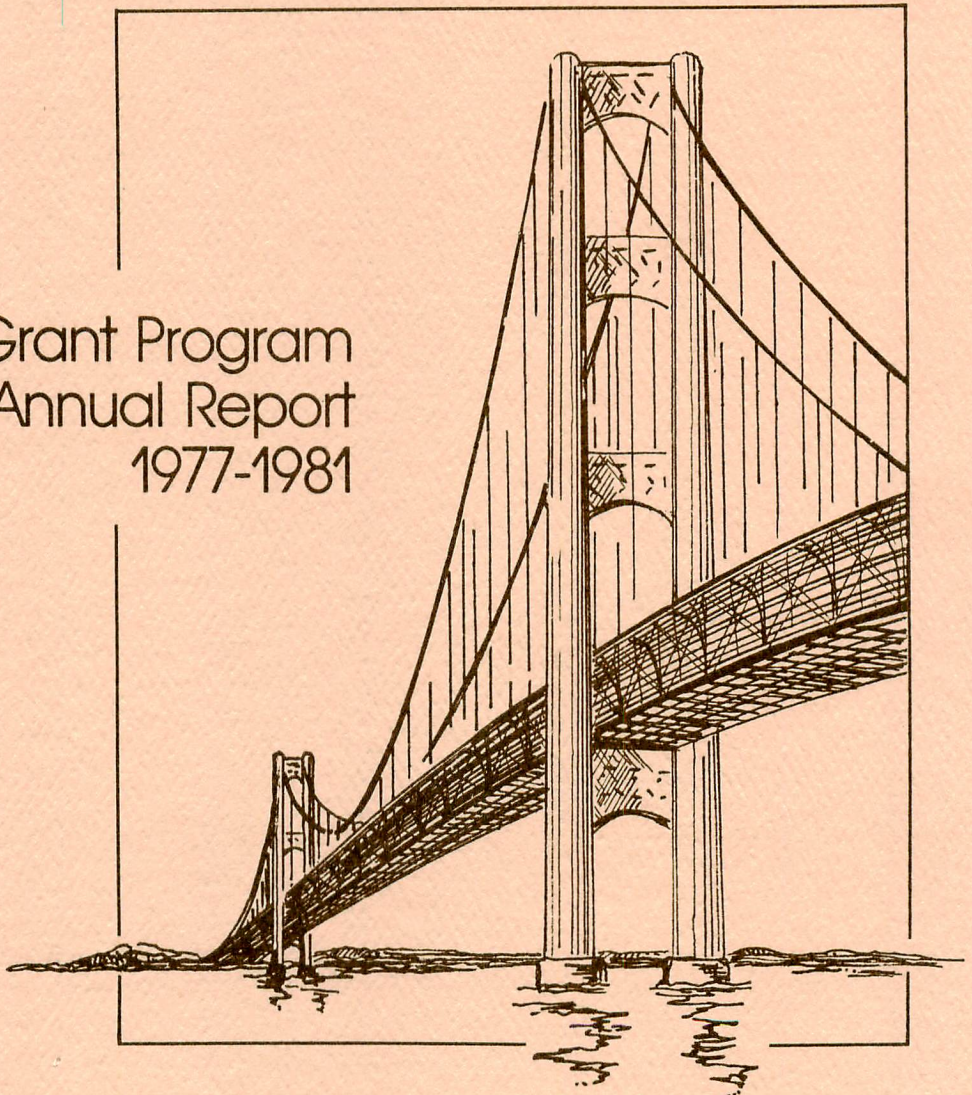


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Michigan Sea Grant Program
Annual Report
1977-1981



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Michigan Sea Grant Program
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The Michigan Sea Grant Program is part of a network of Sea Grant programs which apply the expertise and resources of universities to marine resource issues. Funded primarily by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Sea Grant programs are partnerships between government and academic institutions. In Michigan, the program is a cooperative effort of The University of Michigan and Michigan State University.

Introduction

Bridges on the Great Lakes

Some of the greatest bridges in the world span Great Lakes waters. Among them are those that link Michigan's peninsulas and Michigan with Canada. The Mackinac Bridge spans two halves of a state shaped by four of the Great Lakes, stretching over five miles of cold, silver-green water. The three bridges linking Michigan with Canada remind us of the international character of our lake resources. The Ambassador Bridge joins Detroit and Windsor, the International Bridge joins the two Sault Ste. Maries. The very names of these bridges evoke the spirit of cooperation that exists between these two countries in their use of the Great Lakes. The Blue Water Bridge joins Port Huron and Sarnia; its name evokes the beauty and grandeur of these spectacular inland seas--the Great Lakes.

The bridge is a fitting symbol for the activities of Michigan Sea Grant. The program spans two major universities, which have provided sustained excellence in marine-related research. The Marine Advisory Service bridges the research and public service components of the program by transferring research results to their users and bringing back to the program the needs of the Great Lakes constituency. The Education and Communications components of the program also provide important links between program information and the users of that information.

Bridges represent the application of knowledge in making the impassable passable, and a joining together so that traffic can pass both ways. The bridges that Sea Grant builds and maintains help the Great Lakes community enlist the state's academic institutions to make wise use of the Great Lakes. As a research, advisory, and education program that promotes wise development of marine resources, Michigan Sea Grant efforts have resulted in tangible benefits for the nation, Great Lakes communities, industries, and universities.

As the seventies gave way to the eighties and we bridged one decade to the next, the Michigan Sea Grant Program underwent its own transitions. The funding cycle that spanned 1977 and 1981 bridged some of the efforts of previous years and joined many of the goals of the Great Lakes community. Some research efforts underway in the mid-seventies were completed and research subprograms, such as that of the energy subprogram, were phased out. Other subprograms have spun off new efforts or have focused on other concerns. The subprogram overview in this report describes some of those efforts and how research areas have developed.

One of the most significant accomplishments during this period was the major reorganization of the Michigan Sea Grant Program. In 1977, Michigan Sea Grant had become a cooperative effort of Michigan State University and The University of Michigan. As part of the reorganization, Michigan Sea Grant also expanded its advisory service capability by integrating the program with Michigan State University's Cooperative Extension Service. The two universities continue to be united in one effort through Michigan Sea Grant working on the critical water resource issues in the region.

Although Michigan Sea Grant sponsors projects on issues of concern to the Great Lakes region, program results are often applicable to regions other than the Great Lakes. Some of the program's far-reaching achievements resulting from projects conducted during 1977-81 are highlighted in this report.

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Subprogram Overview

Subprogram Overview

The goals of Michigan Sea Grant's research subprograms are to solve problems created by ever-increasing uses of the Great Lakes and to assist in efforts to fully develop Great Lakes resources. During the last 150 years, the lakes have suffered from conflicting uses and deteriorating environmental quality. Major changes in the lakes occurred as a consequence of eutrophication caused by sewage disposal and farmland runoff, toxic waste disposal, physical alteration of the environment (such as dredging and filling wetlands), introduction of exotic fish species, and overfishing. Thus, there has been a long-term buildup of chemical content in the waters, accumulation of toxic substances in sediments, plants, and animals, declines in populations of desirable fish, and increases in populations of more pollution-tolerant but less desirable species. Nearly every use of the lakes is interrelated and conflicts with other uses. Recreational uses are limited by industrial uses, which in turn impair water quality and fish stock stability and health. High water levels are favored by shipping and hydroelectric power interests, yet high waters cause serious shoreline erosion and flooding.

Michigan Sea Grant approaches these multiple, interrelated problems through its research subprograms. The subprograms are complementary, so that the activities of one subprogram have implications for others. For example, the contaminant studies within the toxic substances subprogram have important consequences for fishery development projects within the fishery subprogram. The work on cold water near-drowning in the water safety subprogram bears on recreational, fisheries, transportation, and education subprogram activities.

This report highlights particular projects within each of the following subprograms: water safety, Great Lakes fisheries, toxic substances, coastal resources, Great Lakes transportation, recreation and tourism, and education. A brief overview of these subprograms follows.

WATER SAFETY

Michigan Sea Grant has long been a leader in water safety, diver training, and underwater technology. In its early years, this subprogram included diving technology development, diving safety, and training. Under the auspices of this subprogram, Michigan Sea Grant also installed, and continues to operate, a hyperbaric chamber to treat diving injuries; the chamber is also used to test underwater equipment and to treat other medical conditions, such as gas gangrene. Hundreds of hours of treatments of diving accidents and other medical conditions have taken place in the chamber. A comprehensive study of diving accidents resulting in ideas to prevent such tragedies was the model for similar studies underway at other institutions.

Michigan Sea Grant's revolutionary work in documenting cold water drowning incidents has led to saving hundreds of lives worldwide. Sea Grant researcher and physician Martin Nemiroff had revived victims who had been underwater for more than a half hour, and his techniques have been widely taught. Aggressive CPR and rewarming techniques have saved lives again and again, and survivors suffer no brain damage or other impairments.

The subprogram has continued research on cold water near-drowning and initiated new projects to determine any special risks of diving for women. This work was particularly necessary in light of the growing participation of women as recreational, commercial, research, and military divers.

GREAT LAKES FISHERIES

Much of the early work in this subprogram focused on developing alternative fishing gear for the commercial fishing industry. Sea Grant found purse seine nets to be successful alternatives to the traditional gill nets, which were prohibited in Michigan's Great Lakes waters in the 1970s. Also, small-mesh trap nets, a modification of a traditional deepwater trap net used in the Lakes, were found successful at harvesting round whitefish, an abundant species that eluded conventional Great Lakes gear. Throughout both gear development projects, Michigan Sea Grant worked closely with the commercial fishing industry, often in partnership with commercial fishing operations.

Another major thrust of the subprogram has been to expand commercial harvests of underutilized species. This required development of marketable products from species without widespread consumer acceptance, such as suckers. Improved techniques for handling, processing, and marketing fish products were also developed and transmitted to the commercial fishing industry.

In fisheries, as in most uses of the Lakes, much basic information on the economic returns of the resource had been lacking. Determining economic impacts of the fisheries has been a multi-year effort within the subprogram. This has resulted in better information for management decisions and recasting of Michigan's outdated commercial fishery law. New directions for the subprogram include greater emphasis on fishery management information and basic fish biology, such as research on where yellow perch spawn and competition in the streams between the young of native trout and introduced salmon. This information will lead to better management of the sport fishery.

TOXIC SUBSTANCES

Michigan Sea Grant has emphasized research on the identification and distribution of toxic substances within the Great Lakes ecosystem and their impact on living resources. At its inception, the subprogram identified polychlorinated biphenyls (PCBs) as the most critical toxicological problem affecting Great Lakes environments. A concerted multidisciplinary study of the environmental toxicology of PCBs provided a basis for understanding of, and research on other toxic substances. A more complete understanding of PCBs will facilitate management decisions on PCBs and other toxic materials. One of the benefits of this subprogram has been to assemble a team of researchers who can effectively further the resolution of future toxicological problems.

COASTAL RESOURCES

For several years, this subprogram focused on ways to mitigate coastal erosion. The research produced guidelines to help property owners and community planners choose effective and economical erosion control techniques. When much of this work concluded in 1979, Michigan Sea Grant reevaluated the direction of the subprogram. After consultation with coastal users, public agencies, and researchers, the subprogram shifted to coastal wetlands research.

The rate of decline in wetland acreage in Michigan is alarming and poses an unknown threat to the ecological role of wetlands as fish spawning areas, wildlife habitats, and nutrient sinks (trapping river-borne pollutants that would otherwise enter the lakes).

Many current problems facing Michigan's coastal region are complex and defy simplistic solutions. The natural processes in coastal freshwater wetlands are neither well understood nor well researched. There is little information

available concerning how Great Lakes coastal wetlands affect the quality of waters flowing through them, nor on the extent of wetlands necessary to ensure their natural functions. This information is necessary so we can avoid disrupting the wetland's critical chemical and biological processes.

The coastal resources subprogram attempts to better understand the role of coastal wetlands in Great Lakes ecology and economy to assist in establishing enlightened policies for their preservation and use. Initial research is focusing on natural wetland processes, such as how wetlands affect water quality and quantity, the effects on wetlands of changes in water levels, and the response of marsh birds to changes in wetlands. Other research is assessing the impacts of different wetland management options.

GREAT LAKES TRANSPORTATION

The goal of this new subprogram is to focus on technical problems in marine transportation. The subprogram initially concentrated on the major bottleneck of the Great Lakes system, the narrow St. Marys River. Several major areas where solid information could facilitate Great Lakes transportation were identified: navigation in the connecting waterways; the effects of wind and waves on ships; problems of operating in ice; and development of energy-efficient transportation.

The passage of large bulk carriers through the narrow connecting waterways is perhaps the most serious difficulty in current transport on the lakes. Sea Grant researchers have investigated the use of modern path control systems for safer and more expeditious transit of the channels. The economic benefits of applying this new technology were also evaluated, and estimates were developed of shoreline damage as a result of large vessel transits.

RECREATION AND TOURISM

Recreation is Michigan's second largest industry. Yet there had been little basic data on recreational uses of Great Lakes resources, the economic benefits of these uses, or measures needed to increase economic returns. The recreation subprogram began addressing these knowledge gaps with a study on the feasibility of establishing underwater parks in Michigan. Subsequent subprogram activities focused on market research on the habits and expenditures of recreational boaters, tourism information networks, and people's perceptions of Great Lakes recreational resources. The findings from these studies will help promote recreational opportunities and tourism in Michigan, which will, in turn, help to improve the state's economy.

Education projects provide training at graduate, undergraduate, and vocational levels, both to create awareness of marine resource issues and to provide training in a range of necessary skills. Sea Grant supported over 200 students during 1977-81. The training received through actual experience on Sea Grant research projects helps to shape the scientists and resource managers of the future.

Michigan Sea Grant's education efforts have concentrated on a major Great Lakes curriculum project for junior high school students, university courses in Great Lakes aquatics and management, and vocational short courses in ship production and fishery science. For the Great Lakes Environment Curriculum Project, 1980 marked the production and distribution of the first of five instructional units. This interdisciplinary unit, The Sea Lamprey Story, uses the case history of the sea lamprey invasion and resultant alterations in the Great Lakes ecosystem to show the interrelatedness of Great Lakes biological, physical, and sociological components. The unit was well received by educators and has been purchased by school systems throughout Michigan and the Great Lakes region from Milwaukee to Buffalo. More than 1000 teachers and 15,000 students have used the curriculum materials. The learner-centered materials can also be adapted to older and younger students; some activities have been used, with appropriate additions, in university courses.

