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MINNESOTA SEA GRANT
SUPERIOR SCIENCE FOR YOU



Sea Grant
Minnesota

1998-2001
PROGRAM GUIDE

Minnesota Sea Grant is a statewide program that supports research and public education programs related to Lake Superior and Minnesota's inland waters. It is part of the National Sea Grant Program, which supports research in 31 coastal and Great Lakes states and territories.



UNIVERSITY OF MINNESOTA

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This document is dedicated to Athelstan Spilhaus, originator of the Sea Grant concept. While he was dean of the University of Minnesota Institute of Technology, Spilhaus gave the keynote address at a 1963 meeting of the American Fisheries Society. In his speech, Spilhaus suggested that in order to promote a better relationship between academic, state, federal, and industrial institutions involved in fisheries, we should do what "wise men" had done in the 1800s to promote better cultivation of the land. They had created Land Grant colleges... Spilhaus suggested creating Sea Grant colleges.

Spilhaus' idea was taken up by legislators Senator Claiborne Pell of Rhode Island and Representative Paul Rogers of Florida and was authorized by Congressional legislation in 1966. The first four universities designated as Sea Grant colleges were Oregon State University, the University of Rhode Island, Texas A&M University, and the University of Washington. The University of Minnesota became a Sea Grant College in 1974.

This year marks the 30th anniversary of the first Sea Grant research awards. Since 1968, Sea Grant has awarded thousands of grants for marine and coastal science research, education, and outreach, passing the \$1 billion grant award mark in 1997. A 1987 analysis estimated that Sea Grant-sponsored research and outreach provided a 20:1 return on the federal government's investment.

Spilhaus, died on March 29, 1998, at age 86. As technology dean at the University of Minnesota, Spilhaus was outspoken in his support of science education and innovative scientific research. Sea Grant lives on as a legacy of Spilhaus' love of scientific research.

dedication

mission statement



Minnesota Sea Grant enhances the state and coastal environment and economy through high-quality research and public education programs. Our outreach staff conveys the needs of user groups, industry, and management agencies to university scientists. We then transfer research results to resource users and managers, and policy-makers at the local level. Minnesota Sea Grant-funded scientists are expected to conduct sound, relevant research, incorporate graduate student training into their projects, and be willing to help transfer their results to appropriate audiences.

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program guide introduction



OVERVIEW OF THE MINNESOTA SEA GRANT COLLEGE PROGRAM

Minnesota Sea Grant is part of the National Sea Grant College Program. Congress established the National Sea Grant College Program in 1966. The National Sea Grant College Program Act called for a network of Sea Grant colleges which would conduct education, training, and research in all fields of marine study. It directed that grants and contracts would go to "suitable public and private institutions of higher education, institutes, laboratories, and public or private agencies which are engaged in, or concerned with, activities in the various fields related to the development of marine resources."

The Secretary of Commerce has designated 39 Sea Grant College programs in coastal and Great Lakes states and in Puerto Rico. These programs are the heart of a nationwide network of some 300 participating institutions that each year draw on the talents of over 3,000 scientists, engineers, educators, students, and outreach specialists. This network has provided a powerful national capability in marine resource research and outreach which did not exist prior to 1971 when the first Sea Grant College was designated.

Minnesota Sea Grant is dedicated to providing the tools and technology for responsible management and policy decisions to maintain and enhance Lake Superior and Minnesota's inland aquatic economies and resources. We involve universities, federal and state agencies, the public, and industry in a partnership to understand the complex nature of the multidisciplinary problems facing us and to help in developing the infrastructure necessary for innovative solutions.

We take our state and national mandates seriously; focusing on our inland aquatic resources as well as on Lake Superior. For example, we have provided outreach assistance on exotic species to a number of states along the Mississippi River and on the West Coast. In addition, our biotechnology, aquaculture, water quality, and recreation/tourism programs have significant relevance for inland as well as Great Lakes audiences. These programs have received multistate, national, and international attention. We take care not to duplicate what other agencies do, particularly in inland waters.

Environmental and economic sustainability are potentially conflicting goals. Specialists working in isolation from one another often fail to understand the links between human and natural resources. This lack of integration among various disciplines to produce real world solutions to problems results in a lack of successful ecosystem stewardship. A goal of the Minnesota Sea Grant program is to encourage multi-disciplinary, integrated solutions that incorporate good science with economic, societal, and political concerns. Within this context, and within our funding constraints, for the near future we will be focusing on these five priorities, or "thematic areas:"

- 1 NONINDIGENOUS SPECIES
- 2 BIOTECHNOLOGY AND AQUACULTURE
- 3 SUSTAINABLE COASTAL COMMUNITIES
- 4 LAKE SUPERIOR ECOSYSTEM MANAGEMENT
- 5 PUBLICATIONS, INTERNET, AND MEDIA

Minnesota Sea Grant's mission and thematic areas reflect careful integration of national (National Oceanic and Atmospheric Administration's, National Sea Grant College Program's strategic plans) and regional (International Joint Commission's Science Advisory Board report of 1993) priorities. The primary goal of our efforts is to contribute information for environmental stewardship, assessments, and predictions, while at the same time using our resources to enhance both state and national economic competitiveness.

The mission and thematic areas of Minnesota Sea Grant have been and continue to be strongly influenced by regional and national issues and strategies. Our short-term objectives and long-range plans thus take into consideration the carefully developed plans and programs of the other Great Lakes Sea Grant programs and the various state, regional, federal, and international organizations that have jurisdiction over the Great Lakes and the nation's marine resources. In addition to these other plans, our strategy was developed with the help of our Advisory Committee, outreach staff, and clientele.

ADVISORY
COMMITTEE

In 1995, we reinstated our Advisory Committee to provide general guidance to our program. The committee helps us identify coastal resource issues and assists us in disseminating research and outreach results back to the community. The committee is made up of 15 leaders from the community, businesses, management agencies, and academia, who serve three-year terms.

We asked them to identify Great Lakes coastal and Minnesota water resource-related issues that could be aided by research. Issues identified by the Advisory Committee were compiled, categorized, combined with national Sea Grant priorities, and used to help us structure our thematic areas.

MINNESOTA
SEA GRANT
OUTREACH

In the last five years, we have maximized our program strengths through internal reorganization and by our relationship with the University of Minnesota. Closer programmatic cooperation was fostered in 1995, when Minnesota Sea Grant merged its extension and communications sections into a single operating unit called "outreach." Another major change to Sea Grant came from reorganization within the University of Minnesota Extension Service. This reorganization transferred much of the administration of the Sea Grant Extension Program to the Sea Grant Director's Office. These two major changes allowed Minnesota Sea Grant to completely reexamine the program and modify the way we do business.

A Minnesota Sea Grant goal has been to place Sea Grant extension faculty in collegiate units to foster closer relationships between Sea Grant Outreach and academic departments. The Biotechnology/Aquaculture position in the University of Minnesota Department of Fisheries and Wildlife has had a consistent extension component since its inception. The other Sea Grant extension positions did not have departmental affiliations. The Fisheries/Aquaculture Specialist now has an extension appointment in the Biology Department at UMD. The Recreation/Tourism Specialist has an extension appointment in the Economics Department at UMD. These appointments have and will continue to bring about closer relationships between Sea Grant programming and the academic departments at the University of Minnesota.

PROGRAM
PLANNING,
MANAGEMENT,
AND STAFFING

The expertise of Minnesota Sea Grant clientele and cooperators are drawn upon to help set programmatic priorities for each two-year proposal cycle. Outreach staff are responsible for identifying and using clientele groups to help determine priority areas of emphasis, programmatic objectives, and action plans. A variety of techniques are used by staff to develop these plans. Some staff develop semi-formal advisory groups to help shape their programmatic efforts. These groups frequently help facilitate programs in addition to their advisory capacity. Other staff use existing committees, commissions, and boards that they serve on to help determine programmatic priorities. Other programs, agencies, and groups are included when appropriate.

