

MICHU-Q-01-004



Sea Grant

Michigan



ANNUAL REPORT
OMNIBUS PROPOSAL
Fiscal Year 2000

Michigan Sea Grant College Program
University of Michigan – Michigan State University
2200 Bonisteel Boulevard
Ann Arbor, MI 48109-2099

To: The Office of National Sea Grant
NOAA, U.S. Dept. of Commerce

Title of Program: Michigan Sea Grant College Program
2000-2001 Annual Progress Report

Years of Activity: 32

Grant Number: NA76RG0133

Time Period of Report: March 1, 2000 — February 28, 2001

NIHU #01-105

Table of Contents

Introduction	2
Selected Accomplishments and Impacts:	
Outreach (Extension, Communication) and Research	3
I. Sustainable Coastal Development	5
II. Anticipating Great Lakes Trophic Change	9
III. Great Lakes Coastal Wetlands	12
IV. Aquatic Nuisance Species	14
V. Great Lakes Education	18
VI. International	23
Appendices	
Michigan Sea Grant Funded Projects (2000)	24
Sources of Significant Non-Federal Funding	25
Papers Supported by Michigan Sea Grant Research	26
Students Supported by Michigan Sea Grant Research	28
Collaborating Institutions	30
Program Awards and Honors	31
Publication List	32

Introduction

Michigan Sea Grant (MSG) was founded in 1969 at the University of Michigan (UM), became a partnership with Michigan State University (MSU) in 1977 and was elevated to Sea Grant College Program status in 1982. The program coordinates and focuses the best available academic and professional talent at the local and regional level to advance understanding of Great Lakes issues. It uses research-based knowledge to help solve resource problems through technology transfer, community assistance and education.

In November 1999, Michigan Sea Grant submitted an Omnibus proposal to the National Sea Grant Program covering program activities for 2000-2001. This document reports on progress under year one of the Fiscal Year 2000 Omnibus proposal (March 1, 2000 through February 28, 2001; Grant # NA76RG0133). This report summarizes progress made in 2000-2001 on research projects and on the stated objectives for Extension and Communications, all of which are described fully in Michigan Sea Grant's Fiscal Year 2000 Omnibus Proposal.

Michigan Sea Grant continues to implement its five-year Strategic Plan, 2000-2005. During the 2000-2001 grant period, Michigan Sea Grant prepared and submitted an Implementation Plan, which describes specific steps that will be taken to achieve program goals outlined for its five strategic initiatives—sustainable coastal development, anticipating Great Lakes trophic change, Great Lakes coastal wetlands, aquatic nuisance species, and Great Lakes education. In this report, selected accomplishments and impacts are listed within each strategic initiative for Outreach and Research.

During the past fiscal year, Michigan Sea Grant has undergone the following administrative staff changes.

- Director Russell Moll departed the program in September 2000. Dr. George Carignan, Managing Director of the Institute for Environmental Science, Engineering and Technology in the University of Michigan College of Engineering, became Acting Director.
- Assistant Director and Communications Coordinator Peggy Britt departed in March 2000. Fiscal Officer Jennifer Smith replaced Britt as Acting Assistant Director and retained her fiscal officer duties. Jennifer Smith departed during the first quarter of 2001.

Outreach

Michigan Sea Grant Outreach promotes the sustainable use of the Great Lakes by educating and informing stakeholders, resource users, policy makers and the public about important Great Lakes issues. Michigan Sea Grant Outreach is composed of Extension field agents located around the state and Communications staff based at the University of Michigan and Michigan State University.

Michigan Sea Grant Extension

Michigan Sea Grant Extension (MSGE) field agents are strategically based in seven coastal communities around Michigan. They serve as liaisons between coastal resource users and the academic research community. Extension agents educate and provide technical assistance to residents, businesses, resource management agencies, and coastal communities on managing Great Lakes resources, creating sustainable coastal businesses, and understanding Great Lakes ecosystems.

During fiscal year 2000, Michigan Sea Grant Extension (MSGE) staff changes included the following:

- Dennis TenWolde joined the program in February 2001 as a MSGE agent in the Saginaw Bay watershed.
- Dr. Rochelle Sturtevant also joined the program in February 2001, as a Great Lakes Sea Grant Network Extension agent, based at the Great Lakes Environmental Research Laboratory (GLERL) in Ann Arbor, MI. MSG coordinated the successful search with NOAA's GLERL.
- Lee Somers, nationally renowned dive safety expert, retired after approximately 30 years as a MSG specialist.

Michigan Sea Grant Communications

Michigan Sea Grant Communications plays an integral role in program outreach and education efforts by providing Great Lakes information and resources to Michigan residents, educators, policy-makers, resource managers, and organizations. Communicators produce and distribute publications, including media news releases, a quarterly program newsletter, and program reports, and maintain the program's web site to highlight current projects and events. Additionally, communicators participate in state and regional conferences and events to disseminate knowledge about the Great Lakes and information about Sea Grant.

During fiscal year 2000, Communications staff changes included the following:

- Communications Coordinator Peggy Britt left the program in March 2000. Following Britt's departure, Communications Specialist Carol Swinehart and Editor Joyce Daniels served as team co-leaders.
- Minti Henderson joined the program in April 2000 as a Program Assistant in charge of publications distribution.

- Web Specialist Devra Polack departed in August 2000 and was succeeded by Dave Brenner (formerly of Alaska Sea Grant), who serves as the program's Web and Graphics Specialist and staff photographer.

Research

Michigan Sea Grant College Program employs the skills and intellectual assets at Michigan universities and research institutions to address Great Lakes coastal resource management, development and conservation issues. The program is an impartial source of scientific information for public policy and decision makers. During fiscal year 2000, the following new and ongoing research projects received support from Michigan Sea Grant:

- Nathaniel Ostrom, Peggy Ostrom, *Evaluation of the Trophic State of Lakes Michigan and Superior*;
- James R. Bence, *Developing and Communication Improved Methods of Fish Stock Assessment*;
- Gregory Zimmerman, Doug Landis, *Habitat Restoration During Biocontrol of Purple Loosestrife*;
- Richard D. Horan, *The Economics of Policy Options for Controlling the Introduction and Spread of Aquatic Nuisance Species in the Great Lakes*;
- Orlando Sarnelle, *Understanding the Influence of Zebra Mussels on Toxic Cyanobacterial Blooms*;
- Michael, M. Bernitsas, *Reduction of Slow Large Amplitude Motions of Towed/Moored/Anchored Systems*.

Selected Accomplishments and Impacts—Outreach and Research
The following accomplishments are a compilation of extension, communication and research summaries.

I. Strategic Initiative: Sustainable Coastal Development

One of the greatest challenges in coastal community development is overcoming the existing institutional and environmental barriers 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.

Greater Detroit American Heritage River (GDAHR) Initiative

President Clinton designated the Detroit River as one of 14 American Heritage Rivers in July 1998. A MSGE agent chairs the Greater Detroit American Heritage River Steering Committee. Among the major accomplishments of this project during 2000-2001 were the following:

Soft Engineering. The Greater Detroit AHR Initiative and partners sponsored a binational conference on soft engineering in 1999. The conference resulted in a manual on *Best Management Practices for Soft Engineering of Shorelines*, published in October 2000. The manual promotes soft engineering practices and techniques and informs others about efforts underway in the Great Lakes region to improve shorelines for multiple uses. MSGE assisted the City of Detroit with obtaining a \$25,000 grant to conduct a demonstration of these techniques on Belle Isle's Lake Muskoday.