Other education efforts are aimed specifically at college students. One such effort is the Great Lakes Limnology class which has been given at The University of Michigan Biological Station. The combination of classroom, laboratory, and field work makes the class a unique offering in the region. This class provided rarely available practical experience, including cruises on the research vessel, The Laurentian.

Michigan Sea Grant also began a Great Lakes seminar that draws on the many people in southeastern Michigan with Great Lakes-related expertise. As part of the curriculum of the College of Engineering, the seminar focuses on Great Lakes resource use problems. The class investigates issues and prepares an in-depth report. Student research reports have been used in League of Women Voters' workshops.

One of the vocational short courses at Michigan State University was in fishery science for commercial fishers and charterboat operators. The purpose of the course was to provide a better understanding of the Great Lakes fishery resource and of fisheries regulations. Veterans of the short course attended a special course to learn the results of a Sea Grant assessment of whitefish stocks. As a result of that class, harvests of undersized whitefish dropped 80 to 90 percent, thus preserving a major Lake Michigan commercial fishery.

Subprogram Highlights

Breakthrough Discoveries in Cold Water Near-Drowning

Until 1976, drowning victims underwater for longer than four minutes were generally presumed dead and efforts were not made to resuscitate them. However, based on medical knowledge and first-hand experience, physician Martin Nemiroff developed a theory in the 1970s that people submerged for even longer periods of time, especially in cold water, could survive without brain damage or other adverse after-effects. He speculated that the body's reaction to cold water protected victims by reducing the body's oxygen needs.

In 1975, Nemiroff, then a Professor of Internal Medicine at The University of Michigan Medical Center, had an opportunity to test his theory. He revived an 18-year old drowning victim submerged in cold water for 38 minutes. After 13 hours of resuscitation and respiratory support, the young man regained consciousness. Two weeks later, he left the hospital and returned to college where he continued to be an A student.

Michigan Sea Grant funded Nemiroff in 1976 to further document his theory. His research activities revealed that cold water drowning victims could survive after submersion for as long as an hour if properly resuscitated.

With Sea Grant support, Nemiroff conducted clinical studies of near-drowning incidents for two years. In that time, he compiled statistics, analyzed possible reasons for survival, and began to formulate medical techniques to administer to drowning victims. He carefully documented 80 cases in which he was directly involved and consulted in over 200 cases. Half of these cases involved cold water (below 70° Fahrenheit).

Why do cold water drowning victims survive without brain damage? According to Nemiroff, cold water sometimes activates an automatic response called the "mammalian diving reflex" which maintains life even after the victim becomes unconscious. This primitive reflex allows many water mammals, such as whales, to remain under water without breathing for long periods of time. The reflex slows the blood supply to the skin, muscles, and other tissues that are resistant to oxygen-loss damage. At the same time, the remaining blood oxygen is directed to the brain and heart, permitting a person to be without external oxygen for longer periods. The mammalian diving reflex is most pronounced in children and young people and operates even if the victim has all appearances of death: no pulse or heartbeat, cold and blue skin, no breath, and fixed, dilated pupils.

Many factors affect the chance of survival according to Nemiroff: duration under water, the temperature of the water, the age of the victim and the promptness, persistence, and correctness of resuscitation efforts (CPR and gradual rewarming techniques).

By the summer of 1977, Sea Grant was sure enough of Nemiroff's findings to realize that unless the rest of the world knew about chances of surviving cold water immersion, many people could die needlessly. Thus, in cooperation with Michigan Sea Grant, the U.S. Coast Guard, and Michigan State Police, Nemiroff spearheaded a widespread public information and education program to promote awareness of the nature of cold water near-drowning and resuscitation techniques. Sea Grant communicators assisted in developing and disseminating informational materials through national and international media and other outlets. Advisory service agents began an extensive program to train "first responders" (such as paramedics, firefighters, sheriffs, water rescue personnel) and those in charge of hospital emergency room treatment of cold water accident victims. Agents also developed support materials to help those already trained to train others. In the first ten months of this public education effort, more than 1400 people were trained, who, in turn, trained groups of their peers.

The goal of this major outreach program was to have life-saving information about cold water near-drowning used by training programs that would institutionalize it. That goal has been achieved. As a result of Michigan Sea Grant's research and public information efforts:

- o Hundreds of lives are saved worldwide each year. The Coast Guard estimates a 25% drop in drowning fatalities. The Coast Guard continues to train its personnel and has carried out a wide-reaching campaign to teach boaters about cold water near-drowning and revival measures.
- o Hospitals across the nation have set up emergency teams to handle near-drownings and have obtained special equipment to handle these cases. National and international medical personnel have been trained in cold water near-drowning revival techniques.
- o Water safety manuals used by hospitals and organizations including the United States Coast Guard, American and International Red Cross, NATO, and the British Navy have been rewritten to incorporate information on cold water near-drowning rescue techniques.
- o Michigan Sea Grant Marine Advisory Service Agents have informed, educated, and/or trained over 5000 persons (first responders, emergency medical personnel, and others), about near-drowning and rescue procedures.
- o The Michigan Sea Grant Marine Advisory Service and the Communications programs have prepared publications on emergency treatment of near-drowning victims which are now distributed by the Coast Guard, Departments of Natural Resources, and other organizations.

According to the Coast Guard, a 50% drop in boating fatalities would be possible if public education programs were maintained. Sea Grant continues to make as many people as possible aware of the life-saving potential of prompt CPR (cardio-pulmonary resuscitation) for a person who appears to have drowned in cold water. Training programs for first responders are still conducted by Marine Advisory Agents. And Michigan Sea Grant has continued efforts to trace the incidence of cold water near-drownings across the nation and to refine the medical protocol for reviving these accident victims.

GREAT LAKES FISHERIES

Bridging Science and Policy

In response to fishery policies and to aid in policy decision-making, Michigan Sea Grant conducted significant projects related to fishery gear development, economics, and management. One of these resulted in the development of highly efficient fishing gear in response to a statewide ban on gill netting. Two others, on fishery economics and management, provided valuable information to the agencies responsible for managing the fishery resources, and have helped people who must follow fishery policies understand fishery management principles. These results have also served consumers, who benefit from careful management of the fisheries.

New Fishing Gear Improves Commercial Harvests

In recent years, Great Lakes commercial fishers found themselves without efficient, legal gear for catching the fish species they wanted. Traditionally, commercial fishers used gill nets successfully. However, several states in the region phased these nets out because they are non-selective and often catch sport and protected fish as well as commercial fish. When the Michigan Department of Natural Resources banned virtually all gill netting in Michigan Great Lakes waters, commercial harvesters had to turn to other gear or go out of business. To find practical, selective gear, Sea Grant scientists at The University of Michigan and Michigan State University experimented with new nets. In two projects, they found that purse seine nets and small-mesh trap nets catch selected species and are efficient and economically feasible.

Purse seine nets are used in ocean fishing but had never been used on the Great Lakes. Their use in Great Lakes waters was evaluated in a two-year demonstration project directed by Sea Grant Advisory Service Agent Tom Kelly. He worked closely with commercial fishers at the Leland Fish Company, fish biologists at the Michigan Department of Natural Resources, and officials of the Upper Great Lakes Regional Commission.

Purse seine nets are selective because a fisher first locates a school of fish, then encircles the school in the net, using a skiff to pull the net around the fish. The net is then closed (pursed) on the bottom to contain the fish and pulled onto a larger boat. Because fish do not become entangled in the net, fishers can release unharmed any protected or sport fish that may be caught. Unlike gill nets, the purse seine is in the water only when being set; it is taken back to port at the end of the day. It is adaptable to many existing Great Lakes fishing vessels, and can be used to catch a variety of fish.

The purse seine net that Kelly and his colleagues used was designed to catch whitefish. During the first year of the project the purse seine caught 61,697 tons of whitefish with only 1% mortality to other species and undersized whitefish.

The purse seine project revealed that ocean gear could be successfully adapted to Great Lakes waters. The net was effective in providing a much needed method for efficiently harvesting commercial fish; protecting sport fish from accidental capture by commercial fishers; providing commercial fishers with gear that can be used in areas not presently fished; and providing the Michigan Department of Natural Resources, other Great Lakes states, and Canada with a workable new technique to help manage Great Lakes fisheries.

Another gear-testing project which required the expertise of an established Great Lakes fishing operation was the small-mesh trap net project. David Jude and Timothy Miller of The University of Michigan Great Lakes Research Division and the Lixey Brothers Fish Company in East Tawas, Michigan, built and tested a small-mesh trap net. The net, with smaller than usual mesh holes, was built to catch local populations of round whitefish, a species that was abundant but left unharvested by conventional mesh trap nets. The researchers also tried the net on yellow perch.

The small-mesh trap net project was a success in a variety of ways. The net was successful in catching round whitefish and yellow perch. The project also yielded useful information about the growth of round whitefish populations in the area. The populations were growing more slowly than previously believed, but faster than Lake Superior stocks. Another aspect of the project involved testing for contaminant levels. Round whitefish tested well below the established federal levels for PCBs, PBB, DDT, dieldrin, and mercury.

Both gear development projects were conducted in close cooperation with the Michigan Department of Natural Resources.

Economic Benefits of Sport and Commercial Fishing

Over the past few decades, sport fishing activity has been far greater than that of commercial fishing in Michigan's Great Lakes waters. This is partly because of fishery allocation policies which reflected resource managers' perceptions about changes in public values. When fish populations began recovering from the devastation caused by the invading sea lamprey, fishing managers encouraged sport fishing instead of returning to former policies that emphasized commercial fishing. The Michigan Department of Natural Resources maintained that sport fishery values had changed in the 1940's and 1950's, and now far outweighed those of the commercial fishery. However, the accuracy of management decisions based on those values was questionable because the actual economic returns of the fisheries had never been determined.

In 1977, Sea Grant began a study to provide much of the economic information which had been lacking. Daniel Talhelm, an economist in Michigan State University's Department of Fisheries and Wildlife, began a multi-year project to estimate and analyze the value of Michigan's sport and commercial fisheries.

Talhelm's preliminary studies revealed that the annual economic value of Michigan's Great Lakes sport fishing resource was almost \$250 million and commercial fishing resource was about \$2-3 million. (Fishery resource values are hypothetical estimates of the amount people would pay to use the resource if such charges were imposed.) Talhelm estimated that commercial fishery resource values could be increased severalfold by reallocating fish stocks, but not without much greater reductions in sport fishery resource values. He also estimated that, statewide, incomes directly and indirectly produced by the Great Lakes fishery were also over \$300 million per year for the sport fishery and about \$20 million per year for the commercial fishery.

Despite the fact that sport fishing values are far greater than those of commercial fishing, Talhelm concluded that the greatest total values can be realized by having both fisheries. He reasoned that the species which are important to commercial fishers but not to sport fishers nor detrimental to sport fish stocks can be efficiently utilized to add to overall fisheries values. Also, some commercial fishing may enhance fisheries values in localities where sport fishing is light.

Talhelm's economic analysis of fisheries values provided useful information to managers of the resource, brought more precision into fishery management decisions, and laid the groundwork for economic analysis of management alternatives.

Bridging Fishery Science and Management Decisions

At the request of the Michigan Fish Producers Association, Michigan Sea Grant began a fishery science short course in 1977. The purpose of the course was to train fishers in management programs to conserve and improve fish stocks. The course was organized by fishery researcher and extension specialist Ray White of Michigan State University's Department of Fisheries and Wildlife. He was assisted by the advisory agents and by fishery professors from MSU and The University of Michigan.

White's course provided training in fish anatomy, physiology, behavior, feeding, reproduction, population dynamics, and management science for a dozen persons each year. The result was a better understanding of how management agencies gather and analyze data used for fishery management decisions. Over the years, the class evolved from one directed solely at commercial harvesters to one also helping other groups with a stake in fish stocks. These have included representatives from the Michigan United Conservation Clubs, Native American fishers, and charter boat operators.

After the basic courses, some students returned for more advanced work in fishery science. In 1977, for example, thirteen commercial fishers attended the first basic fish biology course; in 1978, these fishers attended a fish population dynamics course; and in 1979, they applied their training to a real life situation in a two-day course on lake whitefish. According to Walt Stoddard, president of the Michigan Fish Producers Association, the group wanted to get a realistic picture of the lake whitefish in northern Lake Michigan. Fishers and agency managers disagree on the size of the Green Bay and Bay de Noc fish populations and the impact of current fishing levels. Through the course, the students concluded that whitefish stocks in the region were just holding their own at current catch levels. However, an increase in fishing effort in Bay de Noc would not add significantly to the catch, and it would apparently be harmful to the whitefish population.

The course graduates gained new information to help them make decisions about their businesses. Many also feel better equipped to discuss problems with the various fishery management agencies. And the agencies are pleased, too. The Michigan Department of Natural Resources fisheries chief stated that, since Michigan fishers started attending these short courses, the communications gap has narrowed between the fishers and fishery managers.

Progress in Prevention of Chemical Hazards

Serious environmental damage has resulted from the inability to predict the impact of hundreds of new chemicals used in industrial processes, agriculture, forest management, and by private citizens which are released into the environment. Contaminants in fish were one of the first indicators of the severity of toxic substances problems in the Great Lakes. In 1977, Michigan Sea Grant organized a toxic substances subprogram to provide expertise on this major concern.

Researchers began a multidisciplinary, coordinated investigation of polychlorinated biphenyls (PCBs), chlorinated hydrocarbons similar to DDT that are a major problem in the Great Lakes. Because PCBs were once very widely used in many industrial applications, degrade very slowly, accumulate in the fat tissues of organisms, and are toxic with chronic exposure, PCB contamination is a problem of serious proportions. The research team produced individual studies which, taken together, form a picture of how toxic substances enter and travel through the Great Lakes system, accumulate in fish, and, ultimately, affect humans. Three of those studies are highlighted: a University of Michigan study that resulted in a screening method to identify potential chemical hazards, and two studies at Michigan State University that focused on how PCBs accumulate in fish, and on what their effects are in mammals.

Identifying Potential Chemical Hazards

Of particular practical significance in research on toxic substances was the development of a cost-efficient survey method for identifying potentially hazardous chemicals. Rolf Hartung, a toxicologist at The University of Michigan, devised a screening method for picking out from among the approximately 700 known chemicals released into the Great Lakes environment the ones likely to be hazardous. He focused on the characteristics which hazardous chemicals tend to have: concentration, persistence, and chronic toxicity after prolonged exposures.

