control the spread of purple loosestrife. Classroom teachers and resource managers were teamed and trained to rear and place *Galerucella* beetles, which feed exclusively on purple loosestrife, in infested wetlands and to monitor the impacts. Students gain first-hand knowledge of biological control concepts, and resource managers gain rearing and monitoring assistance.

The program began in 1996 with 6 pilot teachers and resource managers. From the pilot project, Michigan Sea Grant produced classroom materials and field manuals, which are used to train new teachers and resource managers. To date, more than 20 beetle rearing sites have been established around the state to supply teachers and resource managers participating in the program. To date, nearly 100 teachers and 25 nature centers and other organizations have been trained, resulting in 110 active field projects. In the first two years of this project, significant reduction in purple loosestrife has been recorded in several project plots. This project has received the 1998 Environmental Stewardship Award from Meridian Township, Michigan and the 1999 Entomology Educational Project Award from the Board Certified Entomologists of Mid-America.

Great Lakes Education

Citizens of the "Great Lakes State" are stewards of a national treasure—the Great Lakes. Actions and decisions made today will determine the economic and environmental sustainability of the Great Lakes for generations to come. However, disappointingly few Michigan residents have an adequate understanding of our Great Lakes resources. The challenge is to develop a scientifically and environmentally informed citizenry, from the young child to the older citizen, and to do so in a way that includes traditionally under-represented segments of American society.

Michigan Sea Grant is an award-winning leader in the areas of student and teacher education and youth and adult leadership development. Michigan Sea Grant's educational materials for teachers, journalists, and the public-at-large have won critical acclaim and numerous awards.

Great Lakes Camp Creates Teen Leadership and Inspires Careers

Michigan Sea Grant has co-sponsored and staffed the 4-H Great Lakes and Natural Resources Camp each summer since 1983. Students learn about Great Lakes ecosystems and issues. Through intensive hands-on experiences participants learn about Great Lakes fishing, physical shoreline processes, watershed ecology, exotic species, and Great Lakes shipping and mineral resources. In 1997 and 1998 over 100 students attended the Great Lakes Natural Resources Camp.

Another focus of the Great Lakes Camp is preparing participants to take environmental stewardship and leadership roles. Camp counselors are all previous campers who impart their knowledge and enthusiasm to their junior peers. Research sponsored by Michigan Sea Grant found that the Great Lakes Camp experience has significantly increased student interest in natural sciences course work and more than half of the participants were considering a career in natural resources ecology and management.

Vessel-based Education Brings Thousands of City Students to the Shore

The Great Lakes Education Program (GLEP), a ship-based program, provides hands-on learning about the land, water, life and people of the Clinton River, Lake St. Clair, and the Great Lakes. The program introduces students, teachers and volunteers to freshwater concepts and provides an opportunity to experience the Great Lakes firsthand. Following classroom learning, students participate in hands-on shipboard activities on the Clinton River and Lake St. Clair in southeast Michigan. Together the educational activities serve as an introduction to the Great Lakes and are part of an approved science curriculum for fourth-graders. Since it began, GLEP has become one of Michigan Sea Grant's most popular educational programs, growing from 151 participants in 1991 to nearly 5,000 in 1999.

Sea Grant-sponsored research has conclusively shown that students significantly increase their knowledge of Great Lakes resources as a result of their participation in GLEP. This knowledge will help young people and their parents foster positive attitudes, behaviors and aspirations related to the Great Lakes and help them understand their responsibility in maintaining a healthy freshwater ecosystem. Based on the documented success of the GLEP program, Michigan Sea Grant was able to create community and foundation support to expand the program in 1999 to include cruises on the Detroit River. This urban program conducted eight programs that included 200 students, 10 teachers and 32 parents.

Award-Winning Publications and Effective Media Campaigns Keep Michigan Citizens Abreast of Great Lakes Issues.

Michigan Sea Grant has developed a highly targeted information dissemination strategy to keep citizens up-to-date on Great Lakes issues. Efforts include a quarterly newsletter, media outreach, web site, educational materials for use in outreach programs, and publication of general interest books about Great Lakes topics. MSG Communications distributed 34,200 publications, to teachers, resource managers,

Great Lakes region visitors and residents. This dissemination represents a 70% increase over past years, due to stronger marketing and targeting activities. Also, media outreach on Great Lakes topics, including press releases and responding to reporters' requests for information, resulted in more than 163 newspaper articles with an approximate annual circulation of 5,657,850.

Michigan Sea Grant's quarterly newsletter, *upwellings*, was evaluated in 1997 using a reader survey. Reader response was overwhelmingly positive, with a majority of comments indicating that *upwellings* filled a niche that was not met by the many other Great Lakes related newsletters—providing accurate up-to-date information on Great Lakes issues and research. Based on reader feedback the newsletter was redesigned for an updated look, ease of reading and ease of copying (many teachers indicated they use the articles as handouts to students). The content was also refined to focus on research results and to include articles about MSG outreach projects as well as continuing general articles about Great Lakes issues. More than 2,000 educators, resource managers, government officials, journalists, researchers and coastal residents receive this publication. Survey results indicated that 58% share the publication with others, resulting in an estimated total circulation of 5,780.

The Michigan Sea Grant web site was evaluated and reorganized to better meet users information needs. The original website was organized by departmental division, which made finding information difficult for external clients. Now the information is organized by topic. Also, services were updated to include an on-line publications catalog, on-line ordering, a search function, and a question/feedback form. This work has increased the reach of the website by 170%.