Greenways. MSGE contributed material on several greenway projects to a report on *Building the Riverfront Greenway: The State of Greenway Investments Along the Detroit River*, published by the Metropolitan Affairs Coalition. This report is helping develop support for the full scope of greenway initiatives along the 32-mile Detroit River, a major Great Lakes connecting channel.

Publicity. The national board of directors of the Rails-to-Trails Conservancy learned about Detroit River greenways from a tour conducted by a MSGE agent. As a result, the publisher of the *Detroit Free Press* conducted an in-depth interview with the agent afterwards and subsequently wrote a supportive editorial coinciding with the release of the greenways report. In addition, television viewers throughout Michigan learned about greenways initiatives from three news features, produced by MSG, which included interviews with MSG staff members.

Grand Traverse Bay Watershed Initiative (GTBWI). A MSGE agent chaired the board of directors for the Watershed Center. The center hired a professional fund-raiser, who conducted a successful Charter Club campaign to put the center's financial future on a firmer footing. MSGE worked with representatives of the Federal Reserve Bank in Detroit, Old Kent, Smith-Barney Securities, and the Grand Traverse Regional Community Foundation on

their report of a research project on the Role of Financial Institutions in Watershed Protection. MSGE helped make a presentation on GTBWI to the International Association for Great Lakes Research. Other major activities included the annual Boardman River Cleanup and Bay Days 2000, where over 1,000 people participated in an educational celebration of Grand Traverse Bay's water resources.

Grand Marais Harbor Project. MSGE continued to facilitate community connections on this Sea Grant funded project to investigate rehabilitation design alternatives conducted by Guy Meadows, University of Michigan School of Naval Architecture and Marine Engineering.

Coastal Business Management

MarinaNet. MSGE continued to provide leadership for the national Sea Grant MarinaNet task force. At the request of the Marine Retailers Association of America (MRAA), MSGE prepared a concept paper for a national study of boating's economic impacts.

Marina Assistance. MSGE collaborated with the Michigan Boating Industries Association (MBIA) and an MSU professor to conduct an important study of the economic impacts of low Great Lakes water levels on Michigan marinas. Sixty percent of the marinas responded, documenting an estimated loss of \$11 million in 1999. As a result, the state of Michigan established a \$20 million low interest loan program for affected marina owners, possibly the first instance of a recreational industry being assisted because of hardship resulting from weather-climate conditions. The program could increase to \$30 million if lake levels drop another six inches in 2001. Several marinas have already obtained loans for emergency dredging. MSGE has been asked to be involved in future efforts to renew the legislation and to keep legislators informed of developments.

Michigan Boating Industries Association (MBIA). Sixty participants at MBIA's 2000 Recreational Boating Conference learned about Great Lakes water levels and the low interest loan program from a MSGE presentation. MBIA gave an appreciation award to the researcher and the MSGE agent for their service on this project. Participants in a Boating Week conference in Orlando and the Marina Association of Texas also learned about the project, and, as a result, Texas is conducting a similar study.

Marina Development Regulatory Consultations. At the request of MBIA, Sea Grant Extension arranged with the Michigan Department of Environmental Quality (MDEQ) Land and Water Program and the Detroit District of the U.S. Army Corps of Engineers to hold half-hour consultation sessions with eight marina and boating developers preceding the annual Michigan Recreational Boating Conference. Marina owners and developers obtained vital information and guidance as they developed proposals for new or expanded marina developments and submitted applications to the permitting agencies.

North Central Regional Aquaculture Center (NCRAC). A MSGE agent continues to serve on the NCRAC board. During this grant period, he prepared annual reports *Improving Salmonid Aquaculture* and *Marketing of Hybrid Walleye and Sunfish*. The agent conducted a session on EPA involvement with fish waste effluent at NCRAC's annual meeting and

provided a report on the results of group discussions at the symposium on this topic that he conducted in December, 2000.

Symposium on Aquaculture and the Environment. MSGE organized a symposium at Midwest Fish and Wildlife Conference that facilitated discussion among 150 stakeholders from various backgrounds about the impacts of aquaculture on the environment. MSGE is also preparing the proceedings from the event, which was sponsored by over \$15,000 in contributions from several agencies and organizations.

Hazard Analysis and Critical Control Point (HACCP) Training. MSGE has led training and technical assistance efforts on HACCP in the Great Lakes region, assisting more than 90 percent of fish processors in designing and implementing HACCP plans to comply with federal guidelines. MSGE also helped the Chippewa Ottawa Treaty Fishery Management Authority (COTFMA) and the FDA reach a memorandum of understanding that has made it feasible for COTFMA to conduct and oversee the HACCP program for tribal fishing operations.

In August 2000, 25 fish processing employees, some from Wisconsin and Indiana, learned about HACCP via a three-day course conducted by MSGE.

Twenty Great Lakes Sea Grant colleagues learned about MSGE's HACCP work through a presentation at a Great Lakes Sea Grant Network Outreach Conference at Milwaukee in April 2000.

MSGE developed a Fishing Vessel Sanitation audit form to guide commercial fishing operations with procedures to keep their catch safe in transit from the net to the dock.

Neogen Corporation's Food Safety Advisory Committee, which includes representatives of Hershey, Oscar Meyer, Kellogg Corporation and the National Fisheries Institute, learned about HACCP from a presentation by MSGE.

MSGE's Upper Peninsula agent is now a certified trainer for ServSafe, a program that focuses on health conscious food handling practices. With MSGE encouragement and assistance, Bay Mills Community College has developed a curriculum to conduct HACCP/ServSafe training programs.

H.E.A.T. MSGE has led a feasibility study of a project to use waste heat from electrical generating plants in the northern lower Michigan communities of Hillman and Lincoln to produce yellow perch for profit. Phase I of the study indicated that it will be necessary to rear 4 cohorts per year in order for the enterprise to be profitable. Phase II of the study is currently underway.

Fluctuating Great Lakes Water Levels. Many coastal property owners and businesses have learned the latest information on this topic from programs or projects conducted by MSGE. Among the stakeholders who participated during this grant period were the following:

- Commercial fishing operations who asked for technical assistance on the dredging necessary to facilitate their boats' access to the Great Lakes;
- 100 participants in regional and statewide recreational fisheries workshops;
- 170 people who attended a program conducted jointly with U.S. Representative John Dingell;
- County Extension Directors in southeastern Michigan;
- 300 members of service organizations;
- Six members of the Mackinac County Advisory Council, one of whom requested a program in Portage Township, attended by 15 people.

Publicity. News coverage of MSGE's involvement with Great Lakes water levels included a 20-year retrospective program on TV 9/10 (covering northern lower Michigan and the eastern U.P.); MSU's ANR TV news features (distributed to numerous Michigan stations and nationally syndicated programs); WOOD radio (Grand Rapids); WGHN radio (Grand Haven); *Grand Rapids Press*, *Muskegon Chronicle*, *Lansing State Journal*; *Detroit Free Press*; *Macomb Daily*; and *Wayne County Herald*.

CoastWatch Web Site. Using data from NOAA's Great Lakes Environmental Research Laboratory, MSG partnered with the MSU Institute of Water Research, Agriculture and Natural Resources (ANR) Technology Services, and four other Great Lakes Sea Grant programs to create a web site that provides up-to-date surface water temperatures, available as isothermic whole lake, regional maps and port views for all the Great Lakes. These maps, updated four times per day, help anglers and charter boat captains save fuel by pinpointing likely areas for fishing. An average of approximately 15,000 images per week were downloaded during the fishing season in 2000.

Improved Weather Forecasting. MSGE facilitated cooperation between the National Weather Service (NWS) and Michigan Charter Boat Association (MCBA) to improve marine forecasting on Lake Michigan. Charter captains are now providing observations to NWS via cell phone during charter trips. The NWS reports that the data provided by the captains has helped improve some of their forecasts.