Hartung's first step in developing a screening method was to identify which chemicals are likely to accumulate in body tissues. He estimated chemical accumulation by calculating bioconcentration coefficients for many organic chemicals that have caused problems in the past. The coefficient can be derived experimentally or can be calculated from the physical and chemical characteristics of the compound. Hartung used calculations because they are preferred for a screening test.

The second step involved screening those chemicals with high bioconcentration coefficients for persistence. In evaluating environmental persistence, Hartung again sought a physical-chemical measure. His

preliminary laboratory method suggests that the measured susceptibility of chemicals to oxidation under accelerated conditions may be a useful criterion.

Just because a particular chemical is likely to accumulate in an organism and unlikely to degrade quickly, it will not necessarily be toxic. Thus, the third step of the screening procedure was to check for significant chronic toxicity. Those chemicals which exhibited high bioconcentration coefficients and low degradability needed to be screened for chronic toxicity. There are many possible testing protocols for chronic toxicity. In this case, a 21-day exposure of fathead minnow larvae to low concentrations of the toxicants was selected as the most suitable compromise for a screening test. The test measures growth and survival for a sensitive life stage of this minnow.

The result of this three-step process is a manageable, affordable, laboratory procedure for sorting through potential chemical problems and identifying ones that are most likely to be harmful to the environment and possibly to human health.

Hartung emphasized that the screening test cannot verify that a chemical is hazardous, but can help researchers set priorities for subsequent in-depth assessments. Thus, Hartung's findings have helped other researchers and regulatory agencies to concentrate limited resources on the "bad actors" among the hundreds of chemicals used in the Great Lakes region. His findings have been used by the Environmental Protection Agency, the International Joint Commission's Committee on Human Health Effects, and Michigan's Critical Materials Registry Committee.

By adding to our understanding of the nature of toxic substances and how they travel throughout the Great Lakes system, Sea Grant hopes to help policy-makers and natural resource managers solve and prevent critical environmental contamination problems.

How PCBs Contaminate Fish

Fish don't have to eat contaminated insects or plants to accumulate contaminants; they can absorb pollutants through their skins, breathe them through their gills, or drink them. Howard Johnson, of the Department of Fisheries and Wildlife at Michigan State University, studied how fish accumulate PCBs from contaminated sediments.

Johnson wondered whether the PCBs accumulated by fish came from the water or the sediments. So he compared PCB levels in the fish, the water, and the sediments. He found that the PCBs in the minnows more closely resembled those in the water than those attached to sediments. Both the fish and the water contained lower PCBs than the sediments. Because lower PCBs are more water soluble, Johnson concluded that fish absorb PCBs more easily from water than from sediments in the water.

Johnson's experiments revealed that fish will accumulate more or less PCBs depending on the turbidity of the water. Therefore, fish exposed to areas where bottom sediments get stirred up will accumulate more PCBs than those that live in calmer waters.

Because bottom sediments become stirred up during dredging, Johnson's results are used by federal agencies and the Michigan Department of Natural Resources to make decisions about whether or not to dredge in the Great Lakes, and to help determine allowable limits of PCBs in dredged sediments.

Discovering How PCBs Affect Mammals

This Sea Grant project conducted at Michigan State University investigated PCBs' effects on mammals. At the same time, the project sought solutions to a practical problem in the Great Lakes region: reproductive difficulties in mink.

Mink ranchers in the Great Lakes region who had fed their mink Great Lakes fish discovered that the mink had developed severe reproductive disorders. The ranchers had to find other more expensive food sources for their mink.

Meanwhile, it was found that the reason why the mink failed to become pregnant or bear live young was that they had eaten PCB-contaminated fish. But how much of the chemical could poison mink, and what about other mammals? Researchers Robert Ringer and Richard Aulerich of Michigan State University's Poultry Science Department came up with some answers.

They fed two different compounds of PCBs in different dosages to minks and ferrets, a species closely related to mink. They found that one PCB compound (Aroclor 1242) was more toxic than another (Aroclor 1016), but both seriously upset the physiology and reproduction of mink. Most of the mink died. Ferrets, however, could tolerate some dosages of both compounds, and had fewer deaths than the minks. Ringer and Aulerich found that even closely related species have different tolerances for PCBs.

This research started to give hard evidence of PCBs' effects on mammals. It also helped the mink industry understand what levels of PCBs in fish can be tolerated by mink. Thus, Michigan Sea Grant research both provided valuable information about PCBs and helped industry in the Great Lakes region.

Low-Cost Shore Protection Means High Value to Shore Property Owners

Since 500 to 700 miles of Michigan's shoreline erode rapidly, low-cost shore protection can save property owners millions of dollars, and save miles of shoreline that would otherwise be unprotected due to prohibitive costs. Protecting the shore from erosion can cost up to \$500 a foot. Shoreline homeowners need accurate, reliable information about effective, low-cost shore protection methods.

Michigan Sea Grant found ways to protect shore property for less money. In a five-year project, Ernest Brater, of The University of Michigan Department of Civil Engineering, investigated economical ways to protect shoreline property. He tested low-cost shore protection devices at 18 sites in Michigan, areas highly vulnerable to erosion. He found that low-cost devices, those between \$25 and \$100 a foot, can protect shores if they are properly selected for the site, well-designed, and well-built.

Those three criteria may sound simple, but they are not. For a device to be properly selected for a site, the engineer must analyze the slope and composition of the beach and bluff, wind and wave forces, water levels, and also plan for seasonal and yearly variations. The design must also take into account that the shores and erosion forces may vary every few yards. Other factors to consider are types of property and owners, and economics. Brater designed his 18 low-cost installations with all these factors in mind.

Brater and other researchers examined and photographed the 18 trial sites twice a year in the spring and fall. They also observed as many sites as possible after major storms. These field observations, along with observations at other shore locations, told researchers what worked and for how long. Estimating how many years a device stays intact is critical to figuring the cost of shore protection.

All the testing did not take place on coastal sites. Another phase of the research was the measurement of erosion rates from model waves projected in a wave tank at the Hydraulics Engineering unit within the Department of Civil Engineering. Wave action, water levels, and littoral drift (currents created by wind and waves that move beach materials along the shore) all contribute to the erosion process. To better understand exactly how these forces erode shores, Brater projected model waves against a sand bluff at a scale ratio of 1 to 50.

Brater found that three things make a shore protection device low cost: inexpensive and innovative materials, smaller structures, or omission of foundations.

In general, the installations that worked at the test sites were low-cost

wooden groins, short piers build perpendicular to the beach that trap sand carried by littoral drift. Wooden groins built with wooden pilings for foundation can last up to 15 years in the Great Lakes before washing away. Rubble revetments, which cover the base of the bluff like a blanket, were also successful. The rubble can be inexpensive, local, ungraded rock.

Low-cost barriers built parallel to the shore to keep the waves from reaching it were generally not as successful. The barriers tested included sand-filled tubes, giant sandbags, and breakwaters with no foundations.

Each device or method performed differently, depending on its location and the manner of installation. For example, sand nourishment at Tawas City, where the sand was placed between a groin and a pier, was very effective. But where sand was placed on the open beach, it was quickly moved away even though the area was not exposed to high waves.

Reports resulting from Dr. Brater's projects describe various options which can help shoreline property owners and engineers choose the best device for a particular location.

Effects of Shore Protection Devices on Property Value

Even low-cost erosion protection systems can be expensive to the average shoreline landowner. John Armstrong, of the Department of Civil Engineering and Coastal Zone Laboratory, and R. Bruce DenUyl, of the School of Natural Resources, developed a computer model to analyze how erosion control devices changed the market value of properties. They looked at such questions as how much a sandbag sea wall will affect property value compared to a steel sea wall; how those values change over a ten-year period; and how home distance from the shore changes market value and erosion rate.

The investigators used 20,000 cases in the computer model. That gave them specific monetary values for different kinds of erosion control devices in specific places. This model was later refined. The model lets a landowner calculate the cost of various protection options and the return on the investment in shore protection in order to make wise investment decisions.

GREAT LAKES TRANSPORTATION

Automatic Path Control Allows Larger Ships Without Larger Waterways

The Great Lakes-St. Lawrence Seaway is the world's largest body of fresh water and a major North American trade route. Though ships navigate in open water through most of the system, they must pass through constricting channels and locks in the connecting waterways and harbors. The narrow channels present physical and economic constraints on use of the system. Maintaining a tight path through the narrow waterways is of

considerable importance. Also, the constraints limit the number and size of vessels which can use the system, thus limiting its operating capacity. Much of the cargo moved on the Great Lakes are bulk commodities--coal, grain, iron ore--which could be moved in larger, more efficient vessels if the waterway could accommodate them.

Widening and deepening the Great Lakes connecting waterways could entail enormous costs and environmental damage. Automated path control systems, on the other hand, may allow larger vessels through without reshaping the channels.

The questions Michigan Sea Grant asked were: Could an automated path control system be developed for Great Lakes vessels? If so, what would be the optimal size vessel which could use such a system? How would the shorelines in the narrow channels be affected by the transit of these large vessels? Sea Grant researchers at The University of Michigan Department of Naval Architecture and Marine Engineering set about answering these questions.

Developing Automated Path Control Systems

The extent of channel improvement and dredging required for safe and economical operations on the Great Lakes is determined not merely by the overall dimensions of the vessels, but also by their maneuvering and control capabilities. In view of the high cost and environmental sensitivity of dredging harbors and connecting channels, improvements in ship control technology might well minimize the amount of dredging required. Path control systems might prove economically feasible even with existing channel dimensions, since the control systems would allow the use of larger, more economical vessels without increasing waterway maintenance costs. Also, controlling ships along prescribed paths in restricted waterways has important operational, safety, and environmental advantages.

Michael Parsons and his research associate Hua Cuong evaluated various path control options. They looked at several approaches, each with its own strengths, weaknesses, and design compromises. They concluded that multivariable integral control law using a microcomputer on board the ship seemed the best means for providing the sensitivity necessary to guide large ships through narrow waterways.

Path Control Systems Allow Economic Benefits and Optimum Vessel Size

The possibility of economic benefits from increasing ship size has led to continuing interest in enlarging the waterways. Several studies have examined the costs and benefits of increasing the waterway dimensions. They reveal that estimated costs of widening and deepening the waterways are staggering. For example, they could easily exceed \$25 billion if vessels 1500 feet by 175

feet with a 25.5 ft. draft were to be accommodated. (The largest ships currently in use are 1000 feet by 105 feet owith a draft of 25.5 feet.)

All analyses to date have assumed conventional control systems would be used. The question Sea Grant raised was: To what extent might improved vessel control alter the channel dimension requirements? Perhaps with precision vessel positioning and finely tuned vessel steering and response controls, the current channel clearance standards could be reduced. Sea Grant researcher Howard Bunch evaluated how reduced clearance and headway requirements would affect the costs of altering and maintaining channel dimensions for larger ships. He also determined the optimum size for Great Lakes ships, based on economic factors and present draft limitations. His data can be used to help determine the optimum relationships among type of path control system, ship size, and channel dimension.

Bunch's analysis led to two major conclusions. First, he determined that the optimum size bulk carrier for upper Great Lakes transits (above Niagara Falls) would be 1250 feet by 156 feet, assuming the present maximum draft constraint of 27.2 feet. (The shallow draft is the major factor limiting vessel length and widths.) Vessels of the optimum size would produce a savings in excess of 10 percent on the longest transits (Duluth to Buffalo) when compared with the largest (and most efficient) ships in service today.

Second, although it would cost up to \$6 billion to modify the water system so that these larger vessels could be accommodated with traditional clearances, Bunch concluded that up to \$5 billion could be saved in channel, turning basin, and lock improvement costs by using advanced ship maneuvering control systems. The exact amount of savings would be a function of a control system's cost when compared with its ability to precisely regulate the movement of the vessel. The greater the control, the less clearance required between ship and channel bank.

Shoreline Effects of Large Vessel in Narrow Waterways

One problem associated with the trend toward larger vessels in the Great Lakes fleet is the potential for increased shoreline erosion and damage to shore structures along narrow channels. Each pass through a channel is a potential threat to the shoreline and its users, and the threat becomes greater with larger ships. Due to the high volume of traffic on the connecting waterways, the cumulative effect of vessel transits on the shoreline may become a critical factor in future decisions about channel expansion, design and operation of Great Lakes ships, and requirements for shoreline protection.

One of the key environmental effects of vessel transit in confined water is a change in water surface elevation and flow (referred to as the pressure distribution or signature). This causes shore damage and disturbs the

sediments. To predict the magnitude of these effects, Sea Grant researcher Robert Scher used a mathematical, hydrodynamic ship and channel model to estimate the amplitude, duration, and shape of pressure signatures. Scher chose a model that had been validated by comparison with experimental results. Pressure signatures were calculated for various channel dimensions and vessel dimensions, hull forms, speeds, and vessel positions in the channel.

Scher made these calculations for the 1250-foot by 156-foot vessels that Bunch found to be optimum size and compared the results with the 1000 footers in use today. He found that channel dimensions, vessel beam and draft, and vessel speed are the major determinants of the amplitude of pressure signatures. The ship's position is also an important factor. His conclusions indicate the need for careful decisions regarding channel configurations, vessel speed limits, and other navigation rules.

RECREATION AND TOURISM

Underwater Preserves Bring Benefits to Michigan Communities

The first underwater preserves in the U.S. waters of the Great Lakes were established largely due to Michigan Sea Grant research and advisory services efforts. These preserves, which protect shipwrecks from treasure hunters while enabling divers to view them and other interesting underwater objects, are bringing large economic returns to Michigan communities.

The idea of underwater preserves germinated in the mind of Donald Holecek of the Park and Recreation Resources Department at Michigan State University. With Sea Grant support, Holecek looked into the feasibility of establishing underwater preserves in Michigan's Great Lakes waters. He inventoried underwater resources, did research on what management problems might be encountered, and pinpointed positive and negative aspects of establishing underwater preserves in Michigan. Holecek found that Michigan has 3000 known shipwrecks and about 11 areas that would work well as underwater preserves, presenting fascinating recreational opportunities for Great Lakes divers.

This effort culminated in the passage in 1980 of state legislation which enabled areas to be designated as underwater preserves. With the help of Marine Advisory Agents, two communities established preserves: The Thunder Bay Bottomland Preserve in Lake Huron off Alpena, and the Alger County Underwater Preserve in Lake Superior off Munising. These areas help preserve important archeological resources, particularly shipwrecks, and improve the recreational diving business in these areas. In its first year, the Alger County preserve helped increase one dive charter operator's gross income from \$500 a season to \$500 a weekend. The annual value of the diving tourist industry at this preserve is predicted to increase from \$600,000 to \$5 million by 1990.