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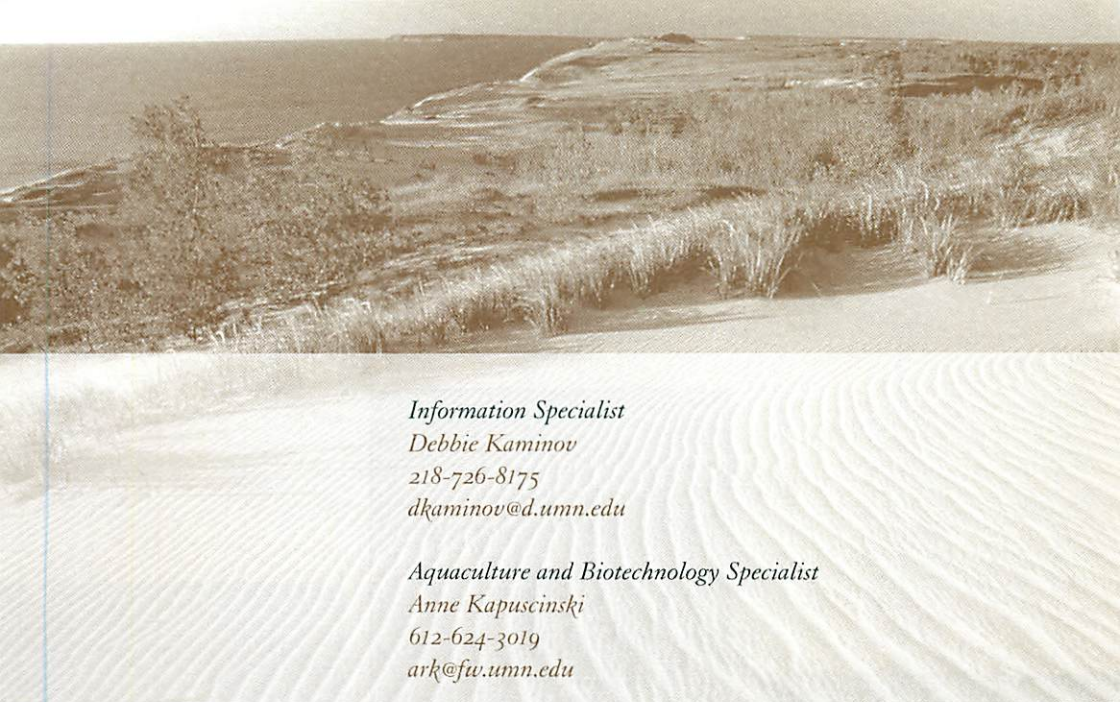
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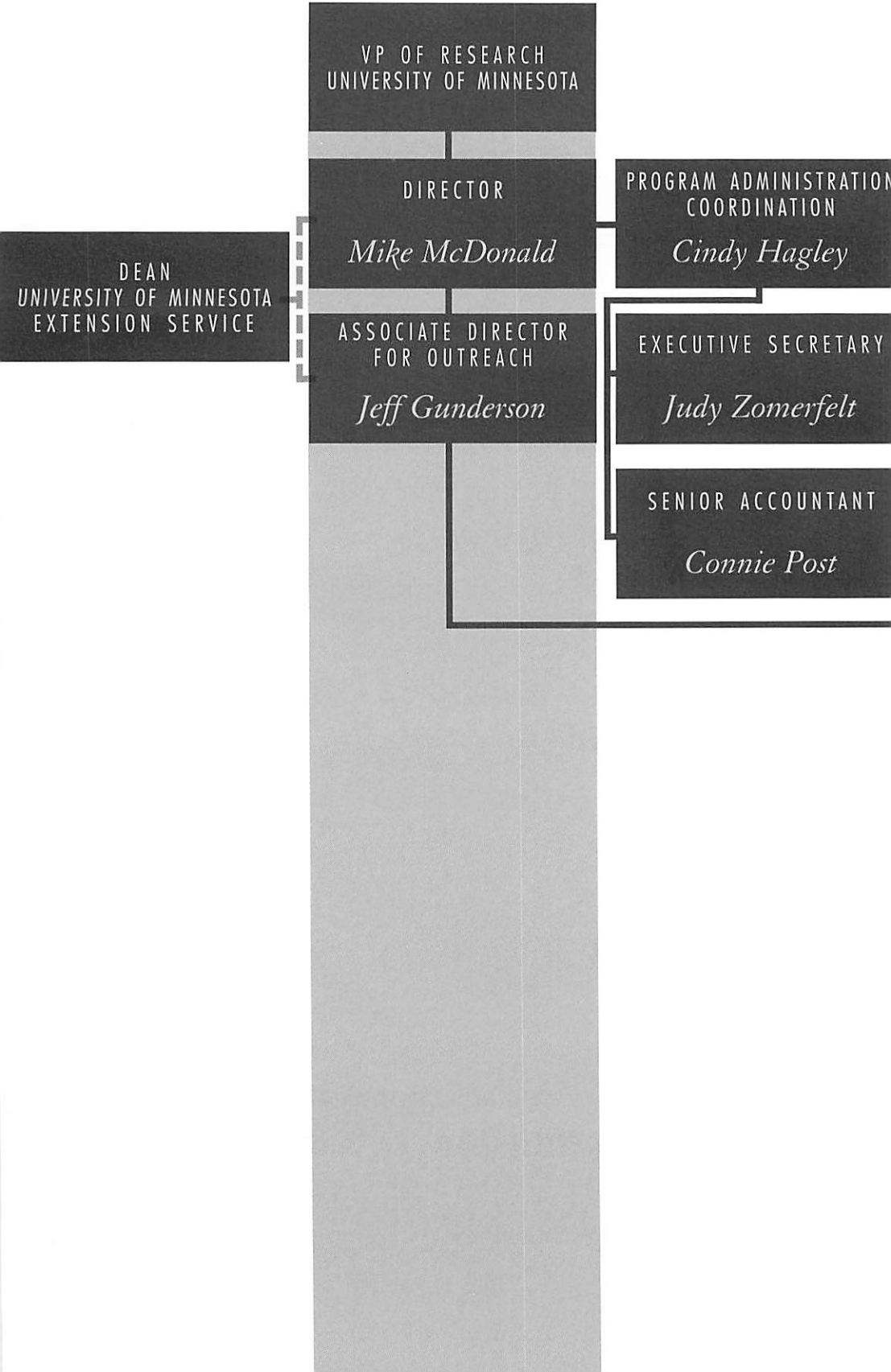
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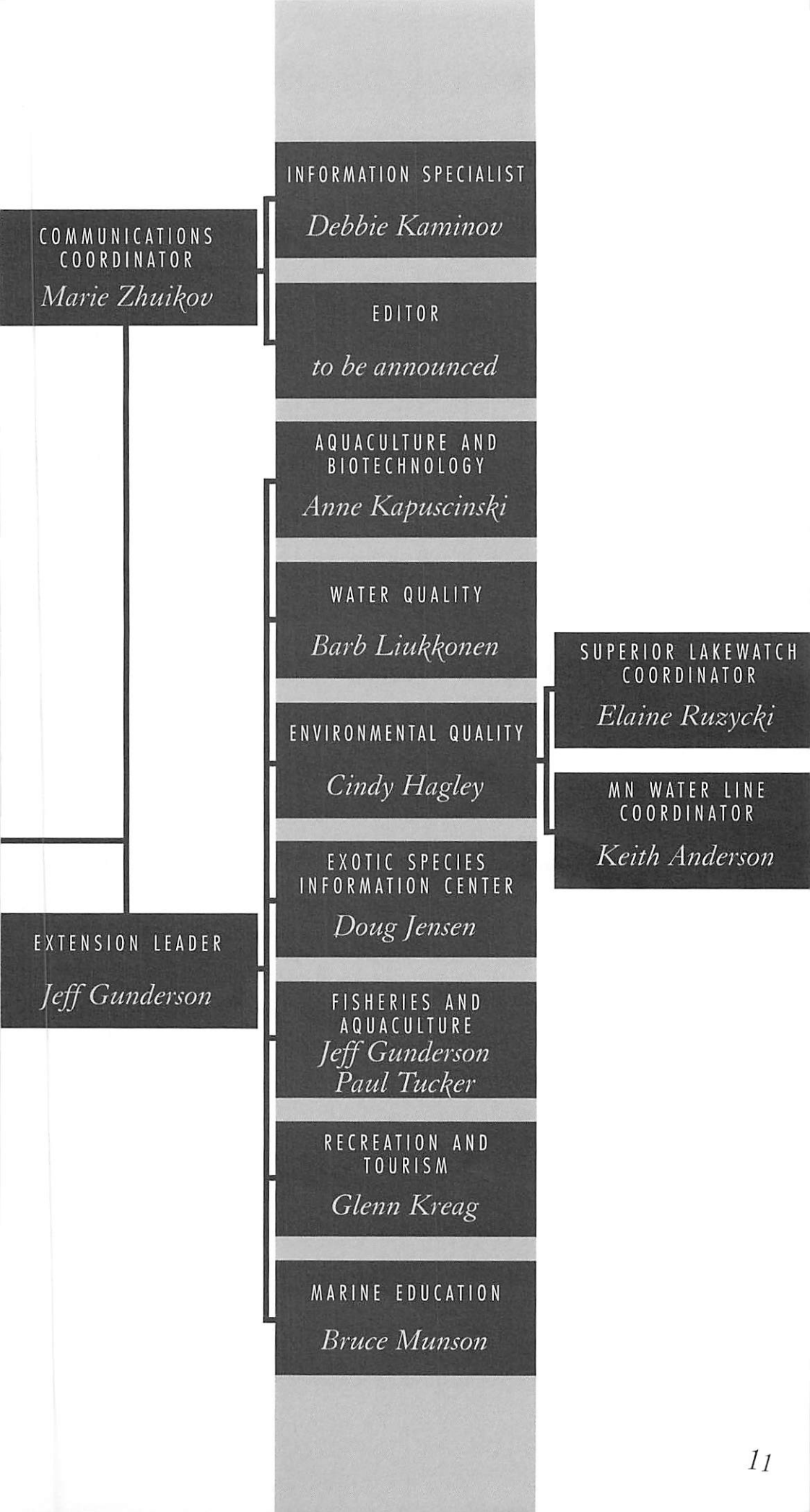
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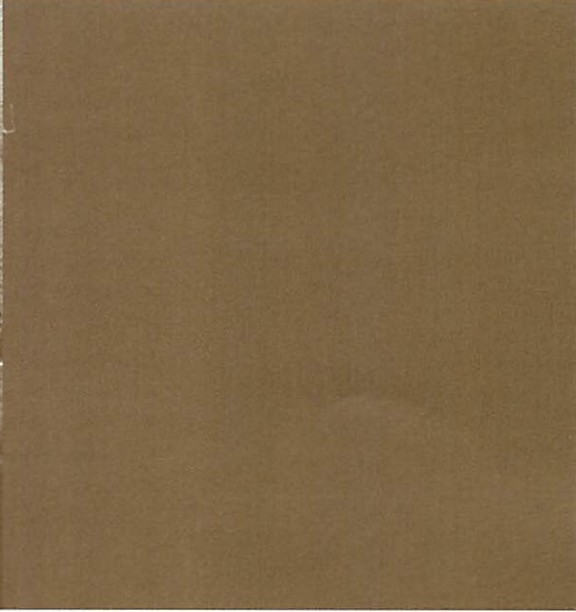
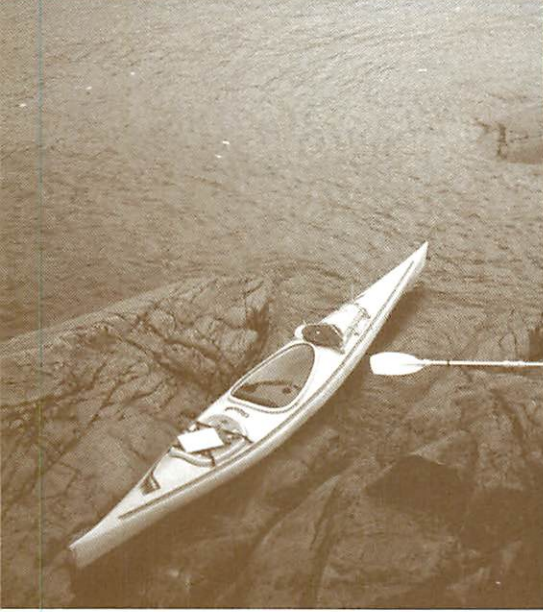
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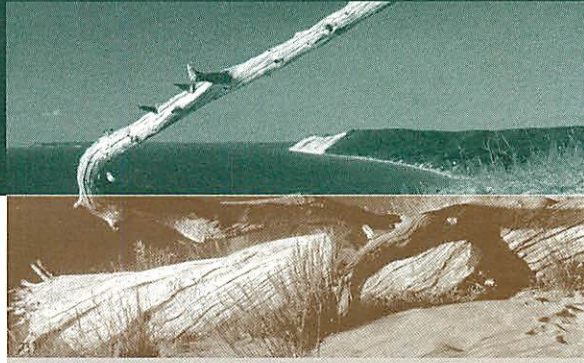
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interactions