II. Strategic Initiative: Anticipating Great Lakes Trophic Change

Understanding the changing biology of the Great Lakes is critical for successful fisheries management. Michigan Sea Grant works to develop and disseminate research-based information to anticipate ecosystem changes and aid in decision-making.

Evaluation of the Trophic State of Lakes Michigan and Superior

Project number: R/ES-18 Funding Date: 3/1/00 – 2/28/02

Research Investigators: Nathaniel E. Ostrom, Peggy H. Ostrom

Deterioration of the water quality of the Great Lakes has been a consequence of human settlement, urbanization, and population growth over the last 200 years. Extensive legislation enacted in the mid-1970s to restore water quality focused on measures to reduce excessive production (eutrophication), such as limiting phosphorus loadings. Emphasis was also placed on long-term water quality monitoring. However, evaluation of the restoration of the Great Lakes based on traditional water column parameters has not been successful. In this study, researchers conducted the first application of a new approach for evaluating gross primary production (trophic state) of Lakes Michigan and Superior based on the concentration and isotopic composition of oxygen and dissolved inorganic carbon.

This study represents a first and critically important step in addressing the response of Great Lakes trophic status to changes in climate and management activities. The specific objectives of this project are:

- 1) to assess seasonal variation in trophic state, gross primary production and respiration at several stations with Lakes Michigan and Superior; and
- 2) to assess spatial variation in trophic state, gross primary production and respiration in Lakes Michigan and Superior.

Between April and December of 2000, researchers collected water column profiles five times per year at three stations in Lake Superior and seven times per year at one station in Grand Traverse Bay, Lake Michigan. They found that the overall trend in Lake Superior is a predominance of respiration over photosynthesis particularly during spring and winter. Researchers believe that for this to occur, respiration must be fueled by extraneous sources of carbon that could be introduced from rivers or possibly from resuspension of sediments. The predominance of respiration over photosynthesis also indicates that Lake Superior is a net source of carbon dioxide (CO₂) to the atmosphere. In Grand Traverse Bay, researchers observed low saturations and high isotope values in October, which provide evidence of extensive microbial respiration in Grand Traverse Bay. This conclusion is exemplified by the dramatic increase in the ratio of photosynthesis to respiration (P:R) in October. Thus, researchers found that although P:R ratios are generally similar to Lake Superior and indicate a predominance of respiration over photosynthesis by 20 percent, respiration predominates in late fall by nearly 100 percent in Grand Traverse Bay.

Researchers will continue seasonal sampling in Lake Superior and Grand Traverse Bay throughout 2001 and will complete their analysis of the concentration and isotopic composition of dissolved inorganic carbon. This will allow them to progress from

characterizations of productivity in terms of P:R ratios to an actual quantification of rates of gross primary production and respiration.

During their work, project researchers have received assistance from various local organizations and have worked extensively with the Keweenaw Interdisciplinary Transport Study (KITES) research group, a NOAA/NSF funded research project based at Michigan Technological University.

Developing and Communicating Improved Methods of Fish Stock Assessment

Project number: R/GLF-50 Funding Date: 3-1-00 - 2-28-02

Research Investigator: James R. Bence

Computer-simulated fisheries models provide vital information to Great Lakes fishery managers, who must make decisions regarding stocking and harvest quotas. Two basic families of models are widely used in the Great Lakes—fish population models, and models with a systems-based approach where the effects of both predator and prey are incorporated. In this project, researchers will test the effectiveness of state-of-the-art, statistical catch-age (SCA) models in predicting fisheries population changes in Lakes Michigan, Huron and Superior. A second aspect of the project will use a workshop approach to transfer SCA techniques to Great Lakes fisheries managers on the upper Great Lakes.

The project will use simulated but realistic data, which will allow researchers to evaluate accurately the model's performance in reaching known goals. The data will be typical of data that are available on fish stocks in the upper Great Lakes and the kinds of system changes that are occurring. Researchers will use salmonine, lake whitefish and yellow perch as model species.

The researchers have recruited a quantitative PhD student, who has gained experience in statistical catch-age modeling through course work and by attending a workshop, sponsored by the Great Lakes Fishery Commission, on stock assessment methods. He has also gained practical experience in statistical catch-age methods and the use of AD Model Builder software through work developing a catch-age model for yellow perch on Lake Michigan. The principal investigator has gained experience in holding workshops on statistical catch-age methods by participating and helping lead two workshops sponsored by the Great Lakes Fishery Commission.

Initial work has begun toward simulating catch-age data and developing an experimental design for the simulation study.

Great Lakes Fishery Commission (GLFC). MSGE agents continue to participate in GLFC processes by serving as advisors and on lake basin technical committees, providing information and insight to the Commission as it deliberates on Great Lakes fishery issues.

Michigan Department of Natural Resources (DNR). DNR continues to enlist MSGE agents in its task forces on lakes Superior, Michigan, Huron and Erie-Lake St. Clair. Of particular interest and sensitivity during this grant period were the re-negotiation of agreements on tribal fishing.

Fishing Organizations. One hundred thirty-five members of the Great Lakes Sportfishing Council, the Holland Steelheaders and Grand Haven Steelheaders learned more about Great Lakes fishery and trophic change issues from presentations from MSGE.

Regional Fishery Seminars. MSGE conducted five regional fishery seminars during the grant period, with more than 200 charter captains and others attending. Participants learned about issues such as Great Lakes water levels and treaty fishing, and charter captains fulfilled some of their licensing requirements. These programs continue to receive excellent ratings.

Michigan Fish Producers Association (MFPA). Through a program developed and presented by MSGE, 50 participants in MFPA's annual meeting learned about trends in Great Lakes whitefish populations and changes in Great Lakes' lower food web (components of Michigan Sea Grant's strategic initiative on anticipating trophic change), the 2000 Consent Decree, Lake Superior State University's Aquatic Research Laboratory, fish waste handling and composting, and monitoring of Great Lakes fish contaminants

Lake Herring Research. A MSGE agent spawned eggs obtained from a tribal fishing operation for MSG research project on *Overwinter Mortality on Young of the Year Lake Herring*.

Water Resource Management

Center for Water Resources. MSGE helped solidify a commitment from Northwest Michigan College to host a regional center for water resource research and activities and facilitated dialogue with Michigan State University officials on potential collaborative efforts.

Superior Lakewatch. MSGE continued to coordinate the collection of water clarity and temperature information in the Michigan waters of Lake Superior. In 2000, eight volunteers, including a Michigan DNR research vessel, completed Superior Lakewatch log books, and MSGE reported the findings to the Superior Lakewatch long term data base.

Pesticide Applicators. Eighty certified pesticide applicators learned about the Great Lakes implications of their work through MSGE presentations at their training workshops.

III. Strategic Initiative: Great Lakes Coastal Wetlands

Incremental losses of coastal wetlands in the Great Lakes have resulted in a net loss of over 60 percent. Great Lakes coastal wetlands provide important spawning areas and habitat for fish and wildlife. Michigan Sea Grant has piloted two initiatives in wetlands protection. The first initiative partners with local leaders, resource managers, and schools to use biological control to reduce the impact of the exotic purple loosestrife plant on wetland habitat. A second wetland education initiative targets township and municipal officials, developers, and realtors to help them reduce wetland conversion while encouraging the reuse and full utilization of existing coastal developments. This initiative is based on Connecticut Sea Grant's successful Nonpoint Education for Municipal Officials (NEMO) model.