With the increased interest in scuba diving and the growing economic benefits the preserves are bringing to nearby communities, other areas in Michigan have expressed interest in establishing underwater preserves.

The success of the underwater preserves project led to the creation of Michigan Sea Grant's recreation and tourism subprogram. This is an important subprogram for Sea Grant to have in Michigan, where tourism is the second largest industry. And, since the state has 3200 miles of Great Lakes shoreline and 41 percent of Great Lakes waters, a good portion of Michigan's recreational activity is Great Lakes-oriented. With the decline of the auto industry in Michigan, development of a subprogram in recreation and tourism was an effective response to the state's search for ways to diversify its economy.

EDUCATION

Training Course Helps American Shipbuilders Compete Internationally

A general decline occurred in the United States shipbuilding industry after World War II, and the industry became increasingly less competitive in the world markets. Numerous factors contributed to this unfavorable posture: the high American wage scale, low capital investment for new facilities, and the industry's perception of uncertainty and variability for new ship demand. In the past few years, however, efforts have been initiated to overcome these deficiencies. Capital investment has significantly increased; new marketing strategies have been developed; and production research has been greatly expanded. Typical of the last area--production research expansion--has been the National Shipbuilding Research Program, a cooperative industry/government research program to promote and coordinate national self-improvement of United States shipbuilding. As a result of this program, the U.S. shipbuilding industry is now at the threshold of a period of significant change in its business strategy and organizational approach to ship construction.

Among other things, it has been recognized that the ability to improve shipbuilding is critically dependent upon effective and continuing training of industry personnel at all levels, from the yard worker to the senior manager. And one of the most important needs is in the area of ship production, planning, scheduling, and control, especially among those who are (or will be) mid-level technical and production managers. Without question, the naval architect is one of the most critical professional classifications in this range. It is the naval architect who has the first opportunity to incorporate features into the ship design that will enhance the production control process. And the ability to effectively control the construction process inevitably results in an increased construction efficiency and a reduction in total cost.

The University of Michigan's Department of Naval Architecture and Marine Engineering (N.A.M.E.) trains over 50 percent of the naval architects produced in the United States. Because of this dominant position, the department's faculty felt a special responsibility to provide a curriculum that would be most beneficial in meeting the future needs of the students and the industry they will serve. With Sea Grant support, Howard M. Bunch of N.A.M.E. developed a training course in the latest ship production techniques. This project was the first step in the department's attempt to respond effectively to the need for improved education in ship production and production planning.

Courses and, ultimately, a program were established within N.A.M.E. that specifically focused on the latest techniques of ship production and production planning. Because ship production technology and ship production planning and scheduling technology are in such a rapid state of flux and improvement, it was necessary that unusual steps be taken to effectively emplace the course. First there was the need to precisely identify the "current state of art" being practiced in United States and foreign yards. What are various yards doing, and why are there differences in the systems? Which systems are the most effective, and why?

An instructional staff had to be developed that understood the new techniques and resources being utilized in production. As far as could be determined, no naval architect or faculty in naval architecture in the United States was current with the latest developments and interrelationships in ship production and ship production planning, scheduling, and control; thus the faculty had to be familiarized with the state-of-the-art technology.

Separate from the needs associated with preparing course material and training instructors for naval architecture students, there was also a need to quickly provide instruction for persons presently employed within the industry itself. Several ship yards are attempting to incorporate the latest production technology into their system. One of their major bottlenecks, however, has been the training of personnel; and the more rapidly the bottleneck is eliminated the better.

What resulted from this Sea Grant-sponsored project was a short course on ship production for industry personnel. The reports and other material developed for the course were then utilized in instructional programs for naval architects. The most significant result of the short course was the addition of a course entitled "Ship Production and Production Planning" to the Naval Architecture and Marine Engineering curriculum at The University of Michigan. This class is for undergraduate seniors and graduate students.

A number of benefits resulted from the new course on ship production. The University of Michigan received \$250,000 from the U.S. Navy for further development of an overall program in ship production and ship production planning. As a result of positive industry reaction to the short course, the Ship Production Committee of the Society of Naval Architecture and Marine Engineering established a panel on education. Needed communications between industry and academia were increased. And a new graduate level concentration in shipbuilding and ship production planning became available which provides basic support for training staff and faculty in the latest ship production techniques.

The training course has helped American shipbuilders effectively compete in the international merchant marine market. This project illustrates how Michigan Sea Grant education activities do not just benefit students and residents of the Great Lakes states, but have wide applicability within the field of marine affairs.

Marine Advisory Service Highlights

Marine Advisory Service

Marine Advisory Agents are Michigan Sea Grant's representatives in communities around the state. They work with residents and state and local organizations on an everyday basis, delivering the results of Sea Grant research where needed. They also bring back to Sea Grant word of emerging problems and issues that need to be addressed by the research and education sectors of the program.

The Advisory Service functions as a component of the Michigan State University Cooperative Extension Service. This provides an established network covering all Michigan counties, and multiplies individual Advisory Service efforts through Cooperative Extension activities, which draw on Sea Grant projects. The statewide cold water survival programming is a prime example of how Sea Grant agents and Cooperative Extension personnel join together to deliver Sea Grant information (see Water Safety subprogram highlight, "Breakthrough Discoveries in Cold Water Near-Drowning"). Sea Grant agents present cold water survival demonstrations and prepare educational materials, while Cooperative Extension personnel handle local management of these workshops in their counties. The result has been an increased number of people trained in techniques that save the lives of cold water near-drowning victims.

The Advisory Service includes the field staff and campus-based specialists. These specialists respond to critical needs and provide backup for the field agents; they provide technical or practical information and participate in field projects.

The major efforts of the Advisory Service are concentrated in the work of field agents, who serve Michigan's coastal communities, businesses, public and private agencies, and educators. Michigan's coastal regions are divided into five districts; agents headquartered in Grand Haven, Marquette, Traverse City, Tawas City, and Mount Clemens provide services in those districts. For the first time in 1979, Michigan Sea Grant had a full complement of agents serving all five districts when an agent for the northeastern Lower Peninsula was hired. In 1981, Michigan Sea Grant Advisory Service Agents were Ron Kinnunen, John McKinney, Charles Pistis, John Schwartz, and Steve Stewart.

Agents share specialized expertise across district borders. They also cooperate with Sea Grant agents in other Great Lakes states. This results in a fuller service for fewer dollars and less duplication of effort in programming.

Major Marine Advisory Service activities between 1977-81 follow.

WATER SAFETY

- o Cold water survival education program -- statewide effort to educate firefighters, sheriff's departments, rescue and E.M.T. squads, water recreation groups, emergency room staff, and other medical personnel in techniques for reviving persons who have apparently drowned in cold water

GREAT LAKES FISHERIES

- o Fish processing and onboard handling of commercial catch -- updated methods of handling of fish both on board commercial vessels and in dockside plants; lead to improved quality of catch and consumer acceptance
- o Demonstration of production and marketing of underutilized fish -- used Sea Grant-supplied mechanical deboner to produce minced sucker food product with high consumer acceptance; demonstrated that 80% of catch currently going to waste for lack of a market can be used
- o Expanded nutrition/consumer education -- educational workshops merged the need for expanded market for Great Lakes fish products with need for economical, nutritious protein sources for low income families; improved consumer appreciation of Great Lakes fish
- o Fishery economics--developed economic data; lead to rational fishery management and business decisions
- o Fishery science short course -- taught basic fishery biology and management to commercial fishers and fishing charter boat operators; resulted in an 80-90% decrease in the number of undersized Lake Michigan whitefish harvested, and better understanding and cooperation between the regulators and the regulated

COASTAL RESOURCES

- o Shore erosion protection -- assistance to shore property owners and public bodies with devices and methods for analyzing and resolving erosion problems
- o Policy workshops -- provide materials and techniques to help local decision makers participate in forming legislation and public policies related to marine resource management
- o Wetlands assessment workshops -- provide training for local and regional resource managers, elected officials, and environmentalists in using aerial photography to identify, measure, and characterize wetlands

- o Wetlands education programs--provide instruction for youth groups and students and inservice training for science teachers

GREAT LAKES TRANSPORTATION

- o Agricultural commodity transport -- study of commodities currently moved on the Great Lakes; provides information to acquaint potential shippers with economical, energy-efficient transport systems
- o Engineering assistance to marine businesses -- identified areas where marinas and other boat businesses needed engineering assistance; provided services and technical expertise for owner/operators

RECREATION AND TOURISM

- o Marina management education -- conferences to improve marina managers' ability to function as a trade group and conduct business in Michigan; group responded with \$7,500 to help Sea Grant do research on boating economics
- o Charter boat operator education programs -- modeled on marina managers course, assisted in forming trade group with group insurance and other benefits; improved knowledge of fishery science
- o Tourism and recreation business -- Helped coastal communities establish underwater preserves for divers to explore shipwrecks and natural underwater features. Provide training in effectively promoting business and serving customers, leading to greater economic return for businesses.

EDUCATION

- o 4-H Great Lakes Heritage Program -- three-year demonstration project in Wayne County to incorporate Great Lakes subject matter into traditional 4-H format; acquainted urban youth with water resources in their community; opened new career opportunities to youth and increased their leadership and communication skills
- o 4-H Unique Projects -- "seed" money for 4-H projects in individual counties that expand Great Lakes content in 4-H programming
- o 4-H Marine Science -- developed member and leader materials on water subjects for use in 4-H clubs nationwide; increased infusion of aquatic subjects into 4-H activities
- o Coastal Dune and Wetland and Marine Careers Projects -- provided field staff assistance to teachers and 4-H leaders on these subjects

Administration and Communications

A team of administrators from The University of Michigan and Michigan State University oversee operations of the Michigan Sea Grant program, helping researchers, educators, and advisory staff fulfill their objectives. As of 1981, management team members at The University of Michigan are Director Alfred M. Beeton (also Director of the Great Lakes and Marine Waters Center), Assistant Director John H. Judd, Administrative Associate Nancy S. Pruitt, and Communications Coordinator Suzanne Tainter. Michigan State University administrators include Associate Director Niles R. Kevern and Marine Advisory Service Program Leader Eugene F. Dice. (Howard Johnson served as Associate Director from 1979-81, and Erwin Seibel was Assistant Director in 1977-78.) These individuals monitor the progress of existing projects and search for new avenues appropriate for future efforts.

Program administrators are directed by a Policy Committee composed of university vice-presidents, deans, and others from The University of Michigan and Michigan State University, and of representatives from major Great Lakes agencies. This committee establishes program policy which is implemented by the management team.

An External Advisory Committee provides guidance from members representing industry, public agencies, and others who use Sea Grant services. Advisory Committee members are helpful in directing program research into useful paths.

Communications

Communications serves Michigan Sea Grant and the public by producing program information for a variety of audiences. Communications provides useful information to those who use or enjoy the Great Lakes and oceans, and promotes awareness of and appreciation for Great Lakes ecosystems and the role Sea Grant plays in maintaining their integrity.

During 1977-81, Communications produced technical reports, advisory and public information bulletins, news releases, and journal reprints (see Appendix B for a complete listing of Sea Grant publications produced during 1977-81). These publications were distributed to representatives of business, industry, and other user groups; researchers; other Sea Grant programs; and interested individuals. In addition, Communications produced information about Great Lakes issues in a variety of media, including the bi-weekly radio program "Surfbeat;" developed and publicized Sea Grant-sponsored conferences, workshops, and meetings; prepared exhibits and technical and educational materials for user groups, program staff, and other Sea Grant affiliates; produced the broadly disseminated newsletter, Upwellings; and responded to requests for information from the press, government agencies, other Sea Grant programs, universities, businesses, and the general public.

In 1981, the Communications staff included Suzanne Tainter, Communications Coordinator; Sandra Gregerman, Public Information Officer; Nancy Hilary, Assistant Editor; Yvonne Boyer, Publications Distribution Clerk; and Marilyn Eisley, Secretary. Communications Coordinator Leslie Lin oversaw the program from 1977 to June, 1981.

Appendices

Appendix A
Project Titles

COASTAL RESOURCES

Legal Research on Access and Ownership Issues in Michigan's Great Lakes Coastal Zone. Diana Pratt

Implementing Remote Sensing Capabilities in Management of Water and Wetland Resources. C. E. Olson

Coastal Zone Engineering and Shore Protection. Ernest F. Brater

Shoreline Protection Investment Behavior of Residential Property Owners.
Patricia Braden Weber

Engineering Economic Analysis of Shore Erosion Damage Mitigation. John Armstrong

EDUCATION

Great Lakes Environment Curriculum Project. Leslie Lin, William Stapp, and Paul Nowak

GREAT LAKES ENERGY PROBLEMS

Prospects and Problems for Oil and Gas Under the Great Lakes. M. R. Tek

Petroleum Hydrocarbons and Heavy Metals in Great Lakes Surface Films. P. Meyers and Robert Owen

Investigation of Petroleum Transport Operations on the Great Lakes.
Harry F. Benford

GREAT LAKES FISHERIES

Fishery Economics and Marketing. Daniel Talhelm

Biology and Commercial Potential of Underutilized Fish: Carp. Niles Kevern

Improved Fish Handling, Packaging, and Processing Methods. Estes Reynolds

Applicability of Purse Seines to Harvest Fish from the Upper Great Lakes.
Tom Kelly

Evaluation of Small-Mesh Trap Nets for the Harvest of Round Whitefish (Prosopium cylindraceum), an Underutilized Species. David Jude

Time Series Analysis and Forecasting of Yield and Effort for Great Lakes Fisheries.
Al Jensen

RECREATION AND TOURISM

An Assessment of Michigan's Great Lakes' Underwater Park-Historical Preserve Potential. Donald Holecek

TOXIC SUBSTANCES

The Role of Sediments and Suspended Particulate Materials in the Translocation of PCBs in Aquatic Environments. Howard Johnson

Effect of Polychlorinated Biphenyls, a Pollutant of Great Lakes Fish, on the Embryotoxicity of Mink. Robert Ringer and R. J. Aulerich

Absorption of Polychlorinated Biphenyls on Suspended Solids and Their Distribution and Differential Accumulation in Rivers, Harbors, and Lake Systems. Walter Weber