Minnesota Sea Grant makes it a high priority to network, cooperate, and collaborate with others. Following is a list of the associations, businesses, organizations, agencies, and other university entities that we have worked closely with during the last two years.

- *A.W. Research*
- *Agriculture Utilization Research Institute*
- *American Groundwater Trust*
- *Apprise Technologies, Inc.*
- *Arrowhead Regional Development Commission*
- *Bennett's on the Lake*
- *Escola Superior de Biotecnologia, Porto, Portugal*
- *Freshwater Foundation*
- *Great Lakes Aquarium at Lake Superior Center*
- *Great Lakes Commission*
- *Great Lakes Fishery Commission*
- *Great Lakes Panel on Aquatic Nuisance Species*
- *Great Lakes Sea Grant Network*
- *Great Lakes Sport Fishing Council*
- *Harbor Technical Advisory Committee*
- *Individual Lake Associations*
- *International Joint Commission*
- *James Ford Bell Museum of Natural History*
- *Lake Superior College*
- *Louis Kemp Fisheries*
- *McQuade Protected Access Committee*
- *Michigan Department of Environmental Quality*
- *Michigan Department of Natural Resources*

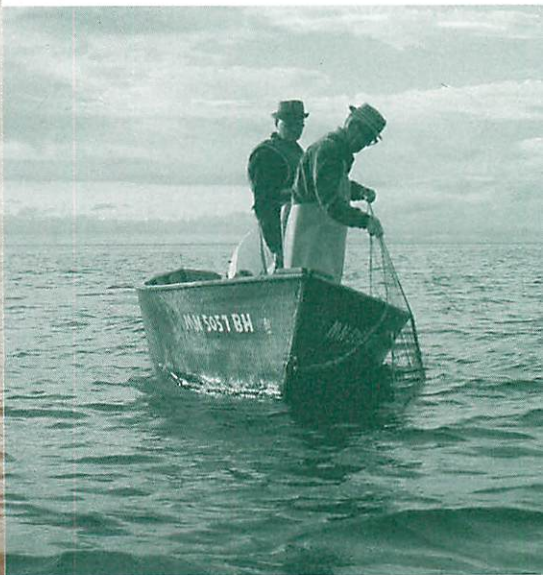
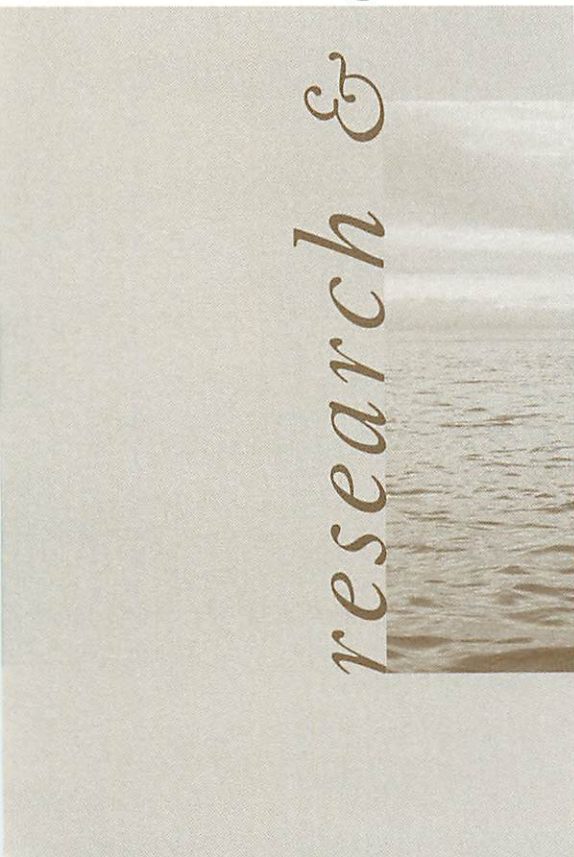




- *Minnesota Aquaculture Association*
- *Minnesota Board of Soil and Water Resources*
- *Minnesota Department of Agriculture*
- *Minnesota Department of Health*
- *Minnesota Department of Natural Resources*
- *Minnesota Department of Tourism*
- *Minnesota Lakes Association*
- *Minnesota Live Bait Dealers Association*
- *Minnesota Office of Environmental Assistance*
- *Minnesota Pollution Control Agency*
- *Minnesota Power*
- *National Marine Fisheries Service*
- *National Park Service*
- *NOAA Office of Coastal Resource Management*
- *Northern States Power*
- *North American Lake Management Society*
- *North Shore Charter Captains Association*
- *North Shore Management Board*
- *Ontario Federation of Hunters and Anglers*
- *Ontario Ministry of Environment and Energy*
- *Ontario Ministry of Natural Resources*
- *Outdoor Writers Association of America*
- *Sea Grant Programs in CA, LA, CT, and NC*
- *Seaway Port Authority of Duluth*
- *Shorelink*
- *Society of Environmental Toxicology and Chemistry*
- *St. Louis River Remedial Action Plan*
- *University of Minnesota Natural Resources Research Institute*
- *University of Minnesota Water Resources Center*
- *U.S. Army Corps of Engineers*
- *U.S. Bureau of Land Reclamation*
- *U.S. Coast Guard*
- *U.S. Department of Agriculture*
- *U.S. Environmental Protection Agency*
- *U.S. Fish and Wildlife Service*
- *U.S. Food and Drug Administration*
- *U.S. Geological Survey*
- *Western Regional Panel on Aquatic Nuisance Species*
- *Western Zebra Mussel Task Force*
- *Wisconsin Department of Natural Resources*

research & outreach projects

- 1** NONINDIGENOUS SPECIES
- 2** BIOTECHNOLOGY AND AQUACULTURE
- 3** SUSTAINABLE COASTAL COMMUNITIES
- 4** LAKE SUPERIOR ECOSYSTEM MANAGEMENT
- 5** PUBLICATIONS, INTERNET, AND MEDIA



1 THE IMPACT AND MANAGEMENT OF NONINDIGENOUS SPECIES

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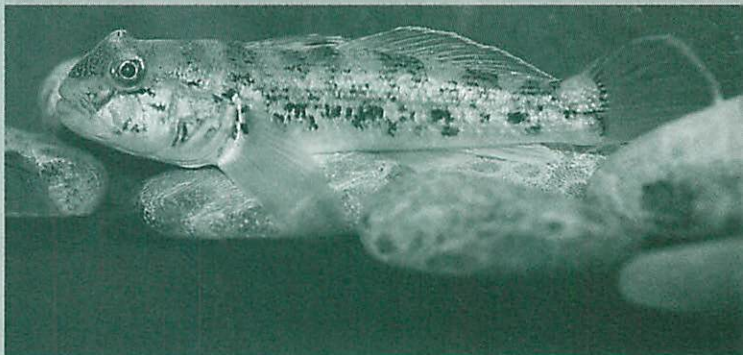
The Great Lakes are now home to over 139 aquatic nuisance species, many of which arrived in the ballast of trans-oceanic ships from Eurasian ports. Major ecological and economic damage in the Great Lakes has been caused by the introduction of many of these invaders. Loss of biodiversity, extirpation of already endangered or threatened species, and impacts on natural food webs and fish, water quality, and nutrient and contaminant cycling are some examples of observed ecosystem impacts. Economic losses due to impacts of exotic species on sport and commercial fisheries and water-related industries are millions of dollars annually.

GOALS

- Prevent Great Lakes exotic species from spreading to other waters.
- Develop techniques to control or manage exotic species.
- Understand the environmental and economic impact of exotic species.

RESEARCH PRIORITIES AND EMERGING ISSUES

- The ecological interrelationships among exotic and endemic species.
- Advanced technological or other innovative approaches to the control of exotic species.
- Development of zebra mussel control demonstration projects for water systems.