Selected Accomplishments and Benefits
Research

Research and Fellowship Programs Train Tomorrow's Scientists

Student participation in Michigan Sea Grant sponsored research and fellowship programs help prepare students for careers in marine and coastal related fields. In 1997-98, 32 undergraduate and graduate students participated in Great Lakes research. Eleven of the students supported completed masters or doctorate degrees using their participation in Michigan Sea Grant research as the basis of their theses and dissertations.

Michigan Sea Grant also sponsored two students for participation in the National Sea Grant Fellows program. One student completed a one year appointment with the Environmental Protection Agency's National Estuary Program. The other worked in the legislative branch, serving as staff to the House Resource Committee and is now working for the U.S. Fish and Wildlife Service in Arlington, Virginia as a fisheries biologist. Michigan Sea Grant also sponsored a Coastal Management Fellow through NOAA's Coastal Service Center. This fellow is serving her fellowship with the Michigan Department of Environmental Quality.

Researchers Link Contaminant Movement with Seiche Activity

As part of a multi-faceted study, funded in part by Michigan Sea Grant, researchers monitored seiche activity in Lake Michigan and linked that to increases in contaminant levels of the western arm of Grand Traverse Bay. This is the first time seiche activity has been shown to re-suspend fine-grained sediments, which tend to be rich in organic contaminants, in depths as deep as 110 meters (360 feet). This finding will help researchers continue to trace the sources and transport mechanisms of three contaminants, polychlorinated biphenyls or PCBs, the banned pesticide toxaphene, and polycyclic aromatic hydrocarbons, a product of combustion.

These research findings are part of a larger study to determine mechanisms of contaminant transportation in the Great Lakes ecosystem. This multidisciplinary research links the biological, chemical and physical sciences to enable Michigan Sea Grant to study the health of an entire ecosystem. Scientists are studying atmospheric deposition, transportation and sedimentation, and re-suspension of contaminants, and how these mechanisms affect bioaccumulation in the food chain. Ultimately this study will provide data that may be used to set policy on pesticide use and to help resource managers predict impacts of atmospheric pollution on sport fish.

River Revival: Fish Respond to Return of Natural Waterflow on Lake Michigan Tributaries

For 80 years, water flow in the western Michigan's Manistee River fluctuated dramatically each day—ranging from 10 year flood levels to drought conditions. The variations were caused by hydropower dam operations. In 1989 this peak flow regime was abandoned in favor of run-of-river flow management. Research sponsored by Michigan Sea Grant and other fundors has documented that survival of young Chinook salmon in the Manistee River has increased dramatically in response to the more stable water flow. This research has documented that natural reproduction of these important sport fish has gone from virtually nothing to approximately 700,000 smolts annually. Researchers estimate that the greater numbers of Chinook and Steelhead salmon surviving in the Manistee River represent an 8.6 and 8.4 percent increase, respectively, in potential harvest available to recreational anglers, as compared to the harvest during peak flow regimes in the late 1980s.

Next steps in the research include determining economic benefits of these ecological changes. This economic analysis is crucial as it is used as a basis for requiring operational changes of dams in the licensing process. The economic model developed in this Michigan Sea Grant-sponsored research will balance the economic benefits of improved habitat against the loss of hydropower revenues due to run-of-river flow regimes.

Relationship Between Great Lakes Water Levels, Wave Energies, and Shoreline Damage

Over the past two decades, the Great Lakes have experienced rising water levels, with record levels in 1974 and 1986. These record high water levels have been associated with reports of elevated shoreline damage, causing millions of dollars in damage to shoreline properties. Michigan Sea Grant funded research to evaluate over 30 years of wave climate and lake level data to determine if significant correlations exist. This analysis found that there is a strong link between increasing lake levels and more intense wind-generated waves. Researchers concluded that shoreline damage is more closely related to periods of high wave energy than to periods of peak water levels. Further, these researchers found a strong correlation with global climate patterns. The Great Lakes have a marked effect on passing cyclone systems, altering wind patterns and affecting wave patterns, which in turn play an active role in air/sea interactions, resulting in wind expending its energies over the lake and in the near-shore zone.

This research is providing a tool for coastal zone management. These research findings are currently being used by the Oceans Engineering Laboratory to predict the effects of harbor structures on near-shore erosion and morphology in the Great Lakes and have influenced federal policy on large navigational structure erosion mitigation practices. The U.S. Army Corp of Engineers and the Michigan Department of Environmental Quality are also using these research results to evaluate changes in shoreline protection policy based on the evolving wave climate of the lake.

Michigan Sea Grant College Program
Funding Sources
March 1997 - February 1999

Funding Source	Amount
NOAA, National Sea Grant College Program Omnibus	$2,463,989
NOAA, National Sea Grant College Program NIS	$476,272
NOAA, National Sea Grant Knauss Fellowship	$72,000
NOAA, Coastal Ocean Fellowship	$64,000
University of Michigan	$852,721
Michigan State University	$980,823
Environmental Protection Agency	$5,000
Scripps Howard Foundation	$5,000
University of Maryland	$38,403
Michigan Technological University	$16,446

Michigan Sea Grant College Program
Institutions Involved
March 1997 - February 1999

University of Michigan
Michigan State University
University of Maryland
Wayne State University
Michigan Technological University
University of Florida
Loyola University

Michigan Sea Grant Projects
March 1997 - February 1999

Research

Development of a Transferable, Multidisciplinary, Vessel-Based, Experiential Education Model
Ecological and Economic Impacts of Watershed Restoration on Salmonid Productivity in Lake Michigan Tributaries
The Effects of Food Web Structure and Dynamics on Toxaphene Bioaccumulation
Management Strategies for Great Lakes Recreational Salmonid Fisheries in the Face of Environmental Variability
Physical and Biological Processes Influencing Recruitment of Walleye
Recruitment Failure of Yellow Perch in SE Lake Michigan: Evaluation of the Starvation and Predation Hypotheses
The Relationship Between Great Lakes Water Levels, Wave Energies, and Shoreline Damage
Risk Analysis of Commercial Fishing Vessels Operating in Extreme Seas
Understanding and Managing Variation in the Lake Michigan Salmonine Fishery

