University of Wisconsin Sea Grant Institute

# 1996-1998 Program Directory

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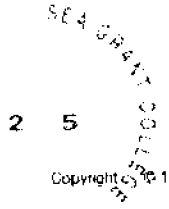
UW Sea Grant Publication No. WISCU-O-97-001

Front cover photo courtesy of James Brozek





Produced by the University of Wisconsin Sea Grant Institute under grants from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce and State of Wisconsin. Federal grant NA46RG0481, project A / AS-2.

Printed in the United States of America
First Printing, June 1997

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# Introduction

# INTRODUCTION

The University of Wisconsin Sea Grant College Program is a statewide program of basic and applied research, education and technology transfer dedicated to the wise stewardship and sustainable use of the nation's Great lakes and ocean resources. It is part of a national network of 29 university-based programs funded through the National Sea Grant College Program, National Oceanic & Atmospheric Administration, U.S. Department of Commerce, and through matching contributions from participating states.

More than 160 faculty, staff and students are currently participating in UW Sea Grant-funded projects at six UW System campuses (UW-Madison, UW-Milwaukee, UW-Green Bay, UW-Manitowoc, UW-La Crosse and UW-Superior). Sea Grant specialists — strategically located at Advisory Services offices on UW campuses in Green Bay, Madison, Manitowoc, Milwaukee and Superior — convey research needs and research results between coastal resource users and the academic community.

During 1996–98, UW Sea Grant is supporting 35 research, outreach and education projects designed to enhance Great Lakes sport and commercial fisheries, improve freshwater aquaculture, analyze the ecosystem effects of zebra mussels, explore the potential of biotechnology and other advanced technologies for marine and Great Lakes applications, analyze socio-economic issues and advise coastal communities and Great Lakes-related businesses, enhance safety for recreational scuba divers, and investigate the cycling of toxic contaminants in Great Lakes systems and develop strategies for pollution remediation.

Since its creation nearly 30 years ago, Sea Grant has proven to be a sound investment. The national Sea Grant network offers an established infrastructure for university research and technology transfer to the marine sector of the national economy. It is the only Great Lakes and ocean program in the United States that combines research and outreach to bring scientific information to state, regional and federal resource managers, the public and industry.

The UW Sea Grant program is internationally recognized for its cutting edge research in fisheries, toxic contaminants and water quality, aquaculture and seafood technology, biotechnology, estuarine and coastal processes, diving physiology, policy studies, and innovative research initiatives. During 1996–98, UW Sea Grant is utilizing an issue-oriented approach to address problems and respond to opportunities in the following thematic areas.

# Lake Superior Initiative

Lake Superior is a vital economic and environmental resource. It is also a fragile ecosystem threatened by toxic chemicals, exotic species and human exploitation. While environmental protection and restoration are vital, economic development is also critical to communities in the Lake Superior basin.

## PROJECTS

Restoring Sustainable Fisheries to Lake Superior

Helping Lake Trout Make a Comeback in Lake Superior

Tracking Trace Metals in the Lake Superior Watershed

Investigating the Effects of Mercury on Fish Populations

The Economics of a Sustainable Lake Superior Fishery

Studying Life Patterns of Recreational Boaters in the Apostle Islands Region

Sharing Wisconsin's Underwater Treasures

Monitoring Wisconsin's Great Lakes-Area Economic Future

## 1. Restoring sustainable fisheries to Lake Superior

Restoring native fish communities remains a long-term goal of Great Lakes fisheries managers. The intent is to establish a state resembling that which existed prior to the major decline in fish stocks due to overexploitation and invasion of the parasitic sea lamprey. But to do so requires a means for collecting, synthesizing and analyzing some basic information.

This project will gather data and provide tools for analysis of Lake Superior fisheries. Researchers will develop a bioenergetics model for populations of key species in Lake Superior — lake and steelhead trout, chinook and coho salmon, and burbot. This model will provide important information about the Lake Superior food web, as well as estimates of contaminant bioaccumulation in the system. Researchers will also assess current and future effects of predation and fishing pressure.

This research will prove invaluable to managers charged with restoring sustainable fisheries in Lake Superior. The findings will help guide continued lake trout restoration efforts, design of salmonid stocking programs, implementation of fishery regulations and development of sea lamprey control strategies.