RESEARCH PROJECTS

POTENTIAL IMPACTS OF INVADING RUFFE ON BENTHIC AND PELAGIC ECOSYSTEMS OF THE GREAT LAKES

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This research will provide managers across the Great Lakes with information that will assist in developing science-based strategies for fisheries management with an ecosystem perspective. Some of the goals are to identify the relationship between ruffe feeding and benthic (bottom-dwelling) communities and to look at the interactions between ruffe and native Great Lakes fishes.

1²³





GEOGRAPHIC VARIATION AND COLONIZATION PATTERNS OF RUFFE IN THE GREAT LAKES: OTOLITH SIGNATURES AND DNA SEQUENCE DIVERGENCE

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123

This research will help determine the European origins of ruffe within the Great Lakes, and its colonization patterns within the streams and estuaries of Lake Superior. Ruffe population control methods and prevention of new introductions depend upon knowing the number of separate introductions to the Great Lakes and how the ruffe extend their range. This research will also help determine if the voluntary ballast water exchange program currently in place is effective.

REPRODUCTION IN THE EURASIAN RUFFE

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123

This project will look for agents that inhibit ruffe reproduction which may be used to help block its spread in the Great Lakes.

2

ECONOMIC VIABILITY AND ENVIRONMENTAL SAFETY IN BIOTECHNOLOGY AND AQUACULTURE

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The growing consumer demand for affordable, high-quality seafood and the need to protect marine and freshwater resources from overharvest have led to increased interest in aquaculture research targeted to improve performance traits in economically-important species. At the same time, dramatic declines in aquatic biodiversity — especially declines in naturally-reproducing populations of many fish and shellfish — have increased public concern about uses of hatchery stocking programs to rebuild depleted populations.

Aquaculture has grown globally at a rate of 8 to 14 percent per year since 1984. World aquaculture production increased 89 percent from 1984 to 1992, to a total production of 19.3 million metric tons. The dollar value of world aquaculture was estimated at \$32.5 billion in 1993. Aquaculture is the fastest growing segment of U.S. agriculture. Yet aquaculture growth in the U.S., especially in the northern states, has not grown as rapidly as the global rate.

Aquatic biodiversity in the U.S. has suffered dramatic and ongoing declines. Of the remaining aquatic species, 27 percent of the fish fauna is endangered, threatened, or of special concern; nearly 50 percent of all mussel species are currently listed or proposed for listing as threatened or endangered under the Endangered Species Act; and two-thirds of North America's crayfish species are rare or threatened. Protection of this natural diversity at genetic, population, and species levels is paramount. There is a need to develop and foster applications of biotechnology in aquaculture and fisheries management that will not adversely affect aquatic biodiversity.

There is also a need to address the impacts aquaculture has on the environment and the impact environmental contaminants can have on aquaculture operations. New technologies need to be developed to improve treatment of aquaculture effluent. And the effects of exposure of cultured fish to endocrine-disrupting chemical contaminants need to be evaluated in order for the aquaculture industry to be environmentally-sound and economically-viable.

GOALS

- *Foster an environmentally-sound and economically-viable aquaculture industry.*
- *Expand aquatic animal product utilization.*
- *Facilitate formulation of aquaculture public policy.*

RESEARCH PRIORITIES AND EMERGING ISSUES AQUACULTURE

- *Develop genetically-modified organisms to enhance aquaculture viability.*
- *Develop aquaculture techniques for species that are currently harvested from the wild or are at, or beyond, sustainable production levels.*
- *Develop new technology to improve the economic viability and sustainability of aquaculture.*
- *Construct cost-benefit analyses of producing different species in a variety of culture operations.*
- *Improve feeding efficiency and feed cost-effectiveness through nutritional analysis and identification of alternative nutrient sources.*
- *Develop improved, environmentally-sensitive technologies to treat aquaculture effluent in a cost-effective manner.*

BIOTECHNOLOGY

- *Evaluate the effects of exposure to endocrine-disrupting chemical contaminants on growth, development, reproduction, pathology, and disease control in cultured fish.*
- *Develop better methods for detecting contaminated seafood, improving processing and depuration, increasing storage life, and controlling parasites and disease sources.*
- *Mechanisms and sites of action of chemical contaminants.*
- *New technologies for monitoring environmental quality of aquatic ecosystems and exploring new approaches for biosensors.*
- *Legal, economic, social, and political issues associated with aquatic biotechnology.*

GENETIC EFFECTS OF HATCHERY RAINBOW TROUT ON NATURALIZED STEELHEAD POPULATIONS

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Hatchery-raised fish are stocked into lakes and rivers for many reasons, from rebuilding depleted populations to maintaining or increasing the catch for anglers. Many hatcheries breed fish taken from non-local sources, and stock these fish into waters containing local populations of the same species.

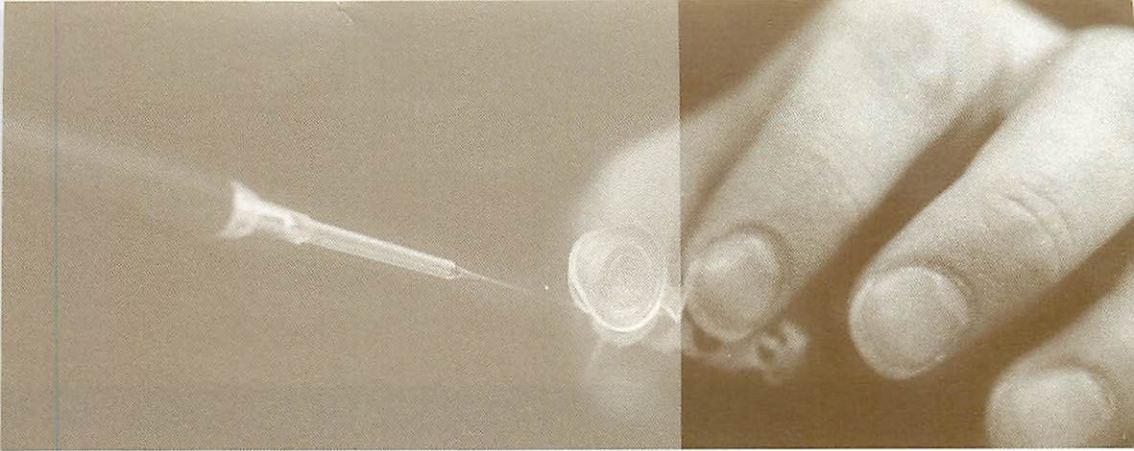
When hatchery fish are released into the wild, how might they affect their wild relatives? It is not known, for example, how the interbreeding between hatchery-raised fish and naturalized stocks might affect the health and survival of the offspring. This research project will study the genetic hazards posed by stocking non-local fish into areas containing wild populations.

Researchers will first develop DNA markers — a sort of genetic signature — for a Minnesota hatchery stock of “kamloops,” an introduced strain of rainbow trout. Such markers will help determine if these fish are interbreeding with naturalized steelhead trout in tributaries along the North Shore of Lake Superior. Researchers will be able to go back in time, collecting DNA samples from fish scales kept from the first batch of kamloops introduced into Lake Superior over 30 years ago, as well as samples from naturalized steelhead of the same era.

This information will allow researchers to reconstruct the historical record of interbreeding between stocked fish and naturally reproducing fish. As a result, scientists and fisheries managers will be able to determine the impact of this hybridization on the health and survival of naturalized steelhead in Minnesota tributaries to Lake Superior.

1²





DEVELOPMENT OF VECTORS TO INACTIVATE GENE EXPRESSION IN FISH

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Reliability is one of the major problems involved in improving fish through genetic engineering. When a new gene is transplanted to promote specific traits or characteristics in a fish, it doesn't always work as desired, or it may not work at all. Unwanted side effects are common. The key to solving this problem is understanding what switches genes on and off; what allows them to be "expressed." Researchers have identified several promoters of gene expression. But currently, they do not know how to suppress gene expression in fish.

This research project will develop vectors for inactivation of genes in fish to improve aquaculture of economically important fish, such as salmon, northern pike, trout, and catfish.

By identifying these vectors, fish biologists will be better able to develop improved stocks needed for U.S. aquaculture. This research will make improved growth, disease-resistance and other commercial characteristics possible.

12

RESEARCH PROJECTS

3

SUSTAINABLE COASTAL COMMUNITIES

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The past decade has seen accelerated growth and development on Minnesota's North Shore of Lake Superior. The greatest expansion has been in second home development, followed by tourism development. The resulting change has raised concerns among those who use and love the North Shore. They are concerned about future development, its impacts on visual beauty, whether overuse and over development of the North Shore will degrade existing parks and trails, and what changes will be successful in preserving the woodsy, unspoiled coastal region. Additional concerns include ground and surface water quality, air quality, crowding, sign proliferation, loss of the North Shore's unique character through franchise development, and, in general, the loss of open space and the loss of opportunities for public coastal access.

GOALS

- *Foster a sustainable economy while sustaining a healthy environment.*
- *Foster business and community tourism initiatives.*
- *Encourage adoption of an integrated resource management approach to natural resources.*

RESEARCH PRIORITIES AND EMERGING ISSUES

- *Linked economic, policy, and environmental models for the Lake Superior basin.*
- *Alternative approaches to wastewater treatment for areas where traditional systems fail or are not feasible.*
- *Economic valuation of environmental resources.*
- *Predictive models for lakes, useful for management and education.*
- *Assessment of the relationship between water quality and clarity, fisheries, and shoreland property values.*
- *The role of tourism in economics and potential for sustainable development of Minnesota's coastal communities (including inland lakes).*



RESEARCH PROJECT

INVESTIGATING PATHOGEN AND NUTRIENT REMOVAL BY CONSTRUCTED WETLANDS FOR TREATMENT OF SINGLE-HOME AND SMALL-COMMUNITY WASTEWATER

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1

Nearly half a million Minnesota residences use individual or small community wastewater treatment systems. Between 55-70 percent of these systems are out of compliance with state standards. In northeastern Minnesota and along the north shore of Lake Superior the failure rate of septic systems is greater than 50 percent.