Outreach

Exotic Species Day Camp: A Regional Teacher Training Initiative: Extending Sea Grant Education on Nonindigenous Species
Exploring Science Writing: A Handbook for High School Teachers
Model HACCP-Like Plan to Restrict the Spread of Nonindigenous Species
MarinaNet
Michigan Sea Grant Communications
Michigan Sea Grant Extension
National Sea Grant Exotic Species Graphics Library
Reporting on Risk: A Handbook for Journalists, third edition
Transferring Sea Grant Zebra Mussel Research and Outreach Results to the Nation Using a World Wide Web Server and Compact Disks
Zebra Mussel and Nonindigenous Species Outreach
Zebra Mussel Workshops for Inland Lake Users: Prevention and Protection through Education

Program Development

Biological Control of Purple Loosestrife
Chemical Signals Regulating Spawning in Zebra Mussels
Dimethylsulfide in Giant Clams and its Manipulation for Food-Value Enhancement
Feasibility Study for Stimulating and Reducing the Noise Generated in a Fishing Boat/Ship
Great Lakes Sea Grant Network CoastWatch World Wide Web Site
Molecular Genetic Characterization of Spatial, Temporal, and Phylogenetic Structure of Contemporary and Historical Populations of Lake Trout in the Great Lakes
Recruitment Failure of Yellow Perch in SE Lake Michigan: Evaluation of the Starvation and Predation Hypotheses
Sea Grant Great Lakes Network Land Use Committee

Fellowships

Anne Gore, Knauss Fellowship 1997-1998
Michael Oetker, Knauss Fellowship 1998-1999
Lynn Dancy, Coastal Fellowship, 1997-1999

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March 1997 - February 1999

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March 1997 - February 1999

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Kowalchyk, Wade. M.S. 1997. Michigan Technological University.

Krause, Ann. MS 1998. *Sampling variability for ten fish species and population dynamics for alewife* (Alosa psuedoharengus) *and bloater* (Coregonus hoyi) *in Lake Michigan.* Department of Fisheries and Wildlife, Michigan State University.

Maclin, Elizabeth B. M.S. 1998, (master's project, not thesis). *Dammed Rivers?: An Evaluation of the Federal Energy Regulatory Commission's Hydropower Relicensing Decisions,* School of Natural Resources and Environment, University of Michigan.

McGervey, Eileen. M.Sc. 1998. *Seasonal cycling of seston and its relationship to PCB concentrations in Grand Traverse Bay.* Department of Geological Sciences, Michigan State University.

Nevala, Amy. M.S. 1997. *An evaluation of educator's participation in the Great Lakes Education Program.* Fisheries and Wildlife, Michigan State University.

Peters, Jennifer. B.S.E. 1997. Electrical Engineering, College of Engineering, University of Michigan.

Schwartz, John. Ph.D. 1998. *An Experiment to Assess the various aspects of catching fish on youth's satisfaction with the fishing experience.* Department of Kinesiology, University of Maryland at College Park.

Scubinna, John. Ph.D. 1998. *The influence of seasonal changes in diet on the condition of deepwater sculpin, bloater and alewife in Grand Traverse Bay, Lake Michigan.* Department of Fisheries and Wildlife, Michigan State University.

Woldt, Aaron. M.S. 1998. *Production of juvenile steelhead in two Lake Michigan tributaries.* School of Natural Resources and Environment, University of Michigan.

Students Supported by Michigan Sea Grant Research
March 1997 - February 1999

Graduate Students

Benjamin, Darren. Department of Fisheries and Wildlife, Michigan State University.
Clark, Christopher F. School of Natural Resources and Environment, University of Michigan.
Cohen, Abby. Chesapeake Biological Laboratory, University of Maryland.
Godby, Neil. School of Natural Resources and Environment, University of Michigan.
Holland, Stephen. Department of Economics, University of Michigan.
Kolchen, Matthew. School of Natural Resources and Environment, University of Michigan.
Kentala, Kyle. Marine and Naval Architecture, University of Michigan.
Krause, Ann. Department of Fisheries and Wildlife, Michigan State University.
Maclin, Elizabeth. Department of Geological Sciences, Michigan State University.
Marcrellis, Amy. Department of Geological Sciences, Michigan State University.
Masterson, Colleen. Department of Geological Sciences, Michigan State University.
McGervey, Eileen. Department of Geological Sciences, Michigan State University.
Meadows, Lorelle. Marine and Naval Architecture, University of Michigan.
Niedermeier, Michelle. Department of Fisheries and Wildlife, Michigan State University.
Nevala, Amy. Department of Fisheries and Wildlife, Michigan State University.
Roseman, Edward. Department of Fisheries and Wildlife, Michigan State University.
Rutter, Michael. Department of Fisheries and Wildlife, Michigan State University.
Scubinna, John. Department of Fisheries and Wildlife, Michigan State University.
Stapleton, Heather. Chesapeake Biological Laboratory, University of Maryland.
Ward, Camille. Department of Fisheries and Wildlife, Michigan State University.
Weeks, Chris. Department of Fisheries and Wildlife, Michigan State University.
Woldt, Aaron. School of Natural Resources and Environment, University of Michigan.