The Effect of Sediment Oil Contamination on the Bioaccumulation and Excretion of Aroclor 1242 by Chironomid Larvae. Peter Meier

WATER SAFETY

The Female Scuba Diver in Michigan and Ohio: A Preliminary Profile. E. H. Crown

Analysis of Commercial and Recreational Diving Fatalities in Michigan 1965-76.
Lee Somers, Martin Nemiroff, and Clifford Ellis

Underwater Technology Laboratory. Lee Somers

Coldwater Drowning and Near-Drowning in the Great Lakes: A Study of Contributing Factors. Martin Nemiroff

COASTAL RESOURCES

Legal Research on Access and Ownership Issues in Michigan's Great Lakes Coastal Zone. Diana Pratt

Implementing Remote Sensing Capabilities in Management of Water and Wetland Resources. C. E. Olson

Evaluation of Low-Cost Shore Protection. Ernest F. Brater

Shoreline Protection Investment Behavior of Residential Property Owners. Patricia Braden Weber

Engineering Economic Analyses of Shore Erosion Damage Mitigation. John Armstrong

EDUCATION

The Development of a Comprehensive Atlas of Lake Michigan Planning Study. Lawrence Sommers

Great Lakes Environment Curriculum Project. Leslie Lin, Paul Nowak, and William Stapp

Aquatic Science Curriculum. Philip Meyers

GREAT LAKES ENERGY PROBLEMS

Prospects and Problems for Oil and Gas Under the Great Lakes. M. R. Tek

Petroleum Hydrocarbons and Heavy Metals in Great Lakes Surface Films. Philip Meyers and Robert Owen

Investigation of Petroleum Transport Operations on the Great Lakes. Harry F. Benford

GREAT LAKES FISHERIES

Market Development Prospects for Michigan Fisheries. Kenneth Shapiro

Fishery Economics and Marketing. Daniel Talhelm

Improved Fish Handling, Packaging, and Processing Methods. Estes Reynolds

Applicability of Purse Seines to Harvest Fish from the Upper Great Lakes. Tom Kelly

Evaluation of Small-Mesh Trap Nets for the Harvest of Round Whitefish (Prosopium cylindraceum), an Underutilized Species. David Jude and Tim Miller

RECREATION AND TOURISM

An Assessment of Michigan's Great Lakes' Underwater Park-Historical Preserve Potential. Donald Holecek

Use of Shoreline Recreation Areas by the Elderly and Handicapped. Joseph E. Vaughn

TOXIC SUBSTANCES

Effect of Polychlorinated Biphenyls, A Pollutant of Great Lakes Fish, on the Embryotoxicity of Mink. Robert Ringer and R. J. Aulerich

The Role of Sediments and Suspended Particulate Material in the Translocation of PCBs in Aquatic Environments. Howard Johnson

Federal, State, Manufacturer, User, and Environmental Group Interactions in Toxic Substances Regulation and Control. Daniel Bronstein

Absorption of Polychlorinated Biphenyls on Suspended Solids and Their Distribution and Differential Accumulation in Rivers, Harbors, and Lake Systems. Walter Weber

Release of PCB from Sediment. Clifford Rice

Bioaccumulation of PCBs by Food Web Concentration in Fish. Peter Meier

Uptake, Accumulation, and Removal of PCBs by Great Lakes Phytoplankton. C. K. Lin and Milgroş Simmons

Environmental Toxicity of Pollutants in the Great Lakes. Rolf Hartung

WATER SAFETY

Accidental Submersion in Cold Water. Martin Nemiroff

Underwater Technology Laboratory. Lee Somers

COASTAL RESOURCES

Coastal Wetlands in Conflict: A Joint-Space Approach for Evaluating Management Alternatives. Patricia Braden Weber

Public Policies Affecting the Management and Protection of Michigan's Coastal Wetlands. R. Barlowe

EDUCATION

Underwater Education Workshop Program. Lee Somers

Great Lakes Limnology Course. Marlene Evans

Great Lakes Environment Curriculum Project. Paul Nowak, William Stapp, and Leslie Lin

Organization and Development of an Integrated Aquatic Science Curriculum. Phil Meyers and Guy Meadows

GREAT LAKES FISHERIES

Fishery Economics and Marketing. Daniel Talhelm

Renewed Use of Underutilized Species of Great Lakes Fish for Animal Feed. R. J. Aulerich

Identification of Current Spawning Grounds and Prediction of Potential Spawning Areas for Yellow Perch in Southeastern Lake Michigan, with Estimates of Associated Early Recruitment. David Jude, John Dorr

Compensatory Response of Lake Trout and Lake Whitefish to Exploitation. Al Jensen

Increasing the Economic Value of the Michigan Commercial Fishery Through the Utilization of Carp. Lawrence Dawson and James Price

Evaluation of Small-Mesh Trap Nets for the Harvest of Round Whitefish (Prosopium cylindraceum), an Underutilized Species. David Jude and Tim Miller

Developing a Model Commercial Fisheries Statute for the Great Lakes States. Daniel Bronstein

PCBs, DDT Compounds, and Dieldrin Levels in Carp. Mary Zabik

Competition Between Juvenile Salmon and Trout in Great Lakes Spawning Streams. Ray White

RECREATION AND TOURISM

Michigan Great Lakes Recreational Boating--Demand, Supply, Marketing, Economic Impact. Daniel Stynes

Development of a Recreation Subprogram: A Cooperative Research Strategy.
Kenneth Polakowski and Thomas Wang

TOXIC SUBSTANCES

Uptake, Accumulation, and Removal of Polychlorinated Hydrocarbons (PCBs) by Great Lakes Phytoplankton and Zooplankton. C. K. Lin and Mila Simmons

Release of PCB from Sediment. Clifford Rice

Contribution of Surface Microlayer to Air/Water Exchange of Organic Pollutants.
Phil Meyers and Clifford Rice

Early Assessment of Potential for Environmental Toxicity of Pollutants in the Great Lakes. Rolf Hartung

Absorption of Polychlorinated Biphenyls on Suspended Solids and Their Distribution and Differential Accumulation in Rivers, Harbors, and Lakes. Walter Weber

Implementation of the Toxic Substances Control Act. Daniel A. Bronstein

GREAT LAKES TRANSPORTATION

Comparative Evaluation of Ship Path Control Systems. Michael G. Parsons

Effects of Control Systems on Optimization of Ship Size for Navigation in Restricted Waters of the Great Lakes. Howard Bunch

Great Lakes Marine Transportation. Francis Ogilvie

Shoreline Effects of Vessel Transit of the St. Marys River. Robert Scher

COOPERATIVE NETWORK PROGRAM

Influence of Lake Michigan and Fox River Waters on the Water Quality of Green Bay. A. M. Beeton, Ruth Holland Beeton, and James Bowers

The Effect of Hyperbaric Exposure on Menstruation, Fertilization, and Pregnancy. J. R. Willson and Martin Nemiroff

Coldwater Drowning and Near-Drowning in the Great Lakes and Inland Waters of Michigan. Martin Nemiroff

PROGRAM DEVELOPMENT

Sawdust and Wood Chip Deposits in Near-Shore Lake Michigan Waters Near Manistique, Michigan. Donald L. Macalady.

Naturally Occurring and Toxic-Induced Diseases in Salmonids in the Great Lakes.
Allen Trapp

1980-81

COASTAL RESOURCES

Effects of Lake Levels on the Hydrology and Type of Coastal Wetlands. Ronald Drobney and John Lyons

Sedimentation Rates in Michigan Coastal Wetlands. John Robbins

Nutrient and Hydrologic Cycling Processes in Great Lakes Coastal Marshes.
Thomas Burton

Sedimentation Rates in Michigan Coastal Wetlands. Robert Kadlec
The Role of Groundwater and Other Factors in Bluff Slumping. John H. Judd

Coastal Wetlands in Conflict: A Joint-Space Approach for Evaluating Management Alternatives. Patricia Braden Weber

Wetland Development: Options and Strategies and Their Relative Environmental Impact. Donald Tilton

Avian Response to Wetland Vegetative Cycles. Harold Prince

EDUCATION

Development of Academic Courses in Ship Production and Production Planning.
Howard Bunch

An Assessment of Great Lakes Studies Potential Based on User Interest and Priorities.
David Johnson and Julian Brandou

Great Lakes Limnology Course. Marlene Evans

Great Lakes Seminar. Jonathan Bulkley

Evaluation of Three Units of the Sea Grant Curriculum Project. Paul Nowak and William Stapp

Scientific/Academic Diver Education Series. Lee Somers

GREAT LAKES FISHERIES

Identification of Current Spawning Grounds and Prediction of Potential Spawning Areas for Yellow Perch in Southeastern Lake Michigan with Estimates of Associated Early Growth, Survival, and Recruitment. David Jude and John Dorr III

Evaluation of Modified Large-Mesh Trap Nets for the Harvest of Lake Whitefish in an Area of Strong Current and Rocky Bottom. David Jude

Renewed Use of Underutilized Species of Great Lakes Fish for Animal Feed.
R. J. Aulerich

Whitefish/Indian Treaty Waters. Charles Liston

Fishery Economics and Marketing. Daniel Talhelm

Competition Between Juvenile Salmon and Trout in Great Lakes Spawning Streams.
Ray White

FOOD PROCESSING AND AQUACULTURE

Incidences and Types of Stress-Induced Diseases in Selected Fish in the Great Lakes.
Allan Trapp and William Carter

PCBs, DDT Compounds, and Dieldrin Levels in Carp. Mary Zabik

Increasing the Economic Value of Michigan Commercial Fishery Through the Utilization of Carp. Lawrence Dawson and James Price

RECREATION AND TOURISM

Regional Variations in the Marketing Potential for Great Lakes Boating. Alfred N. Joyall

The Perceived Influence of Fuel Price and Availability Upon Great Lakes Boating Behavior Among Michigan Boaters. Joseph Fridgen

Michigan Great Lakes Recreational Boating--Demand, Supply, Marketing, Economic Impact. Daniel Stynes

TOXIC SUBSTANCES

Contribution of Surface Microlayer to Air/Water Exchange of Organic Pollutants. Philip Meyers and Clifford Rice

Review of PCB Research in the Great Lakes Area. Mila Simmons, Rolf Hartung, and Clifford Rice

Implementation of the Toxic Substances Control Act. Daniel Bronstein

The Role of Mysis Relicta in the Transport of PCBs Through the Lake Michigan Ecosystem. Marlene Evans and Clifford Rice

Uptake, Accumulation, and Removal of PCBs by Great Lakes Phytoplankton and Zooplankton. C. K. Lin

GREAT LAKES TRANSPORTATION

Comparative Evaluation of Ship Path Control Systems. Michael G. Parsons

Ice Strengthening of Great Lakes Bulk Carriers. Movses Kaldjian

A Study of the Feasibility of Moving Western Coal Through a Transshipment Point Located on Lake Michigan. Howard Bunch

WATER SAFETY

Preliminary Study of Multi-Level Scuba Diving. Lee Somers

The Effects of Hyperbaric Exposure on Menstruation and Pregnancy. J. R. Willson

Cold Water Near-Drowning in the Great Lakes. Martin Nemiroff

COOPERATIVE NETWORK PROGRAM

Whitefish Stocks in Northern Lake Michigan. William Taylor and Niles Kevern

Influence of Lake Michigan and Fox River Waters on the Water Quality of Green Bay. A. M. Beeton, Ruth Holland Beeton, and James Bowers

Study of the Effect of a Rural Clean Water Project in Saline Valley. A. M. Beeton and Ruth Holland Beeton

Appendix B
Publications

Great Lakes Fish Preparation. A. Estes Reynolds, Suzanne Tainter, and Ingrid Bartelli. MICHU-SG-78-100, E-1179. An illustrated guide to purchasing, cleaning, dressing, and cooking Great Lakes fish. Covers basic fish cookery information (methods, cooking times, and temperatures). Recipes for soups, breadings, seasonings, and sauces complement this comprehensive fish cooking guide.

Freshwater Fish Preservation. Revised edition. A. Estes Reynolds, Thomas Rippen, Sharon Kennedy, and Suzanne Tainter. MICHU-SG-78-101, E-1180. This bulletin outlines the basic principles and techniques for preserving fish for home use. Methods discussed include freezing, canning, smoking, salting, pickling. Recipes are also included as a guide to home processing and preparation.

Fishing for Fun. Ned E. Fogle. 4-H 1056. A series of activities for students and 4-H club members which introduce them to fish, fishing, tackle, and sportsmanship.

Fishing For Fun. Leader/Teacher Guide. Ned E. Fogle. MICHU-SG-79-405, 4-H 1057. An activity guide for Leader/Teachers to use with students to help them understand and appreciate the value of fishing and fish products, to survey the status of fishing and fishery management, and to develop fishing skills.

Wood Preservation: Wood and Decay. Eldon A. Behr. MICHU-SG-78-104, E-1247. The first of four booklets on wood preservation of marinas, docks, and wharves. Discusses the structure and property of wood and the principle causes of wood decay.

Wood Preservation: Chemical Treatments. Eldon A. Behr. MICHU-SG-78-105, E-1248. Second booklet in four part series on wood preservation of marinas, docks, and wharves. Emphasis in this booklet is on available chemical treatments for wood preservation, application methods, and toxicity to people, animals, and plants.

Wood Preservation: Treatment Methods. Eldon A. Behr. MICHU-SG-78-106, E-1249. Third part of wood preservation series focuses on non-chemical treatment methods of preservation including thermal and pressure treatments.

Wood Preservation: Using Treated Wood. Eldon A. Behr. MICHU-SG-78-107, E-1250. Final part of wood preservation series. Covers how to determine if wood has been properly treated and the precautions and techniques to use when using treated wood.

Underwater Parks Symposium Proceedings. Donald Holecek. MICHU-SG-79-902, E-1350. The feasibility of developing some of the shipwrecks lying in the bottom of the Great Lakes into Underwater Parks is discussed by divers, educators and resource developers who presented papers at a symposium held at Michigan State University, March 1979. Topics include the characteristics and expenditure patterns of scuba divers, Great Lakes shipwrecks, diving and tourism, and underwater archaeology.

Scientific Marine Careers. Cooperative Extension Service. MICHU-SG-79-408, E-1355. Designed for high school counselors, teachers, and students, this publication is part of a three part series on marine careers. In this one, career opportunities in marine sciences such as oceanographers, maritime historians, and food scientists. Contains information on job requirements including education, work experience, and training.