Habitat Restoration During Biocontrol of Purple Loosestrife

Project Number: R/NIS-5 Funding Date:

Research Investigators: Gregory Zimmerman, Doug Landis

Purple loosestrife (*Lythrum salicaria*) is an invasive plant species that has spread throughout the northern United States and southern Canada. Since 1990, scientists and volunteers have released the *Galerucella* beetle, the plant's natural enemy, to feed on purple loosestrife in Michigan. Evidence has shown that the beetles are suppressing the plant's growth. Objectives of this project were to document changes in plant community composition during biocontrol of purple loosestrife and assess whether purple loosestrife remains dominant or if native plant species re-establish themselves. Investigators also looked at the effect of leaf perforation by insects.

Through a combination of greenhouse studies and field observation, investigators documented reduced growth rate of cattails with increased density of purple loosestrife; sweet gale did not appear to be adversely affected. The competitive effect of purple loosestrife on cattails decreased with increased nutrient availability. From the field studies, researchers confirmed that purple loosestrife growth decreased dramatically in the second growing season following the release of *Galerucella* but began to increase slowly as the insect populations declined. Researchers also detected increased rates of herbivory in areas with increased purple loosestrife density and an apparent competitive influence of purple loosestrife on the native plants in the field. They also confirmed that *Galerucella* herbivory adversely affects purple loosestrife water relations.

Purple Loosestrife Project. Fifty teachers participated in annual workshops on using *Galerucella* beetles to control the invasive purple loosestrife plant, now dominating many wetlands in Michigan. Workshop participants received detailed instruction on *Galerucella* beetle rearing, release and evaluation and a supply of beetles from the U.S. Department of Agriculture APHIS Plant Protection Center in Niles, Michigan. Follow-up evaluation of prior releases by teachers near Grand Haven, this year's volunteer evaluation target area, documented establishment of *Galerucella* at 100 percent of the 10 sites surveyed.

MSG's aquatic nuisance species specialist is the lead author of an adaptation of the Purple Loosestrife Cooperator's Handbook for 4H youth leaders.

Several hundred people learned about the Purple Loosestrife Project Partnership through a video produced by MSGE, which highlights the importance of community volunteerism in controlling loosestrife. The 15-minute tape is being used by nature centers and other CBC network members in marketing or announcing their capabilities.

MSG spearheaded the production and distribution of tens of thousands of Purple Loosestrife WATCH identification cards. The wallet-sized cards, which are also being used in several cooperating Great Lakes states, help raise awareness of the problem while improving citizens' ability to identify loosestrife.

Approximately 400 professionals and volunteers have learned about the Purple Loosestrife Project at educational programs at the following venues: Michigan Master Gardeners Conference, Michigan State University (MSU) Department of Education Teacher Training: Ecology in the Classroom, MSU Department of Fisheries and Wildlife graduate seminar; MSU Extension continuing education course, Michigan Department of Environmental Quality Division of Land and Water Management in service training program, Michigan Science Teacher's Association, Metropolitan Detroit Science Teacher's Association, and Oakland County land managers.

Publicity. National Independent Television News included bytes from its interview with the MSGE aquatic nuisance species specialist in its feature on invasive species, and the audience of a public radio station in the Upper Peninsula learned more about purple loosestrife from an interview with an MSGE agent.

Alpena Classroom. In keeping with MSG's strategic initiative on Great Lakes coastal wetlands, Sea Grant personnel consulted with the owners of a 10-acre parcel of wetlands on Lake Huron's Thunder Bay about using the property as an educational site where students can learn about fundamental wetland concepts. MSG staff provided guidance on establishing a not-for-profit organization, shared display components and educational materials to enhance the learning opportunities.

IV. Strategic Initiative: Aquatic Nuisance Species

Aquatic Nuisance Species (ANS) enter the Great Lakes from other ecosystems wreaking considerable economic and environmental damage. For example, in just over ten years, zebra mussels have permanently altered the entire Great Lakes ecosystem, have colonized nearly 100 inland lakes in Michigan alone, and cost municipal and industrial water users millions each year to control. Michigan Sea Grant's efforts in research and partnerships with state and regional agencies have helped resource managers better understand and cope with aquatic nuisance species. Through presentations and print, audio-visual, and Internet-based educational materials, MSG educates citizens and provides the tools they need to play an active role in preventing the further spread of aquatic nuisance species.

The Economics of Policy Options for Controlling the Introduction and Spread of Aquatic Nuisance Species in the Great Lakes

Project Number: R/EP-9 Funding Date:

Research Investigator: Richard D. Horan

While Great Lakes researchers continue to address the challenge of preventing the introduction and spread of aquatic nuisance species (ANS), formal assessments of the full range of economic policy options are limited. This research project proposes to identify and assess various economic methods, or policy instruments, that may be used to prevent and control aquatic nuisance species.

To date, researchers have identified important differences between biological pollution, specifically, the species affecting the Great Lakes, and other forms of pollution having some similar characteristics, e.g. nonpoint source pollution. This comparison offers important insight into potential policy options. Researchers have begun developing a conceptual, decision-making framework from which to evaluate the economic and environmental performance of various approaches to reduce ANS introductions.

Project investigators are also developing a proposal for a Principle Paper Session for the 2002 annual meeting of the American Association of Agricultural Economists (AAEA) and have contacted economists from across the U.S. and Europe to participate in a session about the management of exotic nuisance species. The proposal will be submitted to AAEA by November 1, 2001.

Understanding the Influence of Zebra Mussels on Toxic Cyanobacterial Blooms

Project number: R/NIS-4 Funding Date:

Research Investigator: Orlando Sarnelle

Blooms of *Microcystis*, a type of bluegreen algae that commonly produces a potent liver toxin, have been reported in some mesotrophic lakes, those which have a moderate amount of nutrients, since zebra mussels colonized the Great Lakes. More recent evidence has suggested that zebra mussels (*Dreissena polymorpha*) may also promote *Microcystis* blooms in oligotrophic waters, those low in nutrients. The purpose of this research project is to clarify the relationship between zebra mussels and phytoplankton species composition to determine whether zebra mussels promote toxic blooms of bluegreen algae.

Working on Gull Lake, an oligotrophic lake in southwest Michigan, researchers have successfully completed a large-scale manipulation of zebra mussel biomass. Researchers

stocked 12 large polyethylene enclosures with zebra mussels (9,000 total) at varying densities and monitored them for four weeks (July 6-Aug. 4).

In enclosures stocked with zebra mussels below the lakewide average, zebra mussels had a negative effect on the biomass of both total phytoplankton and *Microcystis* after three weeks, causing both to decline. In enclosures stocked with zebra mussels above the lakewide average, both bluegreen and total phytoplankton biomass increased with zebra mussel density. Researchers attribute the increase to enhanced nutrient availability stemming from high mussel mortality. Researchers also found that zebra mussels had a positive effect on ammonium concentrations but no effect on soluble reactive phosphorus or total phosphorus, in keeping with the researchers' previous assessments that phosphorus limits primary production in Gull Lake.

Researchers were also successful in isolating 12 clones of *Microcystis* from Gull Lake, which they are maintaining in a laboratory. Preliminary analyses indicate that none of these strains of *Microcystis* produce detectable amounts of the most commonly encountered toxins associated with this species.

This experiment represents the first large-scale, replicated study of the effects of zebra mussels on phytoplankton. It is also the first experiment to examine the functional relationship between zebra mussel density and phytoplankton biomass and community structure. The results to date provide no support for the hypothesis that zebra mussels promote blooms of cyanobacteria in lakes. Researchers plan to conduct up to two additional large-scale experiments to further evaluate this hypothesis, focusing treatments on zebra mussel densities at or below the lakewide average.