Undergraduate

Chai, Ming-chieh. Department of Fisheries and Wildlife, Michigan State University.
Haggerty, Michelle. Department of Fisheries and Wildlife, Michigan State University.
Kotulak, Jay T. Department of Fisheries and Wildlife, Michigan State University.
Peters, Jennifer. Electrical Engineering, University of Michigan.
Walters, Kevin. Department of Fisheries and Wildlife, Michigan State University.

Students not financially supported who have provided assistance in the field

Damstra, Kathleen. Department of Fisheries and Wildlife, Michigan State University.
Brunger, Tamara. Department of Fisheries and Wildlife, Michigan State University.
Frankenberger, Tina. Department of Fisheries and Wildlife, Michigan State University.
Mahan, Meeghan. Department of Fisheries and Wildlife, Michigan State University.
Morgan, Thomas. Department of Fisheries and Wildlife, Michigan State University.

Presentations Given by Michigan Sea Grant Staff
March 1997- February 1999

Date	Audience	# Attendees	Topics
1/97	Iosco County Audubon Club	43	Ruffe and Goby
1/97	MI Zebra Mussel Conference	75	Zebra mussels
1/97	Greening of Detroit Commissioners	50	Coastal development
1/97	Grand Rapids Schools	180	Purple loosestrife
2/97	Great Lakes Fishery managers	200	CoastWatch
2/97	Charterboat Captains	200	Sea Grant programs
2/97	Sterling Elementary School	314	Exotic species
3/97	St. Clair Shores Waterfront Day	100	MSG display
3/97	MI Aquaculture Assoc.	30	HACCP workshop
3/97	Delta County Sportspersons	50	Aquatic nuisance species
3/97	Grand Traverse Bay Watershed Init.	930	Water Watch program
3/97	Charterboat Captains Workshop	53	CoastWatch, fisheries
3/97	Michigan Boating Industry Assoc.	20	Sea Grant programs
3/97	Lake Michigan Steelheaders	35	Fisheries issues
5/97	Grand Traverse Bay Watershed Init.	600	Sea Lamprey
5/97	Magoon Creek Youth Day	150	Coastal ecology
5/97	Hale Area Schools Career Day	75	Marine biology careers
6/97	Sport Anglers	40	CoastWatch
6/97	Detroit Recreation Directors	40	Detroit River issues
6/97	Northwest MI Charterboat Captains	40	CoastWatch
7/97	GL Nat. Resources Youth Camp	55	Lake level changes
8/97	Great Lake Managers	50	Coastal hazard mitigation
9/97	Detroit River Greenways Partnership	40	American Heritage Rivers
9/97	Tall Ship visitors, Grand Traverse Bay	30	Maritime Heritage and management
9/97	Water resource managers	120	Pond management
10/97	MI Tourism Association	43	Michigan Sea Grant Extension Programs
11/97	NALMS Annual Conference	29	Monitoring habitat
12/97	Municipal Water Users	80	Zebra mussel cleanup
12/97	Michigan Charterboat Association	80	CoastWatch
12/97	Lake Erie Charter Boat Association	60	Detroit River ecosystem
1/98	The Thumb Steelheaders	35	Amer. Heritage Rivers, CoastWatch
1/98	UP Sierra Club	50	Ruffe
1/98	MI Aquaculture Assoc.	30	Large bait minnow
1/98	Lake Superior Tech. Committee	30	Lake Superior surface water temp.
1/98	Fish Producers	37	HACCP
1/98	Lake Michigan Charterboat Captains	200	Fish handling
1/98	Great Lakes Sportfishing Council	45	CoastWatch, Internet
1/98	SW Michigan Steelheaders	45	Recreational fisheries, Sea Lamprey
1/98	L. Erie/L. St. Clair Fishery Adv. Comm.	30	American Heritage Rivers Program
1/98	MI Science Teachers Association	60	Zebra Mussel, Purple loosestrife
1/98	Teacher training	100	Biological control of purple loosestrife
2/98	MSU Ag & Nat. Resources Conf.	60	Purple Loosestrife
2/98	Downriver Walleye Federation	80	Amer. Heritage Rivers, fishery potential
2/98	Michigan Harbormasters	70	CoastWatch, MarinaNet