NEW PROJECT (R/LR-72): Sustainability of the Lake Superior Fish Community: An Analysis of Opportunities and Constraints

James F. Kitchell
Center for Limnology
UW-Madison

## 2. Helping lake trout make a comeback in Lake Superior

The rehabilitation of lake trout in Lake Superior is one of the Great Lakes' brightest success stories. Through the efforts of scientists and managers, the once-decimated populations of trout have rebounded significantly. As these populations continue to recover, it is important to determine the stock structure so the fish can be managed for a sustainable harvest.

Lean and siscowet lake trout are closely related salmonids in Lake Superior. Although distinct as adults, the young fish look the same. In order to better control the trout fishery, managers need a way to tell the two fish apart at all ages.

In this project, researchers will identify genetic markers to aid in stock identification and to distinguish between young lean trout and young siscowet trout. This work also will lead to development of a noninvasive DNA test — important because fish won't have to be killed to obtain genetic samples.

State, federal and tribal agencies involved with rehabilitation programs can use such technology to more efficiently manage the recovering lake trout fishery in Lake Superior.

NEW PROJECT (R/LR-73): Application of Microsatellites to Stock Identification in Lake Superior Lake Trout

Ruth B. Phillips
Center for Great Lakes Studies
UW-Milwaukee

3. Tracking trace metals in the Lake Superior watershed

Lake Superior is the cleanest of the Great Lakes, and people want to keep it that way by eliminating as much pollution as possible. That pollution includes metals like lead, cadmium, arsenic, mercury, zinc and others. Even at very low concentrations, some of these metals can exert toxic effects.

Streams and tributaries throughout the Lake Superior watershed are major reservoirs of metals. This project will assess key factors controlling the mobility and fluxes of a dozen different metals in representative tributaries of Lake Superior. Researchers will study trace metal transport and relationships to stream geochemistry, watershed characteristics and hydrologic events. The use of newly developed "ultra-clean" sampling and analysis methods will enable researchers to quantify metal concentrations at the near-molecular level.

This information will enable regulators and managers to develop and enforce realistic standards governing trace metal pollution in Lake Superior and elsewhere.

NEW PROJECT (R/MW-71): Trace Metals in Lake Superior Tributaries: Implications for Contaminant Virtual Elimination

David E. Armstrong
Water Chemistry Program
UW-Madison

William C. Sonzogni
State Laboratory of Hygiene
UW-Madison

4. Investigating the effects of mercury on fish populations

Mercury contamination is widespread in the Great Lakes region. Although its effect on humans has been widely studied, there has been relatively little research about the consequences of mercury contamination on fish populations.

This study will investigate the relationship between mercury consumption by female fish and its effects on their offspring. The researchers will feed female fathead minnows a mercury-contaminated diet. They will examine the minnows' young and determine whether mercury concentrations in larval fish are dependent on concentrations in the maternal fish. They will also observe the effects of maternally transmitted mercury on hatching success, feeding behavior, growth and survival in the young.

The information gained in this research will help fisheries managers understand the relationship between mercury contamination and the health of susceptible fish populations.

NEW PROJECT (R/MW-75): Maternally Transmitted Mercury: Effects on Embryo and Larval Fish Survival, Growth and Feeding Behavior

Mark B. Sandheinrich
River Studies Center
UW-La Crosse

Ronald G. Rada
River Studies Center
UW-La Crosse

5. The economics of a sustainable Lake Superior fishery

Economic research informs public debate and decision-making on policies for Great Lakes fisheries. But to date, economic models have focused almost exclusively upon efficiency based on maximizing the present value of the fisheries. More and more, however, communities and resource managers are working to build and protect the sustainability of their resources, so they can continue producing into the future.

This project will build an economic framework that integrates the concept of sustainability with that of efficiency. This model will be applied to the fisheries of Lake Superior, informing policy-makers of the implications of planning for and achieving a sustainable fisheries resource.

NEW PROJECT (R/PS-46): Sustainability and the Economics of Fisheries Management: A Lake Superior Case Study

Richard C. Bishop
Agriculture and Applied Economics
UW Madison

6. Studying life patterns of recreational boaters in the Apostle Islands region

The Apostle Islands region of Lake Superior has been a popular recreational boating site for many years. But the numbers of boaters and their characteristics are constantly evolving. These changes affect northern Wisconsin's natural and economic environments.