Zebra Mussel BrickWatch. Michigan Lake and Stream Associations (ML&SA) has assumed responsibility for monitoring zebra mussel infestation in the state's inland lakes. At ML&SA's 2000 annual meeting, a simple technique for "testing the waters" was introduced, and as a result, approximately 200 riparians participated in the program by suspending a building brick from their dock and watching for the presence of adult zebra mussels. Thirty-five participants also learned more about the infestation of aquatic nuisance species from an MSGE presentation.

Ballast Water. Several MSGE agents provided critical science-based information at five public hearings sponsored by state legislators to receive comments on preventing further introductions of aquatic nuisance species via ballast water. MSGE Extension also provided information to 35 Lake Erie charter captains, the Western States Ballast Water Group and the International Joint Commission's Great Lakes Water Quality Committee.

Baitfish-Hazard Analysis and Critical Control Point Training Program (HACCP). MSGE partnered with Minnesota Sea Grant and Michigan baitfish producers to develop HACCP-like protocols and plans for the baitfish segment of the aquaculture industry to help prevent the introduction and spread of exotic species. MSGE agents worked with bait producers and dealers, gaining first-hand knowledge of the industry and conducting sampling to find out whether aquatic nuisance species are found in their product. The model safety protocols have been used to train 18 Michigan bait producers and dealers who harvest 90 percent of the baitfish in Michigan. MSGE staff are producing a manual for the producers and dealers to

use in their work. The federal Ruffe Control Committee and ANS Panels learned about this project from MSGE staff members. Other industries and organizations are also considering adopting HACCP-like plans to assure quality control in their operations.

Publicity: Listeners of WMOM radio in Ludington learned about ballast water from an interview with a MSGE staff member. *The Detroit Free Press* quoted an MSGE agent in an article on Baitfish HACCP. Readers of the *Kalamazoo Gazette* learned about aquatic nuisance species from an article based on an interview with the MSGE ANS specialist. *EarthWatch*, Wisconsin Sea Grant's award-winning radio series, also interviewed the MSGE ANS specialist for one of its features. An estimated 25,000 listeners to WSAQ radio in Port Huron learned about aquatic nuisance species from a broadcast by an MSGE agent,

Public Education

One hundred participants learned about Great Lakes aquatic nuisance species from two presentations at the Lake Michigan State of the Lake Conference in November 2000. Also, 75 researchers, policy-makers, teachers and students learned about ballast water issues from an MSGE presentation at MSU's Agriculture and Natural Resources Week Great Lakes conference.

More than 900 students learned about aquatic nuisance species from presentations given by MSGE staff members at Munising, Delta County, Bay Pines, Sault Ste. Marie, Gaylord, Buckley, Traverse City, River Rouge, Livonia, Southfield and Ecorse, Emmet County, AuSable Institute for Environmental Learning, Water Watch Student Congress, and Principia College.

More than 450 members of the following service organizations learned about aquatic nuisance species from presentations given by MSGE staff members: Traverse City Lions, Traverse City and Marysville Rotary, Muskegon Conservation Club, Ravenna Sportsmen's, Southwest Michigan Steelheaders, Northwest Michigan College's Senior Academy on Great Lakes resource issues.

After hearing a MSGE presentation on ANS, the Big Bay Michigan United Conservation Clubs affiliate decided to post signs in an effort to prevent additional introductions of aquatic nuisance species into Lake Independence, which is already infested with rusty crayfish.

Designed seven posters featuring aquatic nuisance species for use by Michigan Sea Grant Extension agents.

Cooperative ANS Projects. Created nine original illustrations for National Sea Grant's poster on Aquatic Nuisance Species ("America's Most Unwanted"), for public distribution via all Sea Grant programs.

Created posters to be placed in bait shops explaining the importance of identifying aquatic nuisance species, which will be distributed to all the Great Lakes State Sea Grant programs.

V. Strategic Initiative: Great Lakes Education

Educating Michigan citizens about the environmental and economic importance of the Great Lakes is one of the state's biggest challenges. 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.

Aquaculture Associations. Fifty-five participants in the Michigan Aquaculture Association's annual meeting learned about new aquaculture species and supporting the Baitfish HACCP program from Sea Grant Extension. Three hundred eighty participants in the Wisconsin Aquaculture Association's annual conference learned about environmental issues affecting the aquaculture industry from a Michigan MSGE presentation. Listeners to a farm radio program also heard about the topic when the MSGE presenter was interviewed.

Designed and produced sponsor poster for aquaculture conference, coordinated in part by MSG Extension.

Fish Waste Composting. With assistance from MSGE, Northern Initiatives, an Upper Peninsula economic development organization, received a \$50,000 grant from the Clean Michigan Initiative to conduct a study on fish waste composting and marketing.

Commercial Fisheries Newslines. Approximately 1,200 commercial fishing and fish processing operations and aquaculture enterprises learned about issues important to their industries from Commercial Fisheries Newslines produced by MSGE and posted to the World Wide Web.

Michigan Charter Boat Association (MCBA). At their annual meeting, 40 members of MCBA learned from MSGE staff members about fluctuating Great Lakes water levels and Michigan's new low interest loan program for businesses affected by the situation, the 2000 consent decree on Great Lakes treaty fishing, and about working with the news media on controversial issues.

Commercial Fisheries and Aquaculture. MSGE worked with two Great Lakes Indian Fish and Wildlife Commission (GLIFWC) scientists on developing a protocol for smoking fish to reduce fish contaminants, including a critical control point involving a cool down period after smoking. As a result, tribal fish processors can now follow a HACCP process to ensure a finished product that will meet U.S. Food and Drug Administration (FDA) guidelines for contaminants.

Fish Contaminants. A MSGE-assisted GLIFWC study of chlordane concentrations shows that siscowet trout, up to 22 inches long, meet FDA guidelines for human consumption. Michigan officials are reviewing those results to determine whether the state's ban on catching siscowet over 18 inches might be lifted.

Treaty Fishing Consent Decree Education. In August 2000, federal and state agencies and tribal governments reached a 20-year consent agreement on management of the Great Lakes fishery in Michigan waters. Since then, several hundred members of the MCBA, Salmon and Steelhead Anglers organizations and many others have learned about the issue from programs developed by MSGE and by related web pages created by MSG Communications.

MSGE contributed material and comments for a traveling exhibit designed to help the public understand the issues involved in the dynamics between recreational and commercial fishing. Several hundred people viewed the exhibit at its opening in Traverse City.

Public Education

Publications

- Distributed a total of 20,713 publications.
- Wrote and produced the *Great Lakes Facts* publication series, distributing 403 copies to audiences throughout Michigan and beyond.
- Designed, wrote, produced and distributed Michigan Sea Grant Implementation Plan, Outreach Proposal, annual progress report, and annual program guide *People and Projects 2001*.
- Designed, wrote and produced four issues of MSG's program newsletter *Upwellings*, distributed to approximately 2,600 subscribers quarterly—an audience that has increased by nearly 20 percent during the last fiscal year.
- Organized and inventoried all publications and created inventory tracking process.

Media. MSG Communications helped educate Michigan citizens about Sea Grant and important Great Lakes issues by disseminating information through mass media. Staff members developed 7 news releases about the spread of zebra mussels in Michigan's inland lakes, purple loosestrife identification cards, the Great Lakes Facts publication series, and new staff members. These releases resulted in more than 72 newspaper articles statewide including major dailies. Staff also responded to direct inquiries from state and national media, which resulted in national exposure for MSG activities in Southwest Airlines' *Spirit Magazine*, *Coastlines* newsletter, and *Horticulture Journal*. In addition, Communications staff members scripted 4 video news features about MSG extension activities, distributed statewide and to nationally syndicated programs.