Date	Audience	# Attendees	Topics
2/98	Upper Great Lakes Captains Assoc.	100	Sea Grant
2/98	Coastal residents	21	Groundwater stewardship
3/98	MSU Ag & Nat. Resources Conf.	100	Purple loosestrife
3/98	MSU Ag & Nat. Resources Conf.	40	Detroit River ecosystem
3/98	Lake Erie Charterboat Association	200	Recreational fisheries
3/98	International Zebra Mussel Conf.	60	Citizen monitoring
3/98	Detroit River Habitat Conference	100	Aquatic nuisance species
3/98	Traverse City High School	33	Marine Biology; Water Ones
4/98	Manistique Lakeside School	40	Aquatic nuisance species
4/98	ACE High School	35	Fish anatomy and physiology
4/98	Math and Sci. teachers, northern MI	14	Aquatic nuisance species
4/98	4-H Youth and Leaders	25	Aquatic nuisance species
4/98	Water Watch Student Congress	600	Field monitoring, Exotic species
4/98	Upper Peninsula Boat Show	200	Exotics Display
4/98	Charterboat operators	30	WWW/CoastWatch
4/98	Pine Lake Property Owners	50	Zebra Mussel ecology inland lakes
4/98	St. Clair Shores Waterfront Adv. Cmt.	40	Protecting Lake St. Clair
4/98	MI Charter Boat Association	30	World Wide Web information
4/98	MI Lake & Stream Assoc.	70	Aquatic nuisance species
4/98	MI Watershed Environmental Assoc.	35	Nonpoint pollution (NEMO)
4/98	MI Steelheaders Association	45	Underwater preserves, stocking
4/98	MI Steelheaders Holland Chapter	60	Current fisheries issues
4/98	The Thumb Steelheaders	55	Lake Huron storm dynamics
4/98	MI Coalition of Nature Centers	30	Purple loosestrife
5/98	MSU faculty	40	Detroit River watershed
5/98	Int'l Assoc. of Great Lakes Research	20	Research on Grand Traverse Bay
5/98	MI Waterworks Conference	60	Zebra mussel effects: water odor & flavor
5/98	Fish Producers	50	HACCP
5/98	Grand Traverse Bay Watershed Init.	500	Sea Lamprey
5/98	Ludington Charterboat Captains	25	CoastWatch
5/98	GLEP pilot on Detroit River	200	Water quality field monitoring
5/98	Magoon Creek Youth Day	300	Coastal ecology, Aquatic nuisance species
5/98	MSU Students	25	Purple loosestrife
6/98	Detroit area Teachers	24	Aquatic nuisance species
6/98	Pres. Council on Sustainability	100	Detroit River rehabilitation
6/98	Upper Peninsula Waterfest	60	Underwater preserves, nuisance species
6/98	Bay Day, Traverse City	300	Coastal processes
6/98	Fins and Feathers Exhibit	1,000	Exotics Display
6/98	MI Steelheaders, Holland Chapter	80	Great Lake fisheries status
7/98	UM Alumni Assoc.	100	MSG, Great Lakes facts
7/98	Council of GL Mayors Conference	85	American Heritage Rivers program
7/98	MSU graduate students	20	Purple loosestrife
7/98	4-H Youth	200	Aquatic nuisance species
7/98	Great Lakes Youth Camp	55	Fisheries, coastal processes, GL educ
9/98	SE MI residents	200	Inland lakes
9/98	NOAA/State resource managers	200	Sustainable coastal communities

Date	Audience	# Attendees	Topics
9/98	Fisheries Managers	30	Fisheries management
9/98	USFWS staff	14	Sea Grant programs
9/98	Sankore Marine Academy	8	Sea Grant programs
9/98	Delta Co. Ag. Day students	450	Zebra mussel
9/98	Lake MI Fish Stocking Conf.	200	Fish stocking rates
9/98	MI Env. and Outdoor Educ. Conf.	20	Purple loosestrife
10/98	Detroit Science Teachers Conf.	50	Aquatic nuisance species
10/98	MI UP teachers	25	Aquatic nuisance species
10/98	Nemesis of GL Teachers Seminar	10	Culturing zebra mussels for classroom use
10/98	Fall GLEP program	3,600	Great Lakes facts, water quality
10/98	UM Alumni	200	Aquatic nuisance species, MSG, GL facts
10/98	MI Charterboat Assoc.	30	Business management
10/98	Trout Unlimited, MI	25	Status of GL fisheries
10/98	Ruffe Control Committee	30	Developing HACCP-like plans for ANS
10/98	National Natural Areas Conference	120	Purple loosestrife
10/98	Washington State Legislative Panel	25	Citizen monitoring of zebra mussel
11/98	Pesticide Applicators	45	Fate of contaminants in the Great Lakes
11/98	Friends of the Detroit River	60	Amer. Heritage River/Detroit R.
11/98	Detroit River Remedial Action Plan	20	American Heritage River program
11/98	Detroit Teachers at Detroit Zoo Days	25	Purple loosestrife
12/98	Pesticide Applicators	15	Fate of contaminants in Great Lakes
12/98	MI Boating Industry Association	20	CoastWatch, marinas
12/98	Recreational Anglers	15	Fisheries, water levels
12.98	Trout Unlimited	25	Great Lakes fisheries
12/98	Water Resource Managers	80	Great Lakes ecosystem
12/98	Midwest Fish and Wildlife Conf.	100	Lake Superior temp./Herring survival
12/98	Harbor Masters Workshop	70	Coastal issues
12/98	Homeowners Associations	40	Management of coastal erosion
12/98	Lakefront Property Owners	30	Zebra mussel monitoring
1/99	Aquatic Nuisance Species Panel	30	Progress on HACCP for baitfish
1/99	Michigan Fish Producers Ass.	75	HACCP models
1/99	Lake Superior Technical Committee	30	Year-Class strength of *coregonids*
1/99	Elementary School students	65	Aquatic nuisance species
2/99	N. Central Region Aquaculture Conf.	150	Seafood and food safety
2/99	Charterboat Captains	150	Great Lakes issues
2/99	MI Fish Producers Annual Meeting	50	CoastWatch & other web sites
2/99	Traverse Bay Shoreline Planners	26	Water quality monitoring, land use
2/99	North Central Aquaculture Conf.	150	Seafood safety issues
TOTAL PARTICIPANTS:		**16,449**	

Awards Received by Michigan Sea Grant Staff & Programs
March 1997- February 1999

Award	Organization	Project
Environmental Steward	Meridian Township, MI	Purple Loosestrife Project
Educational Project Award	Board Certified Entomologists	Purple Loosestrife Project
Outstanding Program	GL Sea Grant Network	CoastWatch website
John Hannah Award	MSU Extension	CoastWatch website
President's Award	Sea Grant Association	Leadership Role