Technical Marine Careers. Cooperative Extension Service. MICHU-SG-79-409, E-1357. Second pamphlet in career series, this one looks at marine jobs which require technical skills and on-the-job experience, such as boat building and repair, merchant marine positions, commercial fishing, offshore mining, port activity and maintenance, marina dealers, and operators. Information about job availability is included.

Professional Marine Careers. Cooperative Extension Service. MICHU-SG-79-410, E-1356. Third pamphlet in marine career series, this one describes water resource related careers that require varying amounts of college education. Includes descriptions of occupations such as environmental affairs, business and industry, education, and merchant marine careers.

Guide to Projects and Activities for the 4-H Great Lakes Heritage Program. Patrick Livingston. MICHU-SG-79-411, E-1410. Contains a variety of activities and projects in the areas of boating, fishing, sailing, watersports, and waterfowl. The collection is designed to familiarize club members with various water-related recreation activities around the Great Lakes.

Cold Water Survival (Hypothermia). Stephen Stewart and Sue Tainter. MICHU-SG-80-315, E-1415. Brief descriptions of hypothermia, first aid for the hypothermia victim, and hypothermia prevention.

Ice Uplift on Piles on the Upper Great Lakes. James E. Muschell and Raymond G. Lawrence, Michigan Waterways Commission, and Techmedia, Inc. MICHU-SG-80-506, E-3636. Interim report on research project to determine why certain recreational boating harbor structures are damaged by ice and others are not. Provides information that could be useful to developers and operators of small craft harbors in the Great Lakes region.

Testing for Nitrates in Well Water. John McKinney. MICHU-SG-80-507, E-1411. Brief descriptions of the nitrogen cycle, movement of nitrogen through soil into water, and how to test for nitrates in well and surface water.

Commercial Fish Handling and Sanitation on Great Lakes Vessels. Tom Rippen and A. Estes Reynolds. MICHU-SG-80-508, E-1324. This bulletin suggests some important on-board handling and sanitation methods designed to maintain fish quality and to extend shelf life.

Commercial Freezing of Freshwater Fish. A. Estes Reynolds, Tom Rippen, and Cherie LeBlanc. MICHU-SG-80-509, E-1323. Presents information on the quality of frozen fish, handling procedures during preparation and packaging to maintain quality, and the importance of using an antioxidant when freezing fish.

Understanding Contaminants in Fish. Thomas E. Rippen. MICHU-SG-80-510, E-1434. Explains the types of contaminants found in Great Lakes fish, possible health effects, sources of contaminants, and precautions individuals can take when buying, preparing, and cooking fish to reduce contaminant intake.

The Marine Advisory Services Brochure. Marcia Bradford. MICHU-SG-80-517, E-1440. A brief description of the Michigan Sea Grant Marine Advisory program, the program's main outreach effort.

Changes in Boat Use and Purchases Resulting From the Energy Situation. Gregory Mannesto. MICHU-SG-80-518, E-1479. Presents the results of a 1979 survey of recreational boaters and the effects of the "energy crisis" on boat use and buying patterns in Michigan.

A Guide to Sand Dune and Coastal Ecosystem Functional Relationships. Joan M. Peterson and Dr. Eckhart Dersch. MICHU-SG-81-501, E-1529. Sand dunes bordering Lake Michigan are the largest assemblage of freshwater dunes in the world. This publication contains information on sand dune ecosystems, dune dynamics, sand dune management, and more.

How Citizens Can Influence Legislation. Peter Kakela and Gary Chilson. MICHU-SG-81-502, E-1553. Citizens guide to Michigan's legislative process. Describes how a bill becomes a law, how to introduce a bill, and lobbying methods. Uses the legislative history of Michigan's Wetlands Protection Act as an illustration of the citizens role in the legislative process.

Pescado. Lois Thieleke. MICHU-SG-81-503, E-1563. A Spanish language brochure that describes how to cook nutritious, low cost, and tasty meals using underutilized Great Lakes fish species. Includes recipes and basic fish cookery information.

Wetlands Affect You and Me. The Wetlands Team of the Michigan DNR. MICHU-SG-79-400, 4-H 1038. Activities prepared as part of the 4-H Marine Science program to teach members/students about wetlands--what they are, why they are important, how to preserve them, and more.

Wetlands Affect You and Me Leader/Teacher Guide. The Wetlands Team of the Michigan DNR. MICHU-SG-79-401, 4-H 1039. Leader/Teacher's guide to member/student activities on wetlands prepared as part of the 4-H Marine Science program. See publication listed above.

Our Basic Environmental Series: Water. Robert W. George. MICHU-SG-79-402, 4-H 1044. Basic educational unit on water for 4-H club members.

Our Basic Environmental Series: Water Leader/Teacher Guide. Robert W. George. MICHU-SG-79-403, 4-H 1045. Another in the 4-H marine education series. Teacher/Leader's guide to the basic unit on water: water characteristics, water cycle, water pollution, water quality, and more. See publication listed above.

How to Obtain State and Federal Permits to Develop and Operate Marinas in Michigan. David Rood. MICHU-SG-77-105, E-1166. Reference guide to obtaining state and federal permits to develop and operate marinas in Michigan. Includes sample application forms and texts of leases and permits.

COASTAL RESOURCES

Michigan Demonstration Erosion Control Program in 1976. Ernest F. Brater, John Armstrong, Michael R. McGill, and Nora D. Hyma. MICHU-SG-77-200. This report provides results of erosion control methods performed on various beachfront areas within Michigan.

An Investment Decision Model for Shoreland Protection and Management. John M. Armstrong and R. Bruce DenUyl. MICHU-SG-77-302. Outlines an investment decision model for problems associated with shoreline erosion. Model determines economic benefits landowners can realize from alternative protection structures and policies such as non-structural shoreland protection, wetlands regulation, and public beaches. Reprinted from Coastal Zone Management Journal, 1977.

Coastal Engineering and Erosion Protection. Ernest F. Brater and C. D. Ponce-Campos. MICHU-SG-78-201. Describes field observations of 18 erosion protection demonstration projects located on lakes Huron, Michigan, and Superior. The project was designed to study the effectiveness and durability of the field installations.

Low-Cost Shore Protection on the Great Lakes: A Demonstration/Research Project. John M. Armstrong. MICHU-SG-78-300. This publication summarizes the results of a demonstration project on the Great Lakes that studied a variety of low cost shore protection systems in 19 sites around Michigan. Methods included: artificial nourishment, groins, revetments, offshore breakwaters, and seawalls. Materials varied from sand to reinforced concrete walls. Discusses each site. Includes photos, diagrams, and tables. Reprinted from Proceedings of the Fifteenth Coastal Engineering Conference, July 1976: 2858-2887.

Laboratory Investigation of Shore Erosion Processes. Ernest F. Brater and David Ponce-Campos. MICHU-SG-78-301. Explains the use of a laboratory model to measure and predict erosion rates and to evaluate the effectiveness of various control methods. Reprinted from Proceedings of the Fifteenth Coastal Engineering Conference, July 1976: 1493-1511.

Consumer Investment in Shore Protection. Patricia L. Braden and Susan R. Rideout. MICHU-SG-80-200. Reports on the results of a survey of Great Lakes shoreline property owners and how they dealt with shore erosion problems. Researchers found that shore property owners: 1) invest money in protection without adequate engineering help, and 2) overestimate the value of their property and thus may over-invest in shore protection.

Remote Sensing Analyses of Coastal Wetland Characteristics: The St. Clair Flats, Michigan. John Grimson Lyon. MICHU-SG-80-313. Describes two approaches to wetland quantity and quality analysis. The first delineates wetlands with aerial photography. The second examines the capability of computer classification of LANDSAT digital data to provide coastal land use and vegetation community information. Reprinted from Proceedings of the Thirteenth International Symposium on Remote Sensing of the Environment, April 23-27, 1979, Ann Arbor, Michigan.

Data Sources for Analyses of Great Lakes Wetlands. John Grimson Lyon. MICHU-SG-80-319. Paper presents a comparison of data sources for assessment of coastal zone wetlands. Evaluates aerial photography, Landsat imagery and Seasat radar data. Reprinted from Technical Papers of the American Society of Photogrammetry ACSM-ASP Convention, St. Louis, Missouri, March 9-14, 1980.

Shoreline Erosion: Questions and Answers. Fred Clinton, Ernest F. Brater, Mike McGill, Sam Ehlers, Claire Eberwein, and Sally Grebe. MICHU-SG-80-511. Pamphlet, in question-answer format, containing answers to questions frequently asked by shoreline property owners about erosion, structures, permits, laws, costs and contractors. Useful for existing or prospective property owners, realtors, and local government officials.

If You Are Thinking About Buying Great Lakes Shoreline Property Consider....Michigan Sea Grant Advisory Service. MICHU-SG-80-512. Brochure describes environmental factors prospective property owners should consider before purchasing shoreline property.

Shoreline Erosion: What to Do. Michigan Sea Grant Advisory Service. MICHU-SG-80-513. Illustrated booklet describing what homeowners can do about shoreline erosion. Includes descriptions of five protection methods: sandfill, breakwaters, groins, revetments, and sea walls.

The Michigan Shore Protection Demonstration Project Final Report: Wave Histories by Means of a Computer Program. Ernest F. Brater and C. David Ponce-Campos. MICHU-SG-81-203. Final technical report of a project to evaluate low-cost shore protection methods. Includes a description of a computer program developed to determine wave characteristics from wind. Results of its application to measure the effectiveness of 18 demonstration projects are included.

Deciding to Buy Lakeshore Erosion Protection. David B. Robbins and R. Bruce DenUyl. MICHU-SG-81-304. Due to the active geological processes along the Great Lakes coastline, shore land owners face tough decisions when deciding to buy property. This publication describes an investment decision model which simulates what would happen to the market value of a shoreland property undergoing erosion. Reprinted from The Michigan Riparian, February 1981.

Observations on Low-Cost Shore Protection. Ernest F. Brater. MICHU-SG-81-305. Outlines some of the practical results of a research program on low cost shore protection in regard to the evaluation of field observations and effective protective methods. Reprinted from Journal of the Waterway Port Coastal and Ocean Division, Technical Notes, Proc. Paper 14944.

Underwater Education. Lee H. Somers. MICHU-SG-79-307. Brief article on the importance of underwater education at the university level as part of academic programs. Reprinted from the Journal of Physical Education and Recreation.

Aquatic Science at The University of Michigan. Michigan Sea Grant. MICHU-SG-79-406.

Pamphlet describing the aquatic science program at The University of Michigan. Lists degree programs offered and addresses to write for further information.

The Sea Lamprey Story. Leslie Lin, Paul Nowak, William Stapp, Wilfrid Rollman, and Augusto Medina. MICHU-SG-80-400. A twenty activity curriculum unit that provides an in-depth study of the sea lamprey's dramatic impact upon the Great Lakes. Designed for middle schools, materials include background information, teacher and student procedures, masters of student worksheets, wall charts, map, game board, and two slide/tape shows. Format is a three ring binder.

An Expanded Perspective of Fisheries Education. Leslie Lin, Augusto Medina, and Wilfrid Rollman. MICHU-SG-81-320. Article outlines a multi-disciplinary curriculum for fisheries education developed by Michigan Sea Grant. Argues how and why fisheries education is not just a study in biology. Reprinted from Current, the Journal of Marine Education, 1980.

GREAT LAKES FISHERIES

Consumers' Perceptions of and Responses to the Use of Underutilized Fish Species in Hot Dogs. James C. Anderson, Maureen E. Beninson, Mark C. Nilsson, and Mark B. Traylor. MICHU-SG-77-201. Reviews the results of a study to evaluate the feasibility of marketing a product made from suckers. Describes selection of the product, consumer reaction, conclusions, and recommendations.

The Feasibility of Using Waste Materials as Supplemental Fish Feed. Julin D. Lu and Niles R. Kevern. MICHU-SG-77-300. Summarizes the results of a study on the feasibility of using sewage sludge in aquaculture. Study focuses on use with catfish. Reprinted from The Progressive Fish Culturist Vol. 37, No. 4, October 1975: 241-244.

Profiles of Aquaculture in Michigan. Randall D. Johnson and Daniel R. Talhelm. MICHU-SG-78-203. Describes the current aquaculture industry in Michigan, including operating cost and return figures for 1975, characteristics of the operations, and future projections about the industry.

Michigan Commercial Fishing Regulations: A Summary of Public Acts and Conservation Commission Orders, 1865 through 1975. Dean A. Brege and Niles R. Kevern. MICHU-SG-78-605. Outlines changes in Michigan's commercial fishing regulations since the 1800s. Contains summaries of original acts and commission orders and explains the major effects of each.

Purse Seining on the Great Lakes. Vessels, Gear, and Operation. Thomas M. Kelly. MICHU-SG-79-200. An illustrated report on the purse seine net, an actively fished, species-selective, encircling net, and the boat gear and operations required to use it. Purse seining has attracted interest in the Great Lakes since the ban on gill nets, a non-selective fishing gear.

Life History, Abundance, and Potential Harvest of Carp (*Cyprinus carpio linnaeus*) From Michigan Waters of the Great Lakes. Rosanna L. Mattingly and Niles R. Kevern. MICHU-SG-79-205. This report reviews the biology, distribution, abundance, harvest, and management of carp and discusses its potential for commercial sale and marketing using new food science technology.

Bibliography of Coral Reef Fish Research, With Emphasis on Western Atlantic Families. (Subject Index Included). Lee H. Somers and Jeffrey C. Laufle. MICHU-SG-79-206. An annotated bibliography of coral reef fish research covering topics ranging from acoustics to territoriality. Subject index.

Purse Seining on the Great Lakes. Catches, Efforts, and Problems. Thomas M. Kelly. MICHU-SG-79-211. Technical report reviewing the results of a research project to evaluate the use of purse seining in commercial fishing in the Great Lakes. While purse seines have been used in the U.S. for a century, the gill net has been the traditional Great Lakes gear. However, the gill net has been banned, and commercial fishers are in search of an effective, species-selective form of gear. This publication gives the results of every set of the net in the first year's operation. Three tables and ten figures.

Assessment of the Lake Trout Fishery in Lake Superior: 1929-1950. A. L. Jensen. MICHU-SG-79-300. A technical report on the logistic surplus production model as applied to the lake trout fishery during the years 1929-50. Author concludes that trout stocks collapsed apparently because of sea lamprey predation on a population stressed by intensive fishing. Reprinted from Transactions of the American Fisheries Society Vol. 107, Number 4, 1978. pp. 543-549.