Great Lakes and Natural Resources Camp. Fifty-four teens developed their Great Lakes and natural resources leadership skills at the 2000 Great Lakes and Natural Resources Camp sponsored and staffed in part by MSGE. In 2000, MSG provided a special grant to make it possible for 10 urban and minority youth to participate. Program staff (MSGE and volunteers) readily adapted the science learning experiences and counselor training in order to meet the needs of more diverse learners. Within two years, one youth from 1999 had advanced to serve in a leadership capacity as counselor in 2001. This teen also served as a summer minority apprentice researcher in the MSU Department of Fisheries and Wildlife.

Classroom Education. In several classrooms and through various school events, MSGE helped educate dozens of young people about the Great Lakes. MSGE conducted its 16th annual Great Lakes education sessions for all county fourth graders on Magoon Creek in

Manistee County; Emmet County; taught natural resources classes at Munising and in Taylor Schools; and led a marine career education class at Milford High.

Students in the Traverse City area learned about their opportunities in science from Dr. Sylvia Earle—former chief scientist of NOAA and National Geographic Explorer of the Year—who visited the area at the invitation of MSGE and others.

Vessel-Based Education. MSG's Great Lakes Education Program (GLEP) was adopted as a priority program by the Detroit River American Heritage River steering committee. NOAA committed \$40,000 to offset vessel charter expenses in both programs.

Great Lakes Education Program (Macomb). A record 3,187 fourth graders from 111 classrooms participated in Macomb County's GLEP program in 2000, and participants' knowledge of Great Lakes resources increased substantially. Three hundred eighty-six volunteer instructors contributed 2,742 hours of their time, with an estimated value of at least \$34,136. All of the participating teachers rated the GLEP as an excellent experience, and ranked it high or very high in a value/cost ratio. Fall cruises now constitute 40 percent of the annual total.

In 2000, Macomb County's GLEP taught its 20,000th student. Other 10-year cumulative totals were: 840 teachers; 2,989 parent chaperones; 3,196 volunteers contributing \$282,815 worth of time. The Colina Foundation provided a \$1,200 grant for technology, allowing the GLEP to acquire needed equipment such as an underwater camera and microscope. The Detroit Edison Foundation contributed \$10,000 to the Macomb GLEP in 2000, increasing its over all total to \$77,975.

Great Lakes Education Program (Detroit River). The spring GLEP program on the Detroit River involved 24 cruises with schools from nine districts in Wayne and Monroe counties, 695 students, 30 teachers, and 117 parent-chaperones. Teachers rated the overall program 3.7 on a 4 point scale, and the new curricular materials received a 3.6 rating. The Detroit River GLEP conducted its first fall season with six pilot classes, 180 students, and 24 parent chaperones. Since demonstration cruises on the Detroit River began in 1998, 54 classes, approximately 60 teachers, 216 parent chaperones and 1,620 students have participated in this GLEP locale.

The Downriver Technical Career Consortium contributed \$13,000 to enable classes in Wayne and Monroe counties to participate in the cruises. City of Detroit Schools contributed money so that two schools would be able to participate in 2001 cruises. Lake Erie Metropark is providing permanent dockage for a GLEP vessel. A staff member from USEPA's large lakes laboratory on Grosse Ile assisted as an instructor. Wayne County has provided \$10,000 to help staff the GLEP Detroit River program.

Approximately eighty members of the North American Association of Environmental Education and the National Marine Educators Association learned about the GLEP through MSGE presentations at national conferences. As a result of one presentation, a representative of Texas Sea Grant expressed interest in doing something similar on the Gulf of Mexico.

Teacher/leader Education. GLEP volunteers being trained to teach one of the cruise stations learned how to conduct water monitoring from a special GLEP cruise. The Macomb Daily covered the event. The GLEP also hosted a “Fin and Feather” learning experience for its volunteer instructors.

Textbook Educational Materials. Scott Foresman will publish a social studies textbook including an Issues and Viewpoints feature, prepared by MSGE and MSG Communications, on teaching fourth graders about zebra mussels.

Conferences and Events. MSG Communications helped organize and sponsor the annual national conference of the Society of Environmental Journalists (SEJ) as part of an effort to help journalists and editors improve the quality, accuracy and visibility of environmental reporting. MSG distributed resource materials to an estimated 550 journalists and assisted in coordinating the scientific poster session as well as securing several speakers. The MSG program name and mission were highlighted in conference program materials and introductions.

Michigan Sea Grant communicators also participated in several events held in Michigan that helped raise the profile of Michigan Sea Grant and disseminate Great Lakes information. These included the Michigan Science Teachers Association annual conference, Michigan State University Great Lakes Conference, Grand River Expedition 2000, and Michigan State University Outdoor Expo 2000, reaching an audience of more than 2000 people.

- Photographed 2001 National Ocean Sciences Bowl.
- Photographed Great Lakes Educational Project.
- Photographed dedication of the Detroit River as a Canadian Heritage River.

Thunder Bay National Marine Sanctuary and Underwater Preserve. The nation’s first joint federal-state National Marine Sanctuary and Underwater Preserve was created in Lake Huron’s Thunder Bay in October 2000. MSGE’s program leader led the initial nomination for the sanctuary when he was a district MSGE agent approximately 20 years ago. Over the years, MSGE has assisted with various fact-finding aspects of developing the sanctuary, including preparing the Environmental Impact Statement and serving on developmental committees. A MSGE agent is cooperating with the preserve’s temporary staff by contributing more than 1,000 pages of documents and 300 slides to its educational center.

Diving Attractions. Government officials in Wisconsin and in Manistee and Muskegon, Michigan learned from MSGE about intentionally placing vessels in preserves.

Nature-based tourism. MSGE helped construct and place six bird watching platforms at Tawas State Park on Lake Huron, which is located in a major migratory bird and waterfowl flyway. First year assessments indicate that nearly 150 persons per day used the facilities in late spring, and 40 to 60 used them daily during the summer. An article in MSG’s newsletter *Upwellings* gave the project statewide visibility.

Fifty tourism industry leaders learned about nature-based tourism from a second annual conference that MSGE helped to plan and lead.

Twenty-five tourism education leaders learned about the strengths of MSU Extension's Area of Expertise approach from a MSGE presentation at the 2000 National Extension Tourism Conference.

Michigan Sea Grant Web Site (www.miseagrant.org)

- Registered **miseagrant.org** as domain name for Michigan Sea Grant to increase public visibility and redesigned MSG web site, incorporating streaming video clips and search capability.
- Implemented a secure ordering form enabling users to buy publications using credit cards on-line, resulting in nearly a 300 percent increase in online orders.
- Configured web server for MSG digital high-resolution graphics library, incorporating over 500 scanned images from MSG slide archives.
- Designed web feature pages "Identifying and Avoiding Commercial Fishing Nets," which attract more than 200 visitors per month.

Designed web version of *Upwellings* newsletter, increasing total readership.

Michigan Sea Grant Extension created 34 web pages on the following topics: Thunder Bay shipwrecks, birds of Lake Huron, coastal plants, islands, Straits of Mackinac, and wetlands. Within a few months, the pages received more than 10,000 hits at the rate of 1,200-1,500 per week from 37 different countries including Australia, Belgium, Canada, Denmark, France, Greece, Japan, Netherlands, New Zealand, Sweden, Taiwan, and the U.K.