Leadership Positions held by Michigan Sea Grant Staff
March 1997- February 1999

Staff	Organization
Breederland	Detroit River Coastal Development Council Member
Breederland	Greenways Partnership Member
Breederland	Detroit Waterfront Quality Advisory Committee
Breederland	American Heritage River Executive Committee Chair
Breederland	President's Council on Sustainable Development National Summit, planning Comm.
Breederland	Great Lakes Sea Grant Network Conference Planning Committee
Britt	Sea Grant Network Web Committee
Hoagman	Tuttle Marsh Interpretive Development Advisory Board
Hoagman	Thunder Bay Island Lighthouse Preservation Society
Hoagman	Saginaw Bay Community Foundation
Kinnunen	North Central Regional Aquaculture Center Board
Kinnunen	Great Lakes Fish Health Committee
Kinnunen	Vice Chair, Watershed Initiative Board, Upper Peninsula
Kinnunen	Upper Peninsula Waterfest Planning Committee
Kinnunen	Great Lakes Sea Grant Network Land Use Committee
Kinnunen	North Central Regional Aquaculture Center Walleye Work Group
Kinnunen	Mich. Dept. Natural Resources Lake Superior Fish Advisory Committee
Kinnunen	Mich. State University Extension UP Awards Team
Kinnunen	Michigan Dept. of Agriculture Advisory Committee
Klepinger	MI Alliance for Environ. and Outdoor Education Conf. Chair
Klepinger	Blue Ribbon Panel of Great Lakes Economists
Klepinger	1997 Ruffe Symposium Co-Chair
Klepinger	4-H NREE Advisory Committee
Klepinger	Great Lakes Sea Grant Land Use Committee Co-Chair
Klepinger	President of Michigan Alliance for Environmental and Outdoor Education
Klepinger	8th International Aquatic Nuisance Species Conference Technical Committee
McKinney	Environmental Education Association for Northwestern Michigan, founder
McKinney	Nat'l Association of County Ag. Agents, Aquaculture Committee Chair
McKinney	Grand Traverse Bay Watershed Board Chair
McKinney	Selection Team for MSU Awards

McKinney	MI Harbor Masters, Workshop Planning Committee
McKinney	Cedar Camp Historian
McKinney	Grand Traverse Bay Watershed Initiative Board Vice Chair
McKinney	Boardman River Cleanup Planning Committee
McKinney	Michigan State University Extension Core Competency Team
McKinney	Community Youth Program Chair
McKinney	Maritime Heritage Alliance Board
McKinney	Great Lakes Sea Grant Network Land Use Committee Chair
Moll	Sea Grant Association President
Moll	Council of Great Lakes Research Managers
Moll	Technical Advisory Team, MI Great Lakes Protection Fund
Moll	Executive Board, American Society for Limnology and Oceanography
Moll	Board of Directors, Pond Dynamics Aquaculture Research Consortium
Moll	Advisory Working Committee, Oceanographic Data Center, NOAA
Moll	University of Michigan Rep, Consortium for Oceanographic Research & Education
Pistis	Lake Michigan Citizens Fishery Advisory Task Force
Pistis	Lamprey Funding Task Force
Pistis	Lake Erie Fishery Task Force
Pistis	Harbor Island Task Force
Pistis	MI Department of Natural Resources Boating Programs Strategic Planning Committee
Pistis	Sea Grant Network MarinaNet Steering Committee
Somers	MIOSHA Advisory Committee on Commercial Diving Standards, Chair
Schwartz	National Sea Grant Extension Leaders Association, Chair-Elect
Swinehart	National Sea Grant Communications Committee, Great Lakes Representative
Taylor	President, American Fisheries Society

Michigan Sea Grant Publications List
March 1997 - February 1999

General Public

Travel and Nature Guides

Discovering Great Lakes Dunes. 30 pp. MSG-98-502

Fall Beachcombing. 19 pp. MSG-91-702

A Field Guide to Great Lakes Coastal Plants. 136 pp. MSG-94-500

A Field Guide to Great Lakes Coastal Wetlands. 165 pp. MSG-98-506

Lake Superior Recreation and Weather. 94 pp. MSG-94-705

Coastal Environments

Bluff Slumping and Stability: A Consumer's Guide. 66 pp. MSG-82-902

A Profile of Lake St. Clair. 13 pp. MSG-93-700

A Profile of St. Marys River. 20 pp. MSG-91-701

Michigan Wetlands: Landowner's Guide. pp. MSG-99-406

Reporting on Risk: A Journalist's Handbook on Environmental Risk Assessment. 114 pp. MSG-95-600

Upwellings quarterly newsletter. 8 pp. MSG-99-800

Vegetation and its Role in Reducing Great Lakes Shoreline Erosion. 36 pp. MSG-88-700

Boating and Fishing

CoastWatch: An Introduction Video

Commercial Fisheries Newsline, Quarterly Newsletter. 16 pp.

Eating Great Lakes Fish. 8 pp. MSG-94-502

Freshwater Fish Preservation. 16 pp. MSG-94-501

Get A Grip on Ocean Motion. MSG-94-900

Lightning and Boats. 4 pp. MSG-89-700

Protecting Fish Habitat: A Guide for Fishermen and Boaters. 2 pp.

Slow the Spread of Zebra Mussels and Protect Your Boat Too. 4 pp. MSG-94-713

Exotic Species

Biological Control of Purple Loosestrife: Cooperator's Handbook. (six book set) MSG-99-400
- *Cooperator Essentials.* 30 pp. MSG-99-401
- *Rearing & Releasing Natural Enemies.* 18 pp. MSG-99-402
- *Secondary School Activities.* 30 pp. MSG-99-403
- *Upper Elementary: Teacher's Guide.* 107 pp. MSG-99-404
- *Upper Elementary: Student Workbook.* 92 pp. MSG-99-405
- *Michigan Wetlands: Landowner's Guide.* 150 pp. MSG-99-406

Exotics ID Cards: Round Goby, Ruffe, and Zebra Mussels. MSG-98-500, 501, 505

A Field Guide to Aquatic Exotic Plants and Animals. Great Lakes Sea Grant Network. 4 pp. MSG-98-504