A group of Apostle Island-area boaters were surveyed in 1975 to learn what factors influenced their participation in recreational boating. They were surveyed again in 1985, and in 1997 this group will be surveyed again to obtain information about their current lifestyles and to observe changes in their boating participation.

As one of few long-term panel studies in the recreation research field, this project will provide information about how people's recreational lives change as they age. It also will reveal changes in how society regards and uses wilderness. This study will show how recreational boaters have affected the Apostle Islands area and how that area has changed and developed to suit the boating population.

Understanding the recreational choices made by this aging population will reveal what individual, societal and site-related influences affect people's decision-making processes. These findings will help policy-makers, resource managers, business owners and the public make informed decisions related to recreational and economic development in northern Wisconsin.

NEW PROJECT (R/PS-48): Participation in Apostle Islands Boating: Persistence and Change, 1975-1997

Thomas A. Heberlein
Rural Sociology
UW-Madison

7. Sharing Wisconsin's underwater treasures

The Great Lakes are home to thousands of well-preserved shipwrecks that hold recreational, historical and archeological significance. For the past eight years, the Wisconsin state underwater archeologist has been building an inventory of the state's Great Lakes shipwrecks and other submerged archeological treasures. This project will share information on Wisconsin's Lake Superior shipwrecks with the public in entertaining, educational and interactive ways.

Shipwreck information will be made available to recreational divers, educators, archeologists, students and the public in three formats: waterproof dive guides, an interactive multimedia World Wide Web site and a CD-ROM. The effort is also designed to help attract recreational divers to these wrecks. A Michigan Sea Grant study found that shipwreck diving can provide a million-dollar boost to the tourism economies of nearby coastal communities. Another aim of the project is to foster better stewardship and protection of Wisconsin's submerged cultural resources through public education, especially within the diving community.

This collection of Lake Superior shipwrecks will serve as a prototype for developing a more comprehensive, regional Great Lakes shipwrecks database.

In addition to working on multimedia site guides to Lake Superior shipwrecks, the Communications Office will assist the Lake Superior Initiative coordinators as they plan and host a public forum on Lake Superior issues. The forum is tentatively slated for 1998.

NEW PROJECT (A/AS-38): Ice-Water Mansions: Multimedia Site Guides to Lake Superior Shipwrecks

Stephen C. Wittman
Sea Grant Institute
UW-Madison

David J. Cooper
State Historical Society of Wisconsin

## 8. Monitoring Wisconsin's Great Lakes-area economic future

In connection with UW Sea Grant's Lake Superior Initiative, the Advisory Services business specialist is collecting and analyzing information about Wisconsin's Great Lakes-related businesses in the Lake Superior region. These data will be used to evaluate trends and help area communities with their development plans.

In another project, Advisory Services is coordinating a lake herring marketing study, in which commercial fish processors will distribute herring samples — with preparation and storage instructions — to wholesalers and distributors in the Midwest. This study could lead to new opportunities for the Lake Superior fishing industry.

At the same time, Advisory Services is working with Wisconsin Department of Natural Resources to arrange commercial fishing license buy-outs to help reduce pressure on the lake's fish populations.

CONTINUING PROJECT (A/AS-1): Advisory Services, Program Coordination and Field Offices

Allen H. Miller with Harvey Hoven
Sea Grant Institute
UW-Madison

# Nonindigenous Species

The Great Lakes have been invaded by more than 130 species of plants and animals, but the recent invasion of zebra mussels has arguably had the widest impact. The mussels damage human structures and also impact aquatic ecosystems by altering nutrient cycling, contaminant cycling and habitat features.

## PROJECTS

Understanding Zebra Mussels' Effects on Great Lakes Snails

The Inland Invasion of Zebra Mussels

Developing Strategies to Keep Ahead of Zebra Mussels

Tapping Eastern European Resources for Zebra Mussel Information

Determining the Effect of Zebra Mussels on Nutrients Needed by Fish

Determining Zebra Mussels' Influence on Green Bay PCB Contamination

Dealing with the Zebra Mussel and Eurasian Ruffe

Alerting the Public to Problem Species

## NONINDIGENOUS SPECIES

### 1. Understanding zebra mussels' effects on Great Lakes snails

Despite the zebra mussel's rapid spread throughout the Great Lakes and connected drainage basins, its effects on the ecology of these habitats are unclear. For example, native snails of the Great Lakes would seem to be at risk from the zebra mussel's propensity to attach to just about any hard surface. Though the role and importance of gastropods in Great Lakes ecology is not well understood, loss of snail species due to zebra-mussel adhesion or "fouling" might have repercussions that could cascade through the Great Lakes ecosystem.