One result is that minimally treated wastewater is being discharged, which can contaminate drinking water supplies, harm rural and coastal recreation by creating health risks, and damage fisheries in streams, Lake Superior, and inland lakes. Additionally, even functioning conventional septic systems are not designed to remove nutrients like nitrogen and phosphorus, elements that can impair water quality by leading to excessive growth of algae and aquatic vegetation, which in turn can degrade fisheries.

This project will study constructed wetlands (CWs), as an alternative to conventional on-site, soil-based wastewater treatment systems. In nature, wetlands are important as holding areas for floodwaters, and as traps for sediments and contaminants. Researchers will focus on how well CWs might remove disease-causing organisms — particularly bacteria and viruses — as well as nitrogen from residential septic tank effluent. The study complements a larger, multi-partner collaboration to evaluate a variety of alternative on-site technologies for seasonal and year-round use in Minnesota.

Results of this project are important beyond Minnesota; environmentally-sensitive coastal communities nationwide can benefit from effective alternatives to this persistent wastewater problem as can inland regions where site conditions are inadequate for proper wastewater treatment and disposal.

4

LAKE SUPERIOR ECOSYSTEM MANAGEMENT INITIATIVE

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outreach contact

Lake Superior is a unique and valuable international resource. It has the largest surface area of any freshwater lake in the world, yet has remained pristine relative to the other Great Lakes. However, Lake Superior faces many of the same problems from point and nonpoint sources of pollution as the other Great Lakes. Goals of the United States and Canadian governments are to establish programs to achieve zero discharge of toxic substances, identify impairments, and restore and protect the lake's ecosystem. Research is needed in fisheries, erosion, contaminants, coastal hazards, coastal processes, and biotic interactions to fill critical gaps in our understanding of this unique ecosystem and the likely outcomes of management alternatives.

GOALS

- *Promote environmental quality of biotic and abiotic resources in the Great Lakes region, particularly the Lake Superior watershed and Minnesota's inland waters.*
- *Facilitate formulation of appropriate natural resources public policy.*



RESEARCH PRIORITIES AND EMERGING ISSUES

BIOTIC INTERACTIONS

- *Effects of chemical stressors on piscivorous wildlife.*
- *Causes and prevalence of amphibian deformities.*
- *Effects of endocrine disrupters on wildlife.*
- *Sustainable fisheries harvest levels by species (sport and commercial).*
- *Development of predictive models of fish population dynamics.*
- *Energetics modeling of biotic communities in Lake Superior.*
- *Thermodynamics of Lake Superior as related to production and energetics.*
- *More information on how individual fish species fit into the Lake Superior fish communities.*

WATER QUALITY AND COASTAL PROCESSES

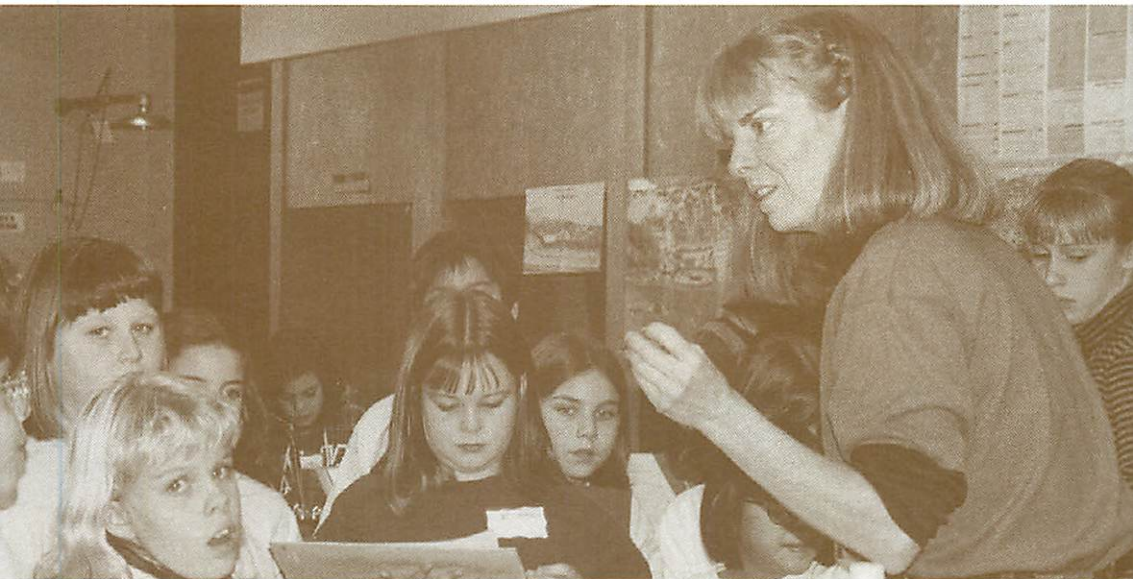
- *Understanding and modeling the dynamics, fate, and ecological effects of toxic contaminants.*
- *Bioremediation or ecological engineering solutions to environmental contamination problems.*
- *Defensible and practical analytical techniques for lowering detection limits for contaminants in water resources.*
- *Bioavailability of metals under different conditions.*
- *Relationship between Total Maximum Daily Loads and the watershed approach to regulating pollutants.*
- *Human carrying capacity of lakes.*
- *Coastal erosion.*

WATERSHED MANAGEMENT

- *Modeling the impacts of climate change on Lake Superior and inland lake ecosystems.*
- *Impacts of cumulative loss of small wetlands.*
- *Diagnosing causes of ecosystem degradation.*
- *Factors influencing the retention and loss of nutrients from watersheds.*
- *Understanding land use/water quality relationships.*
- *Methods for incorporating different sampling techniques into one geographic database.*
- *Contributions to the hypoxia zone in the Gulf of Mexico through Mississippi River drainage.*

COASTAL HAZARDS

- *Biological, sociological, and economic impacts of coastal hazards on humans and aquatic life.*
- *Crisis preparation, communications, and emergency response methods.*
- *Remediation techniques.*



INVESTIGATING THE ROLE SUNLIGHT PLAYS WHEN IT BREAKS DOWN ORGANIC CONTAMINANTS AND NATURAL ORGANIC MATTER IN LAKE SUPERIOR

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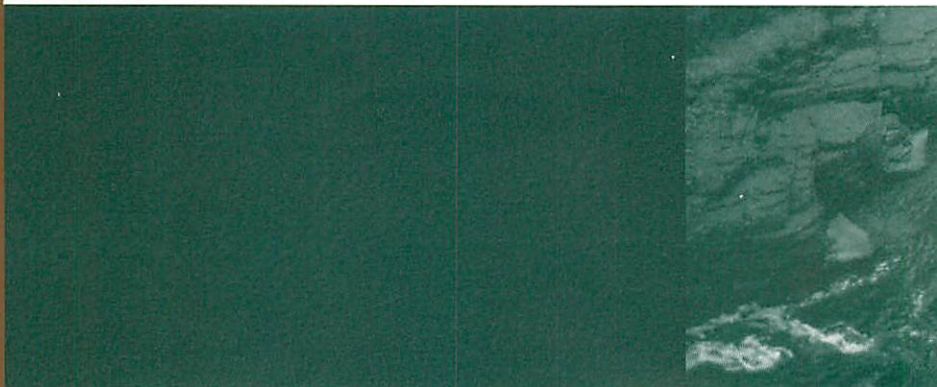
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Concentrations of nitrate in Lake Superior have been rising consistently at least since the beginning of the 20th century. The reasons are unclear, although acid rain and snow likely contribute. In most waters, nitrate levels are kept in check by plant life. However, relative to its size, Lake Superior supports little plant life, and so nitrate remains high in the water column throughout the year.

This project will study the indirect role nitrate plays in breaking down organic contaminants and other organic matter in the lake. Nitrate readily absorbs ultraviolet radiation from sunlight, which sets off a chemical reaction that produces the hydroxyl radical, OH. This radical, in turn, breaks down organic matter. This process may be significant in Lake Superior and in other waters with high nitrate levels, such as rivers and streams that drain agricultural areas where nitrate levels are high because of fertilizer use, or in lakes with high nitrate levels due to acid precipitation.

Calculations suggest this process may play a significant role in breaking down human-caused contaminants and other organic matter in Lake Superior and the other Great Lakes. This project will provide the first measurements of these chemical processes in any of the Great Lakes.

The results will be useful to water quality managers involved in assessing the fate of organic contaminants in aquatic systems and to scientists interested in understanding factors affecting the persistence of such compounds in water bodies.



INVESTIGATING THE EFFECTS OF LAND USE ON STREAM ECOSYSTEMS AND MATERIAL DISCHARGE INTO LAKE SUPERIOR STREAMS

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The water quality in streams along Lake Superior's north shore is important to the region's economy and culture. The way we develop and use land around these streams has a great influence on that water. Urban development near a stream can impact a stream's water quality and chemistry, and affect plant and animal life in the stream. Since North Shore streams empty into Lake Superior, the health of the lake is also affected.

One way to reduce or control the effects of urbanization is to maintain or develop buffer zones of undeveloped land along stream corridors. These buffer zones trap sediments, control erosion, influence water chemistry, and provide important habitat for fish. However, researchers and resource managers know little about the best size and placement of these buffer zones.