Program Development. Designed and produced MSG stationary, business cards and mailing materials to raise public awareness of Michigan Sea Grant and comply with National Sea Grant guidelines for program identity.

VI. International

International agencies have been promoting aquaculture in developing countries for the past 30 years as a way to boost economic development. In poor countries, such as Nicaragua, shrimp farming has become an essential part of the economy. In October 1998, Hurricane Mitch struck Nicaragua and the economy of this small country was devastated.

Hurricane Mitch Reconstruction - U.S. AID - Nicaragua

The National Oceanic and Atmospheric Administration (NOAA) and MSG took the lead in applying outreach methods and relying on the expertise of aquaculture specialists. These methods include training field agents (with the Puerto Rico Sea Grant program) and supplying technical knowledge of aquaculture specialists (a shrimp farming specialist in Michigan, and Florida Sea Grant).

Demonstration project. MSG hired shrimp aquaculture specialist, Russell Allen, to design a zero exchange system that is environmentally sound and minimizes the impact of the viral diseases that had plagued Nicaraguan shrimp farmers for years. The demonstration project consists of production ponds, settling ponds, and a water treatment pond, along with pump stations and the infrastructure needed for operation. Water quality is maintained through fertilization, feeding rates and water aeration. Utilizing local labor and teaching other farmers how to apply the techniques to construct sustainable farms is an essential part of the program.

Shrimp Aquaculture Training. MSGE's program leader collaborated with a colleague in Puerto Rico Sea Grant to conduct training for new Sea Grant Extension agents and the University of Central America who will be working with shrimp farmers and cooperatives whose livelihoods were disrupted by Hurricane Mitch.

Marine agents have held community discussion groups about aquaculture, money management, environmental awareness and other topics in El Viejo and Chinandega.

Appendix A
Michigan Sea Grant Funded Projects

Research – Funded March 2000

Modeling of Noise from the Propulsion System of a Fishing Boat/Ship and Development of Noise Reduction Techniques.

Ecological and Economic Consequences of Hydropower-Related Watershed Restoration on Salmonid Productivity in Great Lakes Tributaries.

Application of Decision Analysis to Great Lakes Fishery Management.

Bioregulation of Trace Metals in the Great Lakes.

Developing and Communicating Improved Methods of Fish Stock Assessment.

Reduction of Slow Large Amplitude Motions of Towed/Moored/Anchored Systems.

Evaluation of the Trophic State of Lakes Michigan and Superior.

Habitat Restoration During Biocontrol of Purple Loosestrife.

Aquatic Nuisance Species – Funded October 2000

Economic Impact of Measures to Limit Introduction of Non-Indigenous Species on St. Lawrence Seaway Shipping.

Understanding the Influence of Zebra Mussels on Toxic Cyanobacterial Blooms.

Outreach

Michigan Sea Grant Communications.

Michigan Sea Grant Extension.

Biological Control of Purple Loosestrife by 4-H Field Volunteers.

Sustaining Wild Harvest and Aquaculture of Bait Fish in ANS Infested Waters.

Program Development

Estimating Chlorophyll Transport Using Sea WiFS Imagery.

Identifying Non-market Values for Great Lakes Coastal Wetlands.

Spatial Genetic Structuring of Forage Fish in the Upper Great Lakes: Evidence for a Subdivided Forage Base and Implications for Structuring in Predatory Fish Species.

Biological Control of Purple Loosestrife in Michigan.

John A. Knauss Marine Policy Fellowship
Class of 2000 - 2001

Hance, Allen

Lindow, Emily

**Hurricane Mitch Reconstruction – Nicaragua Small Shrimp Producer Assistance Program
– Funding July 2000**

Nicaragua Intensive Shrimp Farm Demonstration Project.

Russ Allen, Aquatic Design, Ltd.

Human Resource Development: Shrimp Safety as Food and Best Management Practices
Pertinent to Shrimp Processing in Nicaragua.

Russ Allen, Aquatic Design, Ltd.

Economic Revitalization and Sustainability: Promote Economic Profitability and Access to
Credit and Financial Systems for the Nicaragua Shrimp.

James C. Cato, University of Florida

The Coordination and Development of Outreach Activities Related to the Demonstration Zero
Exchange Intensive Marine Shrimp Production System in Nicaragua.

John Schwartz, Michigan State University

The Hurricane Mitch Reconstruction – Nicaragua Small Shrimp Producer Assistance Program:
Program Management.

George R. Carignan, University of Michigan

**Appendix B
Sources of Significant Non-Federal Funding for 2000**

University of Michigan	\$334,006
Michigan State University	\$480,058
Simon Fraser University	\$4,669
Great Lakes Commission	\$10,000

Appendix C
Papers from Michigan Sea Grant Supported Research

- Borlase, G.A., and Vlahopoulos, N., 2000. "An Energy Finite Element Optimization Process for Reducing High Frequency Vibration in Large Scale Structures," *Journal of Finite Element Analysis and Design*, Vol. 36: 51-67.
- Godby, N.A., Jr., and Rutherford, E.S., 2000. "Diet, Growth and Production of juvenile steelhead in the Muskegon River, Michigan," *North American Journal of Fisheries Management*. (in review).
- Jones, M. 2000. An extended abstract was published and distributed at the Sea Lamprey International Symposium II (August 2000, Sault Ste. Marie MI) entitled "Adaptive management and future sea lamprey control alternatives for the St. Marys River."
- Jones, M. 2000. SLIS proceedings volume (to be published as a Supplement to the *Canadian Journal of Fisheries and Aquatic Sciences*).
- Kim, B K. and Bernitsas, M.M., 2001. "Nonlinear Dynamics and Stability of Spread Mooring with Riser," *Applied Ocean Research*, (in press).
- Lee, J.S. and Nriagu, J.O., 2000. "Arsenic Carbonate Complexes in Groundwater," *11th International Conference on Heavy Metals in the Environment* (J.O. Nriagu, Editor), Contribution Number: 1340. University of Michigan, Ann Arbor (CD-ROM).
- Matsuura, J.P.J., Bernitsas, M.M., Garza-Rios, L.O., and Nishimoto, K. "Sensitivity and Robustness of Hydrodynamic Mooring Models," *Journal of Offshore Mechanics and Arctic Engineering*, ASME Transactions; (submitted February 2001).
- Nosher, T., Lehman, J. and Nriagu, J. 2000. "Evidence for Copper Inhibition of Algal Growth in Saginaw Bay - Lake Huron, MI," *11th International Conference on Heavy Metals in the Environment* (J.O. Nriagu, editor), Contribution Number: 1236. University of Michigan, Ann Arbor (CD-ROM).
- Rutherford, E.S., Thorrold, S.R., Christensen, J.C., and Swank, D.R., "Use of Stable Isotope and Trace Element Chemistry in Otoliths to Distinguish Natal Tributaries Used by Anadromous Rainbow Trout Parr in Lake Michigan," *Limnology and Oceanography*, (submitted 2000).
- Rutherford, E.S., Clapp, D., Wesander-Russell, D., Hesse, J., DeWitt, S., Woldt, A., and Swank, D. "Spatial and Temporal Variation in Natural Recruitment of Chinook Salmon in Lake Michigan Tributaries, 1967 - 1998," *Transactions of the American Fisheries Society*, (submitted 2000).
- Simos, D.N., Pesce, G.P., Bernitsas, M.M., and Cohen, S.B., "Hydrodynamic Model Induced Differences in SPM Post-Pitchfork Bifurcation Paths," *Journal of Offshore Mechanics and Arctic Engineering*, ASME Transactions, submitted January 2001).