Bay Port, Great Lakes Fishing Capital. Leslie Lin. MICHU-SG-79-306. A historic look at Bay Port, Michigan, once the world's largest freshwater fishing port. Reprinted from the Chronicle, the magazine of the Historical Society of Michigan.

Yield Per Recruit of Whitefish (*Coregonus clupeaformis*) in Northern Lake Michigan. A. L. Jensen. MICHU-SG-79-310. Paper describes the author's use of the dynamic pool model to assess whitefish stocks and level of exploitation for a region of Lake Michigan. Explains dynamic pool model and its implications in fishery management. Reprinted from Michigan Academician, Spring 1979, Vol XI(4).

Fishery Management Goals and Tools. Jim Humphreys. MICHU-SG-79-505. A brief, straightforward explanation of fishery management. Outlines several tools for manipulating fish populations to avoid collapse of the stock and to limit the catching capacity of the fishery.

The Use and Construction of Small-Mesh Trap Nets. Tim Miller, David Jude, and Randy Eshenroder. MICHU-SG-80-516. Summarizes two years of use of small-mesh trap nets in the Great Lakes by a Saginaw Bay commercial fishing company. Outlines net design, construction, and use. Includes catch statistics. Study found the nets to be an inexpensive alternative to traditional large-mesh trap nets.

Model Great Lakes Commercial Fisheries Statute Adapted for Use in the State of Michigan. Daniel A. Bronstein and Daniel R. Talhelm. MICHU-SG-81-200. Presents the complete text of a model Great Lakes fisheries statute suitable for adoption by the state of Michigan, and with some minor changes, suitable for any Great Lakes state. Contains background information about its development and need.

Preliminary Investigation of Spawning Habitat Conditions and Reproduction of Lake Trout in Eastern Lake Michigan Near Port Sheldon, Michigan. John Dorr III and David J. Jude. MICHU-SG-81-213. Discussion of methodology and results of preliminary study investigating relationships between environmental parameters on newly placed lake riprap and lake trout reproductive success.

Fish in Lake Michigan: A Distribution of Selected Species. Larry Sommers, Cymbria Thompson, Suzanne Tainter, Leslie Lin, and J. Michael Lipsey. MICHU-SG-81-600. This publication explains the natural and human factors which influence fish distribution and have made today's Lake Michigan fishery very different from the fishery of the 1800s. Includes species maps for lake whitefish, chubs, smelt, lake perch, alewives, lake trout, and coho and chinook salmon.

LAW AND POLICY

Acquisition of Public Access Sites to the Great Lakes. Diana V. Pratt. MICHU-SG-79-214. Describes the legal mechanisms available to gain public access to Great Lakes shoreline including dedication, zoning, land use planning, easements, and transfers.

The Legal Rights of the Public in the Foreshores of the Great Lakes. Diana V. Pratt. MICHU-SG-81-209. A summary of the legal principles that govern use and ownership of different wet beaches of the Great Lakes.

A Case Study of Government Regulation of the Chemical Industry, Section 8b of the Toxic Substances Control Act. Daniel A. Bronstein and Linda S. Wennerberg. MICHU-SG-81-306. An examination of how the U.S. Environmental Protection Agency developed regulations under TOSCA, section 8b, which requires the EPA to conduct an inventory of all chemicals which were produced and distributed in commerce during the three years prior to passage of the act. Reprinted from Natural Resources Lawyer 13:704(1981).

Trends or Methodological Differences? Daniel J. Stynes, Malcolm I. Bevins, and Tommy L. Brown. MICHU-SG-81-307. Inconsistency in data collection has confounded attempts to identify and forecast outdoor recreation trends. This report highlights the problems through an evaluation of the methods used in various national outdoor recreation surveys. Includes recommendations for improving data collection, trend measurement, and forecasting. Reprinted from Proceedings 1980 National Outdoor Recreation Trends Symposium, USDA, Forest Service, Forest Service General Technical Report NE-57, Pages 223-232.

LIMNOLOGY

Short-term Transient Variations of Limnological Parameters in Grand Traverse Bay, Lake Michigan. A. H. Vogel, James J. Sygo, Thomas M. Kelly, Raymond P. Canale, H. E. Allen, and E. D. Rothman. MICHU-SG-77-301. Evaluation of data from Grand Traverse Bay, Lake Michigan, on measurements of primary production, chlorophylla, dissolved and particulate nutrients, dissolved oxygen, conductivity, pH, temperature, alkalinity, light penetration, and zooplankton biomass. Reprinted from J. Great Lakes Res., 2(1): 193-205, 1976.

A Factor Analysis of Elemental Associations in the Surface Microlayer of Lake Michigan and its Fluvial Inputs. James E. Mackin, Robert M. Owen, and Philip A. Meyers. MICHU-SG-80-314. Technical article describing the use of factor analysis to examine the geochemical phases and mechanisms which influence the composition of surface microlayers on the Great Lakes. Based on samples taken in Lake Michigan and its tributaries.

MARINE BIOLOGY

A Modified Method for Rearing Midges (Diptera: Chironomidae). Peter G. Meier and Henry C. Torres. MICHU-SG-81-301. Describes procedure used to isolate and culture the sewage midge *G. barpipes* in a clean environment for bioassay and bioaccumulation studies. Reprinted from The Great Lakes Entomologist, 1978.

A General Approach to the Culture of Planktonic Rotifers. R. S. Stemberger. MICHU-SG-81-303. Describes a general method for establishing cultures of rotifers from natural waters. Conducted as part of Sea Grant's ongoing work in the area of toxic substances. Reprinted from Canadian Journal of Fisheries and Aquatic Sciences, 38(6):721-724.

RECREATION AND TOURISM

Fall Beachcombing. Suzanne Tainter. MICHU-SG-78-305. Beachcombing is a pleasant and interesting pastime along Great Lakes beaches. This article describes the natural treasures that can be found on Great Lakes beaches including rocks, plants, and animals. Reprinted from Upwellings, Volume 3, Number 2, Fall 1978.

The Visitor's Climatic Guide to West Michigan's Shore. Karl Luttrell and Leslie Lin. MICHU-SG-79-115. Presents climate data for use in planning trips to the shores of western Lake Michigan. Additional information about harbors, major transportation routes, and safety considerations is included to help your trip planning.

Underwater Parks: An Unexplored Recreation Frontier? Thomas D. Warner and Donald F. Holecek. MICHU-SG-79-308. Discusses the recreational opportunities for underwater park development, especially in the Great Lakes region. Describes the only existing underwater park in the Great Lakes--Fathoms Five Underwater Park in Ontario, Canada. The article also stresses the importance of these parks for protecting scientifically or historically valuable resources such as shipwrecks. Reprinted from Parks and Recreation Magazine, 1978.

Attitudes of a Scuba Diving Population Concerning Government Regulation of Underwater Resources. Donald F. Holecek and Susan J. Lothrop. MICHU-SG-80-201. Reviews the findings of a survey of Midwestern divers' attitudes toward government regulation of underwater resources. Survey found that 85% favor restrictions on salvaging of shipwrecks.

Michigan's Coastal Waters: A Pilot Study in Underwater Cultural Resources. Charles A. Hulse and Donald F. Holecek. MICHU-SG-80-204. Underwater archaeological resources abound in the Great Lakes. This report provides a basic outline for the management of underwater cultural and archaeological resources in the Great Lakes. Recommends the establishment of underwater preserves.

Shipwreck vs. Nonshipwreck Scuba Divers: Characteristics, Behavior, and Expenditure Patterns. Donald F. Holecek and Susan J. Lothrop. MICHU-SG-80-205. Summarizes the results of a survey of scuba divers in Michigan, Ohio, and Indiana. Respondents are grouped by shipwreck and nonshipwreck divers and by demographics, behavior, and expenditure patterns. Shipwreck and nonshipwreck diving sub-populations and compared in terms of demographics, behavior, and expenditure patterns.

Interpretation as a Management Tool for Underwater Parks. John A. Veverka and Sandra A. Ponleit. MICHU-SG-81-308. Paper presented at the Symposium on Underwater Park Management sponsored by Michigan State University. Discusses the use of interpretation as a management tool in parks and its application for management of underwater parks. Reprinted from Association of Interpretive Naturalists Journal of Interpretation, Vol. VI, Number 2, September, 1981.

TOXIC SUBSTANCES

The Effect of Sediment Oil Contamination on the Bioaccumulation and Excretion of Aroclor 1242 by Chironomid Larvae. Peter G. Meier and Richard Rediske. MICHU-SG-79-207. Summarizes the results of a study of the effect of substrate oil contamination on the uptake and excretion of Aroclor 1242(PCB) by chironomid larvae (*Glyptotendipes barbipes*).

Polychlorinated Biphenyls Effects on Survival and Reproduction in Mink and Ferrets. Michael R. Blevins, Richard J. Aulerich, and Robert K. Ringer. MICHU-SG-81-302. Reports on the findings of a study of the effects of feeding mink and ferrets diets containing various levels of supplemental Aroclor 1242 or Aroclor 1016. Reprinted from Archives of Environmental Contamination and Toxicology 9, 627-635, (1980).

GREAT LAKES TRANSPORTATION

Petroleum Transport on the Great Lakes. Robert M. Scher. MICHU-SG-79-217 This report presents an introduction to the Great Lakes petroleum trade, its development, its geographic distribution, and the vessels serving it. Includes forecasts of future trade and an assessment of the safety record in the Great Lakes.

Surface Ship Path Control Using Multivariable Integral Control. Michael G. Parsons and Hua Tu Cuong. MICHU-SG-81-201 Reports on the findings of a study to assess the effectiveness of the multivariable integral controller in reducing ship path control problems. Highly technical presentation.

Effects of Control Systems on Optimization of Ship Size for Navigation in Restricted Waters of the Great Lakes. Howard M. Bunch, Mark E. Lasher, Charles J. Younger, Jr. MICHU-SG-81-204. Reports on a study of ways to alter traditional channel clearances in the Great Lakes to accommodate larger vessels. Includes discussion of ship dimension optimization, costs for modifying channels and harbors, and dredging costs.

WATER QUALITY

Petroleum Hydrocarbons and Heavy Metals in Great Lakes Surface Films. Robert M. Owen and Philip A. Meyers. MICHU-SG-78-202. Petroleum transport on the Great Lakes is increasing and has led to concern about the environmental effects of spillage in the lakes. This publication reports on a study of how much spillage has occurred, where the concentrations of hydrocarbons and heavy metals are, and identifies the respective contributions of petroleum and biological hydrocarbons in the Great Lakes.

A Model for Total Phosphorus in Saginaw Bay. Raymond P. Canale and J. Squire. MICHU-SG-78-303. Describes a two-dimensional model for the concentrations of chloride and total phosphorus in Saginaw Bay. Includes data on the distribution of chloride and total phosphorus in the bay. Reprinted from the Journal of Great Lakes Research, December 1976: 364-373.

Impact of Land Use on Ground Water Quality in the Grand Traverse Bay Region of Michigan. R. Rajagopal. MICHU-SG-78-304. Outlines a study of the geographical variations in groundwater quality with respect to land use and hydrology and identifies statistically significant relationships between seasonal variations in groundwater quality and hydrological variables. Reprinted from the Journal of Environmental Quality (7)1:93-98.

Lake Michigan Surface Films: Fatty Acids and Aliphatic Hydrocarbons. Philip A. Meyers and Robert M. Owen. MICHU-SG-80-202. Final report on a study of the chemical properties of surface films and underlying waters from different physical environments in Lake Michigan.

Environmental Controls on the Composition of the Surface Microlayer in Lake Michigan. James E. Mackin, Robert M. Owen, and Philip A. Meyers. MICHU-SG-80-203. Reviews the results of scanning electron microscope studies on the particulate fraction of selected river plumes and open lake microlayers and subsurface water

samples. The study was conducted in Lake Michigan and samples were taken from 10 locations. Findings indicate an enrichment of fine grained materials in open lake microlayers.

Sawdust and Wood Chip Deposits in Near-shore Lake Michigan Waters Near Manistique, Michigan. Donald L. Macalady and Steven R. Wissler. MICHU-SG-81-211. Report summarizes a 1979-80 study to define the nature and origin of problems associated with sawdust and other wood waste deposits which blanket Lake Michigan beaches near Manistique, Michigan. The wood chips are waste products from past lumbering operations.

Sources of Fatty Acids in Lake Michigan Surface Microlayers and Subsurface Waters. Philip A. Meyers and Robert M. Owen. MICHU-SG-81-300. Summarizes the results of a study to identify the sources and components of fatty acids which are commonly found in Lake Michigan's surface microlayers and subsurface waters. Reprinted from Geophysical Research Letters (7)11:885-888.

Pollution Problems of the Great Lakes Region; Conference Proceedings Traverse City, MI, June 9-11, 1980. Alfred Beeton, et. al. MICHU-SG-81-900. Proceedings of a regional conference on pollution problems in the Great Lakes region sponsored by the National Oceanic and Atmospheric Administration, Michigan Sea Grant, and the University of Michigan. Summarizes recommendations for development of a 5 year plan for federal research on Great Lakes pollution.

WATER SAFETY

Cold Water Drowning: A New Lease on Life. Leslie Lin, Joan Dent, and the U.S. Coast Guard. MICHU-SG-77-104. Detailed information on the steps to take to rescue a victim in a cold water drowning emergency is presented in this 13 page pamphlet. Includes graphics depicting rescue techniques.

Guidelines for Preparation of Occupational Safety and Health Standards for Scientific/Educational Diving Operations. Lee H. Somers and Martin J. Nemiroff. MICHU-SG-77-204. The purpose of this report is to provide a basis for development of safety and health standards for scientific and educational divers and to provide helpful guidelines for academic and research agencies preparing regulations for diving operations.

Diving and Fitness. Lee Somers and Sandy Bacsanyi. MICHU-SG-78-108. Brief pamphlet containing tips for physical fitness and conditioning for divers.

The Diver's Ear. Sandy Bacsanyi, Lee H. Somers, and Martin J. Nemiroff. MICHU-SG-78-109. Middle ear injury is a common divers ailment. This pamphlet, part of the divers safety series, describes the condition and treatment techniques for this and other ear injuries.

Drugs and the Diver. Sandy Bacsanyi and Lee Somers. MICHU-SG-78-110. There has been little research in the area of drug abuse associated with diving. The high pressures encountered with depth may increase a drug's effects, reverse it's actions, or stimulate totally unrelated effects. This pamphlet lists some drugs and their effects on the diver.