Five Lampreys of Michigan. 4 pp. MSG-97-500

Gobies: of the '90s. 4 pp. MSG-96-702

Potential Control of Zebra Mussels Through Reproductive Intervention. 2 pp. MSG-94-703

Purple Loosestrife. 6 pp. MSG-97-501

Ruffe: A New Threat to Fisheries. 2 pp. MSG-96-501

Round Gobies Invade North America. 2 pp. MSG-95-500

The Spiny Water Flea Bythotrephes Cederstroemi: Another Unwelcome Newcomer to the Great Lakes. 2 pp. MSG-97-504

Zebra Mussels May Clog Irrigation Systems. 2 pp. MSG-93-701

Zebra Mussel Distribution Map (Michigan Only). 1 p. MSG-97-505

Zebra Mussels in the Great Lakes. 2 pp. MSG-92-700

Zebra Mussels in North America: The Invasion and its Implications. 2 pp. MSG-97-503

Classroom Materials

Great Lakes Education Program Curriculum Guide

Exploring Science Writing: An Environmental Focus. 74 pp. MSG-98-401

The Life of the Lakes: The Great Lakes Fishery. 64 pp. MSG-93-401

Marine Science Careers. 40 pp. MSG-MSCAREER

Safe Use of Zebra Mussels in Classroom and Laboratories. 2 pp. MSG-93-703

Technical Reports and Papers

Marine Engineering

Effects of Appendages and Small Currents on the Hydrodynamic Heave Damping on TLP Columns. K.P. Thiagarajan, and A.W. Troesch. 6 pp. MICHU-98-300.

Differentiated Compliance Anchoring System and Slow Motion Dynamics. L.O. Garza-Rios. 16 pp. MICHU-97-306

Mooring System Design and Slow Motion Dynamics. M.M. Bernitsas, and L.O. Garza-Rios. 10 pp. MICHU-97-305

Spread Mooring Systems Bifurcation Boundaries. L.O. Garza-Rios, and M.M. Bernitsas. 17 pp. MICHU-97-304

Spread Mooring Systems Stability. L.O. Garza-Rios, and M.M. Bernitsas. 14 pp. MICHU-97-303

Turret Mooring Systems Slow Motion Dynamics. L.O. Garza-Rios, M.M. Bernitsas. 12 pp. MICHU-97-302

Differentiated Compliance Anchoring System Design. L.O. Garza-Rios, and M.M. Bernitsas. 9 pp. MICHU-97-301

Effect of Mooring Line Arrangement on the Dynamics of Spread Mooring Systems. M.M. Bernitsas, and L.O. Garza-Rios. 14 pp. MICHU-97-300

Modeling Issues Related to the Hydrodynamics of Three-Dimensional Steady Planing. Canhai Lai and Armin W. Troesch. 24 pp. MICHU-95-300

An Assessment of Fuzzy Logic Vessel Path Control. Michael G. Parsons, Ailan C. Chubb, and Yusong Cao. 9 pp. MICHU-95-304

Nonlinear Stability and Maneuvering Simulation of Single Point Mooring Systems. Michael M. Bernitsas, and F.A. Papoulias. 19 pp. MICHU-94-302

Invariant and Consistent Redundancy by Large Admissible Perturbations. FE. Byungsik Kang, Eleni Beyko, and Michael M. Bernitsas. 48 pp. MICHU-94-303

Hydrodynamic Heave Damping Estimation and Scaling for Tension Leg Platforms. K.P. Thiagarajan and Armin W. Troesch. 7 pp. MICHU-94-307

A Nonlinear Probabilistic Method for Predicting Vessel Capsizing in Random Beam Seas. Shang-Rou Hsieh, Armin W. Troesch, and Steven W. Shaw. 17 pp. MICHU-94-308

Reliability of Complex Structures by Large Admissible Perturbations. Eleni Beyko and Michael M. Bernitsas. 12 pp. MICHU-SG-93-307

Modern Nonlinear Dynamical Analysis of Vertical Plane Motion of Planing. Hulls Armin W. Troesch and Jeffrey M. Falzarano. 12 pp. MICHU-SG-93-308

Hydrodynamic Damping Estimation and Scaling for Tension Leg Platforms . K.P. Thiagarajan and Armin W. Troesch. 6 pp. MICHU-SG-93-309

Structural Model Correlation Using Large Admissible Perturbations in Cognate Space . Michael M. Bernitsas and Ricky L. Tawekal. 11 pp. MICHU-SG-92-301

On the Hydrodynamics of Vertically Oscillating Planing Hulls . Armin W. Troesch. 15 pp. MICHU-SG-92-309

Admissible Large Perturbations in Structural Redesign . Michael M. Bernitsas and Byungsik Kang. 10 pp. MICHU-SG-91-302

Hydrodynamic Forces Acting on Cylinders Oscillating at Small Amplitudes . Armin W. Troesch and S.K. Kim. 14 pp. MICHU-SG-91-303

Great Lakes Physical and Chemical Processes

Physical, Chemical, and Biological Conditions Associated with the Early Stages of the Lake Michigan Vernal Thermal Front . R. Moll, A. Bratkovich, W. Chang, and P. Pu. 12 pp. MICHU-SG-93-302

Effects of Ultraviolet Radiation on the Primary Production of Natural Phytoplankton Assemblages in Lake Michigan . William R. Gala and John P. Giesy. 17 pp. MICHU-SG-92-300

A Thermodynamic Partition Model for Binding of Nonpolar Organic Compound by Organic Colloids and Implications for Their Sorption to Soils and Sediments . Yu-Ping Chin, Walter J. Weber, Jr., and Cary T. Chiou. 23 pp. MICHU-SG-91-306