In this study, researchers will determine the extent of zebra-mussel fouling on the snail fauna of southwestern Lake Michigan. In addition, the research will: document the extent of fouling by zebra mussels on native gastropod fauna among habitats, among species and among individuals; examine the population-level impacts of zebra-mussel fouling on native gastropod fauna; analyze impacts of zebra-mussel fouling on such individual snail metabolic and life-history parameters as consumption, respiration, reproductive capacity and growth; and investigate variables like behavior, shell characteristics and habitat that influence gastropod species' susceptibility to fouling.

CONTINUING PROJECT (R/I R-60). Population and Energetic Consequences of Zebra Mussel Fouling on Native Gastropod Fauna of Lake Michigan

Dianna K. Padilla
Zoology
UW-Madison

### 2. The inland invasion of zebra mussels

Despite widespread empirical information on the spread of zebra mussels through navigable waters, almost nothing is known about the potential rate and direction of the overland spread of zebra mussels to North American inland lakes.

In this project, researchers will look for zebra mussels in plankton samples collected from six regional "lake districts" in Wisconsin, Michigan, Indiana and Illinois. These districts differ in their potential exposure to sources of zebra mussels. Within each region, researchers will sample contrasting sets of lakes that differ in characteristics likely to make them susceptible to invasion. Information on boat transfer will also be collected from these sites.

From these findings, researchers will seek to document the spatial and temporal pattern of zebra mussels' spread within local systems of inland waters. They will compare the characteristics of invaded and noninvaded lakes to determine correlates of invasion susceptibility and infer likely dispersal mechanisms; assess the relative importance of primary and secondary invasion events on the spread of zebra mussels within local

systems of inland waters: compare patterns of local invasions in different regions to determine the generality of any observed patterns; and test predictions of importance of the exposure of inland systems to nearby source populations.

CONTINUING PROJECT (R/LR-62): An Assessment of the Overland Dispersal of Zebra Mussels into Inland North American Lakes

Clifford Kraft
Sea Grant Institute
UW-Madison

3. Developing strategies to keep ahead of zebra mussels

As zebra mussels spread from the Great Lakes to Wisconsin's inland lakes, they can cause major ecological changes. By altering nutrient availability, these prolific nonindigenous mollusks could transform lake systems based on plankton-fish interactions into systems dominated by zebra mussels and bottom-feeding fish.

This study will help fish managers keep ahead of the zebra mussels. Researchers will investigate the effect zebra mussel infestations have on energy transfer between primary producers, like phytoplankton and plants, and higher-level consumers. Also, they will determine what characteristics make a lake susceptible to zebra mussel colonization.

Results of this research combined with long-term data from Wisconsin's lakes will contribute to an understanding of how zebra mussels could alter specific inland lakes. This information will help managers predict the probability of zebra mussel infestations and will suggest management strategies for lakes that appear susceptible.

CONTINUING PROJECT (R/LR-63): The Effect of Zebra Mussel Infestation in Inland Lakes on Pelagic Benthic Coupling

Russell L. Cuhel
Center for Great Lakes Studies
UW-Milwaukee

David N. Edgington
Center for Great Lakes Studies
UW-Milwaukee

4. Tapping Eastern European resources for zebra mussel information

Eastern European scientists have amassed a wealth of information about zebra mussels. These mollusks were accidentally transported from Europe and deposited in the Great Lakes during the 1980s. Since then they have caused numerous ecological problems. Eastern European researchers have been studying zebra mussels for many years, but due to past political and cultural circumstances, North American scientists have been unable to take full advantage of their findings.

This project brings two Belarussian scientists to the University of Wisconsin-Madison, where they will spend 10 months working with resident faculty and other visiting scientists. They will use their data to test and develop models of zebra mussel establishment and spread, prepare manuscripts about their findings and assist with field research in the Great Lakes region.