This study will examine six streams that drain six different watersheds — three of them forested, along the Lake Superior north shore; and three located near or within urban Duluth. Researchers will determine how urban and suburban development within a watershed affects the health of a stream ecosystem, and how buffer zones might best reduce the harmful effects of this development.

The results of this study will help community planners predict the ecosystem effects of different development scenarios, and will also provide a guide for ecosystem restoration within a watershed.

RESEARCH PROJECTS

THE DISTRIBUTION AND INVENTORY OF HUMAN-CAUSED METAL CONTAMINANTS IN WESTERN LAKE SUPERIOR SEDIMENTS

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Though Lake Superior is the most pristine of the Great Lakes, it suffers from contamination, including the accumulation of heavy metals. These metals, such as lead and mercury, are often generated far removed from Lake Superior and are transported to the lake via the atmosphere. Once in the lake, these pollutants adhere to sediments in the water; in turn, these contaminated sediments may be buried or resuspended by various physical, chemical, or biological processes.

The western end of Lake Superior receives the majority of all sediments delivered to the entire lake. When suspended in the water column, these sediments effectively “sweep” the water of many contaminants. But where do these sediments — and the contaminants they carry — ultimately end up? The answer depends on variables like currents, waves, and water circulation patterns.

Currently, knowledge of the contaminants in bottom sediments of large lakes depends on samples taken at random from the lake floor. This method provides an incomplete picture, however. This project will develop a better sampling method, using state-of-the-art acoustic remote sensing to generate maps of sediment thickness and texture on the floor of western Lake Superior.

These maps will help researchers choose the best sites at which to sample sediments and analyze these samples for the presence of both solid and dissolved metals. Results from this study will help improve sampling strategies for future investigations of contaminants and lake-bottom ecology in this part of the lake, and will also help determine where, how, and at what rate sediments are distributed and deposited in the western basin of Lake Superior. The results will provide resource managers a tool with which to better predict the effects of these pollutants and plan cost-effective clean-up strategies.



MODELING SEDIMENT PLUMES COMING INTO LAKE SUPERIOR FROM THE NEMADJI RIVER

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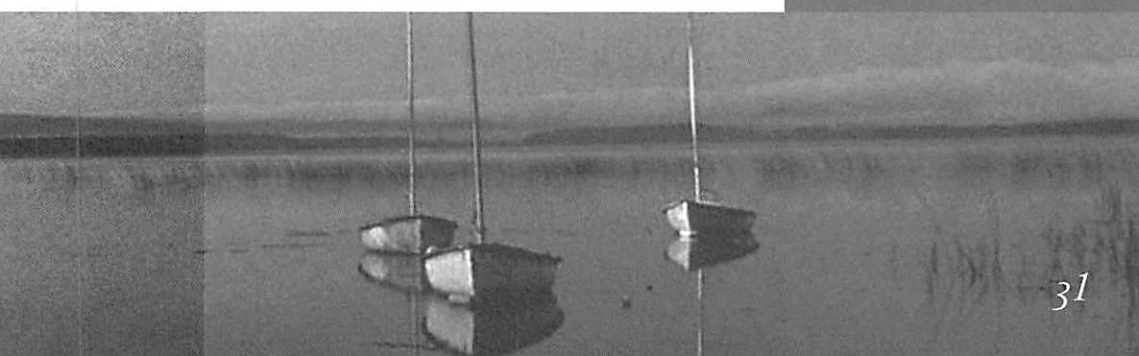
Relative to its size, Lake Superior has a small drainage basin, much of it including rocky land that produces little sediment. However, the Nemadji River watershed, located in Minnesota and Wisconsin, is one of the few in the basin that contributes significant amounts of sediment to the lake — more than 500,000 metric tons annually, into the waters of the Duluth/Superior harbor. Though sedimentation is a natural phenomenon, it is accelerated by human activities in the watershed like forest harvesting, road building, and conversion of forest into agricultural and open land.

Though some of the sediment entering the harbor remains there, much of it travels through the harbor area and into deeper water as a turbidity current — an undercurrent powered by the sediment itself, which renders the flowing turbid water heavier than the clearer water above. Once initiated, such currents can travel remarkable distances in otherwise still bodies of water.

The ultimate quantity and fate of the Nemadji sediments that flow through the Duluth/Superior harbor is not known. It is known, however, that these fine-grained, silt and clay sediments can remain suspended in the water column, and, should these sediments be contaminated, they can affect the health of the lake's ecosystem.

Researchers will develop a model of this turbidity current and apply it to the fate of sediment entering Lake Superior from the Nemadji River. This model will help predict where and how much of the sediment will accumulate, and what will happen to the contaminants carried by this sediment. Since some of these sediments result from land-use patterns, this model also will help communities better plan land-management strategies in the Nemadji River watershed.

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QUANTIFYING VERTICAL UPWELLING CURRENTS ALONG LAKE SUPERIOR'S NORTH SHORE

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Studying and attempting to manage an ecosystem as large and complicated as Lake Superior relies on an understanding of the underlying chemical and physical processes in the basin.

One such phenomenon is an “upwelling,” water movement common to coastal oceans and lakes where deep, nutrient-rich waters rise to near the surface. The nutrients carried in upwellings affect the entire food web of the system, including fish populations. Additionally, upwellings can change water and air temperatures, carry polluted sediments, and affect a variety of other physical and biological processes in a lake.

This project will collect measurements of water temperatures at varying depths in Lake Superior near the Split Rock Lighthouse, off Minnesota's North Shore. Researchers also will gather information on water temperatures, water currents, and biological activity in the lake along the western shore of Michigan's Keweenaw Peninsula.

The result of this study will be a significant advance in our understanding of the physical limnology of western Lake Superior. In particular, researchers will better understand how upwelling events develop and impact the food web and sediment distribution in the lake.

MONITORING LAKE SUPERIOR ZOOPLANKTON SIZE AND DENSITY VIA ACOUSTICAL MAPPING

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An important component of the Lake Superior food web is zooplankton — microscopic animals that ultimately serve as food for all the other creatures in the lake. Despite the importance of zooplankton, their locations and abundances in Lake Superior are poorly known. Previous studies have shown that the distribution of these tiny animals is patchy, and densities can vary significantly over just a few meters' depth or latitude.

Zooplankton are usually collected in nets, but it is expensive and time-consuming to get a sufficient number of samples to determine population density. Also, lakes are so physically and chemically diverse that it is difficult to extrapolate findings from one area to another, even within a given lake.

This project will use sound waves to monitor zooplankton size and density. Signals from two echosounders will be sent down into Lake Superior; the echoes that bounce back will give researchers data that they will analyze and compare with net samples of zooplankton from the same study areas. Once this acoustical system has been calibrated, it will provide researchers a powerful and inexpensive way to classify zooplankton according to size and density. In turn, this information will better inform the study and management of the Lake Superior food web — including its fisheries.

EVALUATING POTENTIAL REINTRODUCTION SITES FOR COASTER BROOK TROUT WITHIN THE LAKE SUPERIOR BASIN

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Brook trout are an important part of Great Lakes history — this fish is the only stream-dwelling trout native to the Great Lakes and one of only two salmonid species native to Lake Superior. Coaster brook trout were once abundant throughout Lake Superior and were popular game fish in the 1800s, but since then their stocks have been reduced by overfishing and habitat degradation. Over the last decade, interest in the fish has grown due to a Great Lakes Fishery Commission report that highlighted the importance of brook trout and other native fishes.

Using existing GIS databases, researchers in this project will identify watershed and landscape features of areas in the Lake Superior basin most suitable for reintroduction of coaster brook trout. Though little is known about the specific habitat requirements of this fish, studies have shown that coasters prefer areas with cool, upwelling groundwater discharge and gravelly bottoms relatively free of sediments.

Researchers will collect habitat data in several watersheds along the Canadian north shore of Lake Superior that support the few remaining coaster populations. The data will be used to construct a model suggesting where other suitable brook trout habitat exists in the Lake Superior basin. Researchers will then survey coastline areas of Minnesota, Wisconsin, and Michigan that meet the criteria.

The project also will work to integrate databases collected by other Sea Grant-funded research in the Lake Superior area as well as other federal and state agencies and Canadian projects. These collaborations will be essential to successfully restore this native Great Lakes species.



5

EFFECTIVE USE OF PUBLICATIONS, INTERNET, AND MEDIA

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SITUATION

This section discusses outreach actions for the entire program. There are several goals and initiatives that do not fit neatly under the other thematic areas. These involve programmatic audiences, visibility, and publications that cover the program as a whole, such as the Seiche newsletter.

The overall goal of the outreach program is to help Sea Grant build and maintain long-term, mutually beneficial relationships with key constituencies. This is done through communications counsel internally and effective communications externally. These communications efforts are organized, when needed, via strategy papers. These papers are developed for significant issues and publicity events such as discoveries of new exotic species, education efforts, to ensure staff "speak with one voice," and effectively reach target audiences.

Sea Grant outreach staff are involved in planning and strategy for all program efforts: publications, our World Wide Web site, events, workshops, and research results. This has allowed Sea Grant to develop and take advantage of opportunities to promote the program. It also keeps outreach staff informed of everyone's work so they can anticipate and plan for communications needs. We will continue to improve the integration of communications with the research and extension programs.

Since the goal of the Sea Grant outreach program is to develop mutual understanding between Sea Grant and our audiences, outreach staff work as much on developing collaborative relationships with other organizations as on producing new products.