University of Michigan Scuba Diving Instructors Guide: Confined Water Training. Lee H. Somers. MICHU-SG-78-278. Technical report developed for the use of scientific/educational diving instructors, assistant instructors, and instructor trainees. Provides information on proper design of a confined diving course, accident management, skill enhancement, and contains a detailed course outline.

Cold-Water and Under-Ice Diving. Craig Tomkow, Sandy Bacsanyi, and Lee Somers. MICHU-SG-79-111. This pamphlet, written for the cold water diver, discusses such topics as cold stress, frostbite, and special equipment needs.

The Deep Diving Syndrome. Lee H. Somers. MICHU-SG-79-112. The hazards of diving are being de-emphasized in many diving courses. Novice divers have only a limited knowledge of the real and more serious consequences of inadequate decompression. This publication explains the problems associated with deep diving, including aseptic bone necrosis.

Diving Safety Series. Various authors. 6 pamphlets. MICHU-SG-79-113. A six-pamphlet series on diving safety which covers: Bends and the Sport Diver, Diving and Fitness, The Diver's Ear, Drugs and the Diver, Cold-Water and Under-Ice Diving, and The Deep Diving Syndrome. Descriptions of individual pamphlets follow.

Lightning Protection for Small Boaters. Thomas Kelly, Joan Bishop Dent, and United States Coast Guard. MICHU-SG-79-114. Although lightning strikes on boats are rare, they can happen with disastrous consequences for the boats and boaters. This pamphlet provides information necessary to reduce the chance of damage or injury by lightning strikes.

Bibliography of Coral Reef Fish Research, With Emphasis on Western Atlantic Families (Subject Index Included). Lee H. Somers and Jeffrey C. Laufle. MICHU-SG-79-206. An annotated bibliography of coral reef fish research covering topics ranging from acoustics to territoriality.

Occupational Safety and Health Standards for Great Lakes Commercial Diving Operations. Lee H. Somers and Martin J. Nemiroff. MICHU-SG-79-208. The purpose of this report is to provide a basis for the development of occupational safety and health standards for diving contractors and divers working in the Great Lakes and to provide guidelines for regulatory agencies preparing regulations for commercial and industrial diving operations.

State of Michigan Skin, Scuba, and Surface-Supply Diving Fatality Statistics 1965-1978. Sergeant Clifford Ellis, Michigan State Police, and Martin J. Nemiroff. MICHU-SG-79-212. Contains statistics on all recorded skin/scuba diving fatalities for the period 1965-1978. Useful information for identifying factors which can create potentially fatal situations. Statistics are classified by recreational and commercial accidents and were obtained from The University of Michigan Medical Center, State Police, and Underwater Technology Laboratory.

Profile of a Great Lakes Diver. Lee Somers. MICHU-SG-79-301. Results of a random survey to identify the characteristics of a Great Lakes diver.

Underwater Education. Lee H. Somers. MICHU-SG-79-307. Short article discusses the importance and role of underwater/scuba diving instruction in schools and shortcomings of most courses in academic institutions. Reprinted from the Journal of Physical Education and Recreation.

The University of Michigan Hyperbaric Chamber Attendant's Handbook (Revised). Lee H. Somers and Martin J. Nemiroff. MICHU-SG-79-603. Newly revised handbook for hyperbaric chamber attendants or operators. Includes descriptions of facilities and equipment, guidelines for personnel selection and training, new charts, tables, and checklists from the U.S. Navy, chamber maintenance, therapeutic compression, medical supplies, record-keeping, and use of the chamber to support diving operations in the field. Excellent text for classroom use and as a reference for trained on-site operators.

Management of Injuries Caused by Marine Organisms. Lee H. Somers and Martin J. Nemiroff. MICHU-SG-79-604. Written for the 40% of Great Lakes divers who travel to the Bahamas, Caribbean, or the Florida Keys, contains information on hazardous tropical marine life and first aid management of injuries.

Near Drowning. Martin J. Nemiroff. MICHU-SG-80-312. Reprinted from Hyperbaric and Under Sea Medicine, this article describes near-drowning rescue techniques and the mammalian diving reflex.

Cold Water Near-Drowning. Leslie Y. Lin. MICHU-SG-80-316. Describes the medical research that led Dr. Martin Nemiroff to change conventional medical wisdom about drowning survival. Includes descriptions of actual case studies and short tests on drowning knowledge.

The Hazards of Sport Diving/Free Ascent Training. Martin J. Nemiroff and John W. Dircks. MICHU-SG-80-317. This paper presents four case studies of free ascent injuries and the hazards involved. Includes bibliography. Reprinted from The Fifteenth Undersea Medical Society Workshop, Emergency Ascent Training.

The Emergency Ascent Dilemma. Lee H. Somers. MICHU-SG-80-318. Presents a reevaluation of emergency ascent procedures in sport scuba diving, critiques the various methods employed today, and their associated hazards, and presents alternative procedures. Reprinted from The Fifteenth Undersea Medical Society Workshop, Emergency Ascent Training.

The University of Michigan Manual of Safe Practices for Scientific/Academic Scuba Diving. Lee H. Somers. MICHU-SG-80-600. This manual is designed to comply with occupational safety and health requirements for a scuba diving safe practices guide. In addition, it includes information pertinent to basic and advance scuba diving instruction.

New No-Decompression Tables Based on No-Decompression Limits Determined by Doppler Ultrasonic Bubble Detection. Karl E. Huggins. MICHU-SG-81-205. Studies done by Spencer in 1976 produced new no-decompression limits designed to eliminate venous bubbles. This paper contains new no-decompression tables based on these new limits. These limits are more conservative than the Navy's present limits and may have more potential for use in multi-level diving.

Mathematical Evaluation of Multi-Level Diving. Karl Huggins and Lee Somers. MICHU-SG-81-207. In this study, the authors analyzed 101 multi-level dives using the mathematical model for the Navy's no-decompression tables in an attempt to validate the safety of the various techniques used.

GENERAL

An Inventory of the Ivan H. Walton Collection. Wilfrid Rollman and Cheryl Baker. MICHU-SG-79-605. A comprehensive guide to four large and diverse collections of tapes and documents on Great Lakes folklore and folksongs collected by Professor Ivan H. Walton during his thirty-year career at The University of Michigan. Includes short descriptions of each item in the collection. Especially rich in materials on shipping in the Great Lakes, particularly the days of sail.

Surfbeat: Commentaries About the Great Lakes. Joan Bishop Dent. MICHU-SG-79-802. Looking for an easy way to stir up interest in the Great Lakes? This collection of 35 commentaries from Michigan Sea Grant's radio series examines aspects of water quality, weather, energy, shipping, recreation, water safety, fishing and erosion. Each chapter includes suggested class activities and lists of related publications.

Calming Troubled Waters. Joan B. Dent. MICHU-SG-78-302. The Great Lakes pose difficult weather predicting and warning problems. This reprinted article reports on a marine weather seminar held to discuss Great Lakes marine weather problems, use and interpretation of meteorological data, proposed navigation and safety regulations, marine safety issues, ice information, and more.

Appendix C
Program Activity Budgets

PROGRAM ACTIVITY BUDGETS
(Summary Totals by Sea Grant Activities)

1977-1978

ACTIVITY	NOAA Grant Funds	Matching Funds
MARINE RESOURCES DEVELOPMENT		
Mineral Resources	\$ 28,000	\$ 8,900
Marine Law and Socio-Economics	61,200	41,800
MARINE TECHNOLOGY RESEARCH & DEVELOPMENT		
Resources Recovery & Utilization	72,025	31,000
Transportation Systems	22,000	14,200
MARINE ENVIRONMENTAL RESEARCH		
Research & Studies in Direct Support of Coastal Management Decisions	58,800	32,400
Pollution Studies	110,800	44,300
MARINE EDUCATION & TRAINING		
Other Education	72,900	37,200
ADVISORY SERVICES		
Extension Programs	229,875	71,000
PROGRAM MANAGEMENT & DEVELOPMENT		
Program Administration	<u>65,400</u>	<u>82,500</u>
TOTAL	\$721,000	\$363,300

ACTIVITY	NOAA Grant Funds	Matching Funds
MARINE RESOURCES DEVELOPMENT		
Mineral Resources	\$ 18,000	\$ 0
Marine Law and Socio-Economics	73,000	61,900
MARINE TECHNOLOGY RESEARCH & DEVELOPMENT		
Resources Recovery & Utilization	58,600	34,300
Transportation Systems	25,000	3,500
MARINE ENVIRONMENTAL RESEARCH		
Research & Studies in Direct Support of Coastal Management Decisions	68,300	32,300
Ecosystems Research	0	10,000
Pollution Studies	143,700	57,700
MARINE EDUCATION & TRAINING		
College Level	12,700	900
Other Education	75,000	41,200
ADVISORY SERVICES		
Extension Programs	209,400	99,900
Other Advisory Services	105,000	0
PROGRAM MANAGEMENT & DEVELOPMENT		
Program Administration	60,700	131,000
Program Development	<u>15,000</u>	<u>0</u>
TOTAL	\$864,400	\$472,700

1979-1980

ACTIVITY	NOAA Grant Funds	Matching Funds
MARINE RESOURCES DEVELOPMENT		
Living Resources, other than Aquaculture	\$ 29,270	\$ 13,187
SOCIO-ECONOMIC & LEGAL STUDIES		
Marine Economics	34,000	0
Ocean Law	0	18,554
Marine Recreation	53,544	114,025
MARINE TECHNOLOGY RESEARCH & DEVELOPMENT		
Ocean Engineering	50,000	0
Resources Recovery & Utilization	35,246	12,084
Transportation Systems	86,777	0
MARINE ENVIRONMENTAL RESEARCH		
Research & Studies in Direct Support of Coastal Management Decisions	31,130	0
Ecosystems Research	19,441	0
Pollution Studies	136,112	20,472
MARINE EDUCATION & TRAINING		
College Level	42,603	10,000
Other Education	52,045	7,817
ADVISORY SERVICES		
Extension Programs	238,555	133,800
Other Advisory Service	122,123	18,889
PROGRAM MANAGEMENT & DEVELOPMENT		
Program Administration	<u>85,154</u>	<u>140,187</u>
TOTAL	\$1,016,000	\$489,015

1980-1981*

ACTIVITY	NOAA Grant Funds	Matching Funds
MARINE RESOURCES DEVELOPMENT		
Living Resources, other than Aquaculture	\$ 54,133	\$ 0
SOCIO-ECONOMIC & LEGAL STUDIES		
Marine Economics	44,429	0
Marine Recreation	191,902	128,124
MARINE TECHNOLOGY RESEARCH & DEVELOPMENT		
Resources Recovery & Utilization	40,850	17,080
Transportation Systems	125,997	0
MARINE ENVIRONMENTAL RESEARCH		
Research & Studies in Direct Support of Coastal Management Decisions	155,264	15,271
Ecosystems Research	80,432	46,399
Pollution Studies	128,121	0
MARINE EDUCATION & TRAINING		
College Level	26,172	0
Other Education	74,284	25,769
ADVISORY SERVICES		
Extension Programs	427,924	193,676
Other Advisory Service	91,315	174,390
PROGRAM MANAGEMENT & DEVELOPMENT		
Program Administration	<u>202,777</u>	<u>242,837</u>
TOTAL	\$1,643,600	\$843,546

*18-month grant.

Appendix D
Policy Committee

Policy Committee — 1980-81

John Cantlon	Vice-President for Research Chairman, Policy Committee, MSU
Carlos Fetterolf	Executive Secretary Great Lakes Fishery Commission
James Anderson	Dean, College of Agriculture & Natural Resources, MSU
William Johnson	Dean, School of Natural Resources, UM
Richard Lewis	Dean, College of Business, MSU
Lois Lund	Dean, College of Human Ecology, MSU
James Fish	Executive Director, Great Lakes Commission
Charles Overberger	Vice-President for Research, UM
Richard Remington	Dean, School of Public Health, UM
Robert Hess	Director, Highway Safety Research Institute, UM
Samuel Milstein	Chief, Bureau of Lake & Water Management Michigan Department of Natural Resources
Alfred Beeton	Director, Michigan Sea Grant, Ex Officio

Other Policy Committee members during 1977-80 included:

Jacob A. Hoefler (77-78)	College of Agriculture and Natural Resources, MSU
Clifford H. Mortimer (77-79)	Professor, University of Wisconsin (Milwaukee)
Alfred S. Sussman (78-80)	Dean, Horace H. Rackham School of Graduate Studies, UM
Howard A. Tanner (78-80)	Director, Michigan Department of Natural Resources

Appendix E
External Advisory Committee

External Advisory Committee — 1980-81

William Carlson	Carlson Fisheries
Barbara Clark	Upper Peninsula Environment Coalition
Robert Courchaine	Chief, Water Quality Division Michigan Department of Natural Resources
James Dooley	Planning Manager, Central Upper Peninsula Planning and Development Region
John Mogk	President, Michigan Energy and Resource Research Association
Wesley Myllyla	Director, American Dairyman's Association of Michigan, Inc.
Steve Otterbein	Representative, Michigan Charter and Sportfishing Industry
John Reynolds	Director, Environmental Services Consumer Power Corporation
Maurice Roach	Director, Wayne County Planning Commission
Ralph Wilcox	President, Michigan Fish Producers Association

Other External Advisory Committee members during 1977-80 included:

Dorothy Brooks (77-79)	Chairperson, Michigan Shorelands Advisory Council
John Cherry (77-79)	Director, Bureau of Outdoor Recreation
Arthur Chomistek (77-80)	Senior Transportation Specialist, Dow Chemical Company
Emil Dean (79-80)	Representative, Michigan Charterboat Fleet
Col. Leonard Goodsell (77-78)	Executive Director, Great Lakes Commission

Frank D. Jones (79-80)	Regional Director, Heritage Conservation and Recreation Service
Peg Kauffman (77-78)	Chairperson and Vice-President, Michigan League of Women Voters
James Kerwin (77-78)	Environmental Writer, <u>Detroit News</u>
Robert Linn, Sr. (79-80)	Chairman of the Board, Bay Haven Marine, Inc.
Olga Madar (77-78)	Vice-President, United Auto Workers
John McNallis (77-80)	President, Michigan Salmon and Steelhead Fisherman's Association
Andy Paulick (77-79)	Coordinator, Conservation Department United Auto Workers
Ron Stebbins (79-80)	Manager, B & W Coop., Inc.
Walter Stoddard (77-80)	President, Michigan Fish Producers Association