Many North American scientists, water managers and policy-makers will directly benefit from sharing information with these Eastern European scientists.

CONTINUING PROJECT (R/LR-65): Facilitation of Exotic Species Information Exchange Between North America and the Former Soviet Union

Dianna K. Padilla
Zoology
UW-Madison

5. Determining the effect of zebra mussels on nutrients needed by fish

The Great Lakes and inland lake ecosystems are undergoing major changes due to zebra mussel invasions. These mollusks, which were accidentally introduced to North American waters in the 1980s, are filter feeders. They take nutrients out of lake water, causing it to become clearer.

In recent years, fewer young fish have entered the fish populations of some lakes. There are many possible causes for this, but some scientists suspect the zebra mussel is the culprit.

This study will help prove or disprove that zebra mussels negatively affect larval fish by taking necessary nutrients out of the water. It will also determine whether that impact, if proven, can be offset by adding nutrients to the water. In addition, the researchers will check whether fish that switch from eating plankton to bottom-dwelling invertebrates are better able to survive in zebra mussel-infested waters than fish that do not change their eating habits.

Findings from this study will help fishery managers identify lakes where zebra mussels could negatively affect native fish and will suggest ways to reduce zebra mussels' impact on these fish.

CONTINUING PROJECT (R/LR-66): Trophic Interactions between Zebra Mussels and Larval Fish: Experimental Tests of Competition for Planktonic Resources

Mark B. Sandheinrich
River Studies Center
UW-La Crosse

William B. Richardson
National Biological Services
UW-La Crosse

6. Determining zebra mussels' influence on Green Bay PCB contamination

Green Bay's bottom sediment and food web contain high concentrations of polychlorinated biphenyls (PCBs). PCBs are toxic chemicals that accumulate in animal tissues. Some members of the PCB chemical family are more toxic than others.

Zebra mussels extract PCBs from water and accumulate high concentrations of the chemicals in their body tissues. Although this might increase PCB exposure for some members of the food web, it could decrease exposure for others.

In this study, researchers will take samples of Green Bay zebra mussels, plankton, fish and deepwater invertebrates and analyze them for the more toxic members of the PCB family — the coplanar congeners. They will combine these measurements with existing models to determine zebra mussels' influence on the flow of PCBs in the Green Bay ecosystem.

The information gained in this study will enable managers to better assess the risks associated with PCB exposure and the potential benefits of sediment remediation.

CONTINUING PROJECT (R/MW-57): Influence of Zebra Mussels on the Distribution and Fate of Coplanar PCB Congeners in the Green Bay Estuary

David E. Armstrong
Water Chemistry Program
UW-Madison

William C. Sonzogni
State Laboratory of Hygiene
UW-Madison

7. Dealing with the zebra mussel and Eurasian ruffe

Outreach efforts are key to controlling nonindigenous species. The zebra mussel, which has spread throughout the central United States, has had significant economic and ecological effects. It clogs water intake pipes and attaches to and fouls boat hulls, dock pilings and other submerged objects. The Eurasian ruffe has become the dominant species in the Duluth, Minn.,-Superior, Wis., harbor and is expected to have a negative impact on nearshore fisheries. UW Sea Grant Advisory Services is enlisting public support for activities and practices that will curtail the spread of these and other invaders.

This project involves a wide range of activities conducted in collaboration with other Great Lakes Sea Grant programs. UW Sea Grant's efforts include coordinating the development of the National Sea Grant Nonindigenous Species World Wide Web site, producing the quarterly *Zebra Mussel Update* national newsletter and training citizen volunteers to collect water samples from inland lakes and send them in to be tested for zebra mussel larvae.

In support of nonindigenous species research, Advisory Services is compiling and analyzing data from the Great Lakes in an effort to further understand interactions between native and nonnative fish.

CONTINUING PROJECT (A/AS-36): Zebra Mussel Outreach Plan: A Continuing Program of the Great Lakes Sea Grant Network

Clifford Kraft
Sea Grant Institute
UW-Madison

Allen H. Miller
Sea Grant Institute
UW-Madison

B. Alerting the public to problem species

The UW Sea Grant Communications Office supports the nonindigenous species research area by preparing news releases about Sea Grant-supported exotic aquatic species research and outreach, and annually distributing thousands of fact sheets and pamphlets about a variety of nuisance nonindigenous species to the public.