Estimating the Effects of Dispersed Organic Polymers on the Sorption of Contaminants by Natural Solids. 2. Sorption in the Presence of Humic and Other Natural Macromolecules Yu-Ping Chin, Walter J. Weber, Jr., and Brian J. Eadie. 6 pp. MICHU-SG-90-302

Geochemical Partitioning of Pb, Zn, Cu, Fe, and Mn Across the Sediment-Water Interface in Large Lakes. J.D. McKee, T.P. Wilson, D.T. Long, and R.M. Owen. 14 pp. MICHU-SG-89-300

Estimating the Effects of Dispersed Organic Polymers on the Sorption of Contaminants by Natural Solids. 1. A Predictive Thermodynamic Humic Substance—Organic Solute Interaction Model. Yu-Ping Chin and Walter J. Weber, Jr. 7 pp. MICHU-SG-89-310

Great Lakes Fisheries Research

1994 Survey of the Michigan Charter Fishing Industry. Chuck Pistis, Karen Lagerberg, and Amy Nevala. 4 pp. MICHU-96-500

Forage Fish Assemblage Structure in the Littoral and Nearshore Areas of St. Martin Bay, Lake Huron. R.W. Brown, M.P. Ebener, T.J. Sledge, and W.W. Taylor. 16 pp. MICHU-96-300

Effects of a Recreational Dip-Net Fishery on Rainbow Smelt Egg Deposition. R.W. Brown and W.W. Taylor. 5 pp. MICHU-95-301

Population Dynamics and Management of Lake Whitefish Stocks in Grand Traverse Bay, Lake Michigan. S.H. Walker, M.W. Prout, W.W. Taylor, and S. Winterstein. 13 pp. MICHU-SG-94-300

Factors Affecting Recruitment of Lake Whitefish in Two Areas of Northern Lake Michigan. Russell W. Brown, William W. Taylor, and Raymond A. Assel. 11 pp. MICHU-SG-93-305

Effects of Egg Composition and Prey Density on the Larval Growth and Survival of Lake Whitefish (Coregonus clupeaformis Mitchill). Russell W. Brown and William W. Taylor. 14 pp. MICHU-SG-92-304

Evidence for Natural Reproduction by Stocked Walleyes in the Saginaw River Tributary System, Michigan. David Jude. 10 pp. MICHU-SG-92-308

Relative Success of Telemetry Studies in Michigan . James S. Diana, et al. 7 pp. MICHU-SG-91-301

Effect of Egg and Larval Survival on Year-Class Strength of Lake Whitefish in Grand Traverse Bay, Lake Michigan . M.H. Freeberg, W.W. Taylor, and R.W. Brown. 9 pp. MICHU-SG-90-305

Biotic and Abiotic Determinants of Lake Whitefish (Coregonus clupeaformis) *Recruitment in Northeastern Lake Michigan.* William W. Taylor, Martin A. Smale, and Mark H. Freeberg. 11 pp. MICHU-SG-88-300

Great Lakes Fish and Human Health

Environmental Exposure and Lifestyle Predictors of Lead, Cadium, PCB, and DDT Levels in Great Lake Fish Eaters, Mary E. Hovinga. MaryFran Sowers, and Harold Humphrey. 7 pp. MICHU-SG-93-301

Size and Seasonal Variations of PCBs in Chinook Salmon (Oncorphynchus tshawytscha) *Fillets from Lake Michigan Near Ludington, Michigan, USA.* Lisa L. Williams, John P. Giesy, Jr. et al. 53 pp. MICHU-SG-89-202

Zebra Mussels and Other Exotic Species

Overview of the International Symposium on Eurasian Ruffe (Gymnocephalus cernuus) *Biology, Impacts, and Control.* Jeffrey L. Gunderson, Michael R. Klepinger, Charles R. Bronte, J. Ellen Marsden. 5 pp. MICHU-98-301

Size-Specific Fish Avoidance of the Spined Crustacean Bythotrephes*: Field Support for Laboratory Predictions.* D. Rae Barnhisel and Heather A. Harvey. 8 pp. MICHU-SG-95-303

Trends in Nutrient Concentrations in Hatchery Bay, Western Lake Erie, Before and After Dreissena polymorpha. Ruth E. Holland, Thomas H. Johengen, and Alfred M. Beeton. 8 pp. MICHU-SG-95-305

*Characterization of Zebra Mussel (*Dreissena polymorpha) *Sperm Morphology and Their Motility Prior to and After Spawning.* J.J. Mojares, J.J. Stachecki, K. Kyozuka, D.R. Armant, and J.L. Ram. 7 pp. MICHU-SG-95-306

Effects of Deionized Water on Sensitivity of Zebra Mussels (Dreissena polymorpha) *to Toxic Chemicals.* J.U. Walker and Jeffrey L. Ram. 6 pp. MICHU-SG-94-304

Ligands in the Zebra Mussel Dreissena Polymorpha *(Pallas).* Peter P. Fong, J. Duncan, and Jeffrey L. Ram. 4 pp. MICHU-SG-94-305

In Vivo and In Vitro Induction of Germinal Vesicle Breakdown in a Freshwater Bivalve, the Zebra Mussel Dreissena polymorpha *(Pallas).* P.P. Fong, K Kyozuka, H. Abdelghani, J.D. Hardege, and J.L. Ram. 8 pp. MICHU-SG-94-306

Long-Lasting, Sex Specific Inhibition of Serotonin-Induced Spawning by Methiothepin in the Zebra Mussel, Dreissena polymorpha *(Pallas).* Peter P. Fong, Jorg D. Hardege, Jeffrey L. Ram. 7 pp. MICHU-SG-94-309

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