Much of Sea Grant's work is relevant to the state's inland lakes and the St. Croix and Mississippi Rivers. Minnesota has 206 miles of shoreline on Lake Superior and thousands of miles of shoreline on inland lakes. It has far more residents living near inland lakes than on Lake Superior.

Minnesota is known as "The Land of 10,000 Lakes," its residents have a fascination with water. The MN Sea Grant office in Duluth is in an area boasting the nation's highest per capita "frequent fisherfolks." According to a 1995 In-Fisherman magazine survey, 45 percent of residents in Duluth-Superior describe themselves that way.

According to a 1991 poll, 25 percent of Minnesota residents own a lake home. Sixty percent of the state's adults make an overnight vacation to the lake each year. This generates incredible economic activity throughout the state. In one county, lake visitors spend \$71 million a year. Shoreline property owners in that county pay nearly 80 percent of the real estate taxes. 42,000 Minnesotans participate in more than 700 lake associations, groups organized to protect water quality, fishing, and to slow the spread of exotic species.

Minnesota's abundance of water, and the importance of water in most residents' lives, creates a big interest in all the lakes, including Superior. Consequently, audiences for many of Sea Grant's projects can be expanded to include users of aquatic resources throughout the state. Our geographic proximity to the mid-continental, non-Sea Grant states also allows us to play a role in disseminating Sea Grant information to those states.

AUDIENCES

Minnesota Sea Grant's research results and outreach products influence natural resource and fisheries management throughout the Great Lakes region, the United States, and internationally. For these reasons, Minnesota Sea Grant emphasizes regional interest in its research and outreach efforts.

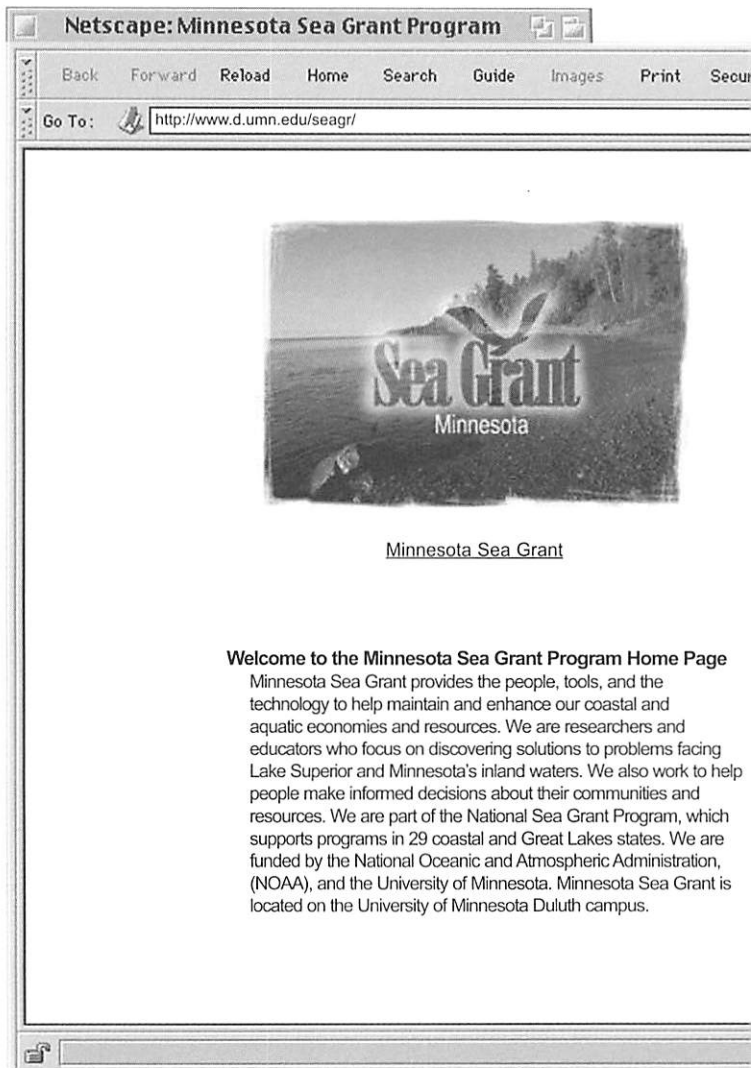
Sea Grant's goal of encouraging sustainable use and development makes it most appropriate for us to work with audiences that can have the greatest impact on these resources. Consequently, Sea Grant's priority audiences are as follows:

- Organizations that influence resource use, such as lake associations, tourism associations, sport fishing groups, environmental groups, legislators, and educators.
- Organizations that can help disseminate Sea Grant research findings and outreach information, such as the Minnesota Department of Natural Resources, the U.S. Fish and Wildlife Service, the National Park Service, the U.S. Army Corps of Engineers, and others.
- Industries and communities that can use or benefit from Sea Grant's work.
- The general public, through mass-media contacts and the Internet.
- Other researchers who can benefit from and build on Sea Grant's work.
- Natural resource planners and other professionals who can use Sea Grant findings to improve the management of natural resources and fisheries.

These target groups can be local, statewide, regional, national, and international.

GOALS

- *Use our newsletter, the Seiche, and other publications as an effective tool to generate interest in our program and to deliver our educational message to a broad audience.*
- *Use mass media strategically to disseminate educational messages to large audiences.*
- *Use Minnesota Sea Grant's home page on the World Wide Web to disseminate useful, research-based information, publications, and educational tools.*



Welcome to the Minnesota Sea Grant Program Home Page

Minnesota Sea Grant provides the people, tools, and the technology to help maintain and enhance our coastal and aquatic economies and resources. We are researchers and educators who focus on discovering solutions to problems facing Lake Superior and Minnesota's inland waters. We also work to help people make informed decisions about their communities and resources. We are part of the National Sea Grant Program, which supports programs in 29 coastal and Great Lakes states. We are funded by the National Oceanic and Atmospheric Administration, (NOAA), and the University of Minnesota. Minnesota Sea Grant is located on the University of Minnesota Duluth campus.



The *Seiche*, Minnesota Sea Grant's newsletter, has been published since 1976. Its purpose is to keep our audience in touch with Lake Superior; inform them about our mission, work, and products; and to expand our message through reuse of articles in other newsletters and magazines.

The *Seiche* allows us to consistently and efficiently reach a diverse audience. It is an effective way to keep reporters, educators, academics, agency staff, and the public informed about Sea Grant's work and Great Lakes issues. It helps Sea Grant place news stories, sell publications, and extend research results.

Sea Grant does reader surveys about every two to three years to see how the newsletter should change. *Seiche* readers were last surveyed in April of 1996. Comments from readers show that the *Seiche* is useful for the program and that we are reaching our target audiences.

The *Seiche* is constantly praised by our readers as a high quality, relevant publication. We are often told that we cover resources issues that are not covered by any other news outlet, or university or agency publication.

special outreach competitions

Minnesota Sea Grant was awarded two years of funding (\$222,363) for seven outreach projects through a special nationwide nonindigenous species competition from the National Sea Grant College Program. The following are the titles, amounts of funding awarded, brief project descriptions, and collaborators.





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Restricting the Spread of Aquatic Nuisance Species Via Baitfish and Fish for Stocking (FY98: \$32,697; FY99: \$16,349): This project's goal is to maintain viable baitfish and aquaculture industries in areas where aquatic nuisance species (ANS) have invaded, and to restrict the spread of ANS. Minnesota Sea Grant will lead this collaborative effort of all Great Lakes Sea Grant Network Programs to work with these industries to develop HACCP-like plans (Hazard Analysis at Critical Control Points — a successful program used by seafood industries to ensure product safety). The industries can use this process to certify that their bait and fish stocks are ANS-free. We will develop a HACCP-like training manual and hazards guide, collect samples of baitfish from retail outlets to analyze them for ANS contamination, and interview anglers to determine their attitudes towards ANS-free bait and how to dispose of unused bait. Minnesota Sea Grant staff involved are Doug Jensen and Jeff Gunderson.

RESTRICTING THE SPREAD OF AQUATIC NUISANCE SPECIES VIA BAITFISH AND FISH FOR STOCKING



The National Zebra Mussel and ANS Clearinghouse (FY98: \$12,947; FY99: \$8,962): As a collaborative effort with New York Sea Grant, this project expands the former National Zebra Mussel Clearinghouse to include other ANS to its Technical Collection by providing users full access to research publications via an on-line searchable WWW site and via interlibrary loan. Combining Minnesota Sea Grant's existing Ruffe Research Technical Library (over 300 papers) will enhance the Clearinghouse's effort to better meet the needs of users on ANS research, and streamline efforts to avoid duplication of effort. Minnesota Sea Grant staff involved are Doug Jensen and Mike McDonald.

THE NATIONAL ZEBRA MUSSEL AND ANS CLEARINGHOUSE

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EXOTIC SPECIES TRAINING FOR K-12 TEACHERS

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Exotic Species Training for K-12 Teachers (FY98: \$19,764; FY99: \$19,264): Because aquatic nuisance species (ANS) can be used to help illustrate the impacts humans have on aquatic ecosystems, they are an important curriculum topic for teachers in K-12 classrooms. In order to meet the needs of teachers and educators, Minnesota Sea Grant will facilitate a one-day workshop that will be hosted by the Lake Superior Center. Similar workshops will be held in 1999 at five regional aquaria and environmental learning centers as part of a larger effort by the entire Great Lakes Sea Grant Network. At each center, 30 teachers and educators will be introduced to ANS education materials, many of which are Sea Grant products. Each center will showcase displays featuring live specimens of ANS. Participants will develop a grade-specific curriculum module, which will be independently pilot tested and then marketed throughout the Great Lakes region. Minnesota Sea Grant staff involved are Doug Jensen and Bruce Munson.