- Wilson, A. E. and Sarnelle, O., 2001 (in press). "Relationship Between Zebra Mussel Biomass and Total Phosphorus in European and North American Lakes," *Archiv für Hydrobiologie*.
- Woldt, A.P., and Rutherford, E.S., 2000. (In review.) "Production of Juvenile Steelhead in Two Northern Lake Michigan Tributaries," *Transactions of the American Fisheries Society*, (submitted).
- Zhang, W., Wang, A., Vlahopoulos, N. and Wu, K., 2000. "High Frequency Vibration Analysis of Thin Elastic Plates under Heavy Fluid Loading by an Energy Finite Element Method," *Journal of Sound and Vibration*, (submitted).

Appendix D

Students Supported by Michigan Sea Grant Research

Graduate Students

- Field, Amanda, M.Sc. (in progress), Michigan State University, "Seasonal Variation in Primary Productivity and Respiration in Grand Traverse Bay, Lake Michigan."
- Haeseker, Steven L, Ph.D. candidate, 2001, Michigan State University, "Application of Decision Analysis to St Marys River Sea Lamprey Control."
- Kotinis, M., M.S. towards Ph.D., University of Michigan.
- Matsuura, J.P. Ph.D. (expected April 2003), University of Michigan, "Station Keeping of Ships Based on Nonlinear Slow Motion Dynamics."
- Raikow, D F., Ph.D. (in progress), Kellogg Biological Station, Michigan State University, "Alteration of Inland Lake Pelagic Food Webs by the Invasive Zebra Mussel."
- Russ, Mary.E., Ph.D. (in progress), Michigan State University, "Quantifying Trophic State: A Comparison of Three Methods of Estimating Gross Primary Production in Two Distinct Oligotrophic Ecosystems."
- Smith, Emily, Ph.D. candidate, (expected 2002), Michigan State University, "Analysis of Recruitment Variation in Lake Michigan Alewife and Bloater Populations."
- Swank, David Swank, Ph.D. (expected Dec 2001), University of Michigan, "Life History Variation in Great Lakes Steelhead."
- Wilberg, Michael, Ph.D. (in progress), Michigan State University, "An Evaluation of Statistical Catch-age Methods."
- Wilson, A.E., M.S. 2001. Department of Fisheries and Wildlife, Michigan State University, "Complex Interactions Between Zebra Mussels and Their Planktonic Prey."
- Zhang, Weiguo. Ph.D. (expected 12/02), Naval Architecture and Marine Engineering, University of Michigan.

Undergraduate Students

- Chiotti, Justin, Michigan State University.
- Frantz, Nicole, Michigan State University.
- Fraser, Timothy, University of Michigan-Dearborn.
- Geoghehan, Daniel, University of Michigan-Dearborn.
- Hanna, Bethany, Michigan State University.
- Hollandsworth, Donna, University of Michigan-Dearborn.
- Irish, Nicholas, University of Michigan-Dearborn.
- Milroy, Elizabeth, Michigan State University.
- Nosher, Todd, University of Michigan.

Schuerer, Allison, Michigan State University.

Toda, Tomoka, Michigan State University (exchange student from Japan).

Degrees Conferred

Godby, Neal, School of Natural Resources and Environment, University of Michigan.

M.Sc. April, 2000.

Horne, Bradley. School of Natural Resources and Environment, University of Michigan,

M.Sc. December, 2000.

Appendix E

Collaborating Institutions

Amoco Research and Development
Chevron
Chippewa Indians Biological Services
Conoco
Eastern Michigan University
Exxon/Mobil
Grand Traverse Band of Ottawa
Great Lakes Commission
Great Lakes Environmental Research Laboratory
Great Lakes Fishery Commission
Great Lakes Science Center
Inland Seas Education Association
Lake Superior State University
Michigan State University
Michigan Technological University
Naval Undersea Warfare Center
Newport News Shipbuilding
Office of Naval Research
Ontario Forest Research Institute
Petrobras, Brazil
Shell Oil Company
Simon Fraser University
U.S. Fish and Wildlife Service
University of Georgia
University of Toledo

Appendix F

Program Awards and Honors

Awards

- MSU Distinguished Academic Staff Award - Ron Kinnunen.
- Sea Grant Advisory Services Association (Award of Excellence) HACCP - Ron Kinnunen.
- Great Lakes Sea Grant Network Program Leaders (Outstanding Program) American Heritage River - Mark Breederland
- Great Lakes Sea Grant Network Program Leaders (Outstanding Program).
- MSUE Employee Development System Team Award.
- Exotic Species Day Camp for Teachers - Steve Stewart and Mike Klepinger.
- MSUE Employee Development System Team Award (Grand Traverse Botanical Gardens) John McKinney.
- USDA Forest Service National Team Award (Mackinac County Water Safety Review Team) Ron Kinnunen.
- APEX Grand Award for MSG web site (www.miseagrant.org) from Communications Concepts - Dave Brenner, Webmaster and Joyce Daniels, Editor.
- APEX Award of Excellence for online publications sub-site from Communications Concepts - Dave Brenner, Webmaster and Joyce Daniels, Editor.
- ACE Gold Award for *Upwellings Online* from Agricultural Communicators in Education - Dave Brenner, Webmaster and Joyce Daniels, Editor.
- APEX Award of Excellence for *Upwellings* from Communications Concepts - Dave Brenner, Designer/Photographer and Joyce Daniels, Editor.

Leadership

- Assembly of Sea Grant Extension Program Leaders – chairperson
- Rotary Charities - board of directors
- Grand Traverse Bay Watershed Initiative – chairperson, board of directors
- Great Lakes Fishery Commission – advisor, member of lake technical committee(s)
- Michigan Department of Natural Resources – member, task forces on lakes Superior, Michigan, Huron and Erie-Lake St. Clair
- North Central Regional Aquaculture Center – member, board of directors
- Council of Michigan Foundations
- Detroit River American Heritage River Steering Committee – chairperson
- Sea Grant Webmasters – member, task force
- Sea Grant Regional web site committee, host for the Great Lakes – lead designer
- Sea Grant Non Indigenous Species Kid’s Site Planning Committee – designer

Appendix G Publication List

Michigan Sea Grant Communications distributed 20,713 publications from March 2000 through February 2001. In addition, newsletters were mailed to 3,600 subscribers quarterly. Many publications distributed by Michigan Sea Grant are published and/or distributed cooperatively with other Sea Grant programs.

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 Newslines* (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
- Great Lakes Fishes Poster,* MSG-00-900
- Lightning and Boats.* 4 pp. MSG-89-700
- Protecting Fish Habitat: A Guide for Fishermen and Boaters* 2 pp.
- Rip Currents,* brochure and poster. North Carolina Sea Grant. MSG-00-700
- Slow the Spread of Zebra Mussels and Protect Your Boat Too.* 4 pp. MSG-94-713
- Water Wise,* MSG-01-900

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: Purple Loosestrife, Round Goby, Ruffe, and Zebra Mussels.
MSG-98-500, 501, 505, 507
A Field Guide to Aquatic Exotic Plants and Animals. Great Lakes Sea Grant Network.
4 pp. MSG-98-504
Daphnia Lumholtzi: The Next Great Lakes Exotic. 2 pp. MSG-99-500
Five Lampreys of Michigan. 4 pp. MSG-97-500
Gobies: Cyberfish 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 pp. 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. MSG-GLEP
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
Great Lakes Facts (publication series). MICHU-SG-00-406
Marine Education, (bibliography). 67 pp. MSG-98-401
Marine Science Careers, (second edition). 32 pp. MSG-MSCAREER
Safe Use of Zebra Mussels in Classroom and Laboratories. 2 pp. MSG-93-703