ZEBRA MUSSEL PREVENTATIVE MAINTENANCE FOR CALIFORNIA

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Zebra Mussel Preventative Maintenance for California (FY98: \$13,624; FY99: \$7,587): To date, three recreational boats trailered from the Midwest have turned up at California's border with live zebra mussels on them. If zebra mussels and other invasive ANS get into the enormous drinking water and irrigation delivery systems due to boat contamination, it will create huge problems. Minnesota Sea Grant, New York Sea Grant, and North Carolina Sea Grant programs are teaming up with the two California Sea Grant programs to bring proactive prevention, control, risk assessment, and mitigation information to workshops for private and public water-related agencies in California. The University of Southern California Sea Grant program will provide a Web Site as a central source of ANS information for workshop participants. Minnesota Sea Grant staff involved are Doug Jensen and Marie Zhuikov.



SEA GRANT IN THE ELECTRONIC AGE

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Sea Grant in the Electronic Age (FY98: \$23,412; FY99: \$12,673): Access to Sea Grant-sponsored research and outreach materials is critical to our users. That's why we've worked together with the Great Lakes Sea Grant Network to enhance the availability of these materials via a WWW site and CDs. Debuted in September 1996, the national web site is called the Sea Grant Nonindigenous Species site (or *sgnis*). It provides rapid access to over 160 peer-reviewed research and 60 outreach products. Through this continuing two-year effort, plans are to include materials from other state and federal agencies, universities, and organizations as well. We will produce a CD based on the *sgnis* site, which will ensure that people who do not have Internet access will have access to *sgnis*. Offered with a complete user manual, the CD will be updated annually. Our staff will continue to identify materials and to offer technical review for materials to be included on the site and CD through 1999. Minnesota Sea Grant staff involved are Marie Zhuikov, Doug Jensen, Debbie Kaminov, and Scott Robertson.

ZEBRA MUSSEL PUBLIC EDUCATION WORKSHOPS

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Zebra Mussel Public Education Workshops (FY98: \$15,916; FY99: \$9,084): Sea Grant and its partners have developed excellent materials such as slides, graphics, videotapes, and electronic presentations that are of value in educating the public about zebra mussel issues, preventing their spread, and controlling and mitigating their impacts. Minnesota Sea Grant will use our expertise to bring these resources together to create computer presentations and scripts that will be used during three zebra mussel education workshops in Minnesota scheduled for spring-summer 1999. This project led by Illinois-Indiana Sea Grant will also allow Minnesota's Zebra Mussel Volunteer Detection Program to continue for two more years. Minnesota Sea Grant staff involved are Doug Jensen and Glenn Kreag.

OPERATION PATHFINDER

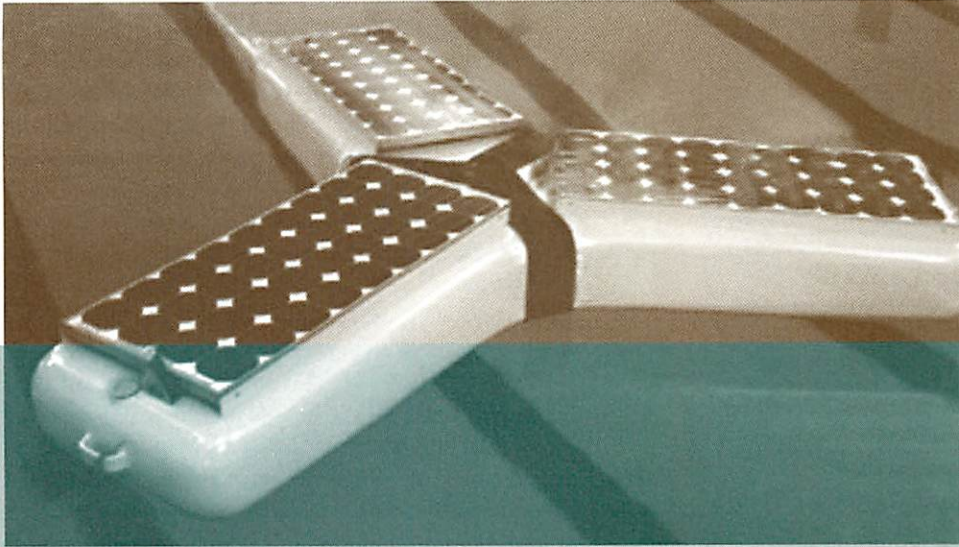
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Operation Pathfinder (FY97: \$46,000): This National Sea Grant partnership program gives teachers hands-on experience with marine and aquatic science. Our teacher training session was held in Minnesota for the first time in 1997. Twenty elementary and middle school teachers representing five midwestern states participated in the program, which we offered in cooperation with the Lake Superior Center (the educational development arm of a proposed Great Lakes Aquarium). These teachers will infuse an estimated 1,800 students each school year with the excitement of science. We plan to continue this successful program through a new proposal, COAST, developed through the Mississippi-Alabama Sea Grant program. The Minnesota Sea Grant staff member involved is Bruce Munson.

extramurally-funded projects

Minnesota Sea Grant partnered in four other successful grants totaling almost \$1 million. The following are the titles, amount of funding awarded, brief project descriptions, and collaborators.





WATER ON THE WEB

Water on the Web (WOW) (FY97 - FY00: \$650,000): Funded by the National Science Foundation. Remote underwater sampling system (RUSS) units will be placed in four diverse Minnesota lakes and connected to participating community colleges and high school classes via the Internet. Students can design experiments, program the units to collect data at water depths and frequencies they determine, and interpret the results with help from the curricula designed for the project and with the on-line WOW "help desk." Curricula will be designed and tested with help from multi-disciplinary advisory boards. Evaluation of WOW will address the project's success in meeting objectives, generating content-specific learner outcomes, and creating a successful link between the remote sampling technology and the classroom. Minnesota Sea Grant staff involved are Bruce Munson, Cindy Hagley, Mike McDonald, Marie Zhuikov, Debbie Kaminov, and Scott Robertson.

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TREASURES UNDER PRESSURE: THE FUTURE OF NORTHEASTERN MINNESOTA LAKES

Treasures Under Pressure: The Future of Northeastern Minnesota Lakes (FY98 - FY00: \$7,000): Funded by the Minnesota Department of Natural Resources. The purpose of this initiative is to focus attention on how to best manage lake and shoreland in a way that accommodates people and preserves economic value, while maintaining a high-quality resource. The DNR asked Sea Grant to lead this effort to bring people interested in Northeastern Minnesota lakes together to define issues and to generate ideas for solutions. A roundtable of public agencies will be held to define issues for two separate public workshops that will be held in Duluth and Grand Rapids. Minnesota Sea Grant staff involved are Cindy Hagley, Glenn Kregg, Keith Anderson, Doug Jensen, Marie Zhuikov, Debbie Kaminov, and Scott Robertson.

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ASSESSING AND COMMUNICATING RISK: A PARTNERSHIP TO EVALUATE A SUPERFUND SITE ON LEECH LAKE TRIBAL LANDS

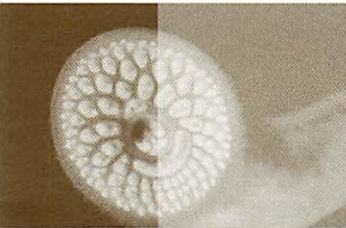
Assessing and Communicating Risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands (FY98 - FY99: \$250,000): Funded by the EPA Environmental Justice Program. Cooperators: Natural Resources Research Institute, Leech Lake Band of the Minnesota Chippewa Tribe, Minnesota Department of Health, Minnesota Pollution Control Agency, U.S. EPA. The Leech Lake Band initiated a dialogue with the Natural Resources Research Institute and Minnesota Sea Grant regarding collaboration on a study of a former wood preserving site currently being remediated as a federal Superfund site. This funded project focuses on developing unbiased assessments of historical data and of groundwater models developed by the company; the development of long-term monitoring; the potential ecological and health risks of the site; and the communication of these risks to the public. Inherent in these objectives is the need to empower the Band by developing partnerships and dialogues between the Band's natural resource managers and the other stakeholders in the region. These include the company, the numerous local, state and federal agencies which are involved, and local educators. Minnesota Sea Grant staff involved are Cindy Hagley, Jeff Gunderson, and Mike McDonald.

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DEMONSTRATION PROJECT TO EXPORT GREAT LAKES SEA LAMPREY FOR HUMAN CONSUMPTION

Demonstration Project to Export Great Lakes Sea Lamprey for Human Consumption (FY96 - FY98: \$92,000): Funded by the Great Lakes Protection Fund. The St. Marys River, which connects Lakes Superior and Huron, has a large population of lampreys that has proven especially problematic for traditional lamprey control. So even though lamprey in the Great Lakes have been the focus of a large control effort for nearly 40 years, there still remain significant populations of lamprey in the Great Lakes. It has been estimated that there are about 600,000 to 800,000 spawning phase sea lamprey in the Great Lakes. A project to examine the marketability of Great Lakes sea lamprey in Portugal and Spain has had positive findings and may offer another lamprey control option. Results indicate live Great Lakes sea lamprey are marketable in Portugal. Frozen lamprey are also marketable in Portugal and possibly in Spain. Successful completion of this project will finally answer a question that has been debated among Great Lakes fishery managers for over 40 years — are Great Lakes sea lamprey marketable when harvested during their spawning run? Minnesota Sea Grant conducted a seminar at the Great Lakes Science Center in Ann Arbor, MI, to disseminate the results of this demonstration project. The Minnesota Sea Grant staff member involved is Jeff Gunderson.

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MINNESOTA SEA GRANT