The Communications Office also publishes the Sea Grant network's national newsletter, *Zebra Mussel Update*, in collaboration with Advisory Services' exotic species specialist, The Ohio State University Sea Grant College Program and Mercury Marine, a Brunswick Company. Distributed quarterly coast to coast, the newsletter currently has an estimated readership of more than 100,000.

In cooperation with the University of Minnesota Sea Grant program, UW Sea Grant is preparing a series of special public-service announcements about the Eurasian ruffe, a new nonindigenous fish recently found in Lake Superior, in hopes of helping to prevent its spread to other waters. UW Sea Grant is also providing publicity support for an international conference on Eurasian ruffe.

CONTINUING PROJECT (A/AS-2): Communications Office and Program Coordination

Stephen C. Wittman
Sea Grant Institute
UW-Madison

# Aquaculture for the Great Lakes Region

Wisconsin and the Great Lakes region have abundant resources and existing markets that are well-suited to commercial aquaculture. Aqualculture is vital to the valuable Great Lakes commercial fishing industry, which depends on hatchery production and fish stocking.

## PROJECTS

Overcoming Yellow Perch's Growth Limitations

Improving Growth and Survival Rates of Yellow Perch and Walleye in Aquaculture

Controlling Stress Response in Salmon and Trout

Making Aquaculture Information Available to the Public

Providing Financial Advice

## 1. Overcoming yellow perch's growth limitations

Raising yellow perch to an acceptable market size is a difficult task. The faster-growing females are more desirable than males, but when they reach sexual maturity their energy goes into egg making — not flesh production. This reduces fillet yields and profits.

One way to solve this problem is to produce triploid females, which are sterile. In this project, researchers will create female tetraploids — fish with four sets of chromosomes — and treat them with male hormones so they produce sperm. They will cross the tetraploids with regular diploid females, which have two sets of chromosomes, in an attempt to produce triploid females — fast-growing, sterile fish. They then will compare the growth and development of triploids with that of normal yellow perch.

This project will provide aquaculturists, managers and researchers with information about genetic and hormonal manipulations that can be used with yellow perch. The techniques gained in this study will also help with developing improved coolwater fish strains. It should result in more efficient perch production, greater development of commercial aquaculture and improved fisheries in the Great Lakes region.

CONTINUING PROJECT (R/BT-8): Evaluating Yellow Perch Tetraploids for the Production of Polyploids, Gynogens and Hybrids

Jeffrey A. Malison
Food Science
UW-Madison

## 2. Improving growth and survival rates of yellow perch and walleye in aquaculture

Growth of the walleye and yellow perch aquaculture industry is hampered by variable fish survival rates and poor fish growth. To a large extent, these problems can be attributed to the harmful effects of physiological stress.

The overall goal of this project is to characterize the physiological stress response of purebred and hybrid walleye and yellow perch, and to use measures of stress to evaluate various fish culture strategies and develop improved culture techniques. This research will generate baseline information for evaluating the influence of selected rearing conditions and pond-harvest, transportation, and fish-culture strategies on purebred and hybrid walleye and perch. The information will be used to develop practical "least-stress" methods to raise these fishes.

The use of "low-stress" procedures developed by this study should result in lower production costs for public and private hatcheries and fish farms, greater development of commercial aquaculture and improved fisheries in the Great Lakes region.

CONTINUING PROJECT (R/AQ-22): Assessment and Management of Physiological Stress in Cool-Water Fish Culture

Jeffrey A. Malison
Food Science
UW-Madison

3. Controlling stress response in salmon and trout

Researchers know that physiological stress decreases the health, growth and reproductive performance of cultured fish. In fact, stress is one of the most important problems in aquaculture and fisheries management.

In this study, researchers will administer reproductive steroids to cultured coho salmon and rainbow trout. Then they will measure cortisol levels to determine the steroids' impact on the fishes' response to stress. This work will contribute to the ongoing development of "least-stress" husbandry techniques and the breeding of stress-resistant strains of fish. Additionally, the research will contribute new information on the relationship between stress and reproduction, which will be useful for improving egg quality and larval fish survival. The work will also increase understanding of the mechanisms by which physiological stress causes post-spawning mortality in Pacific salmon and accelerates the normal rate of aging in all vertebrates.

The two species targeted in this study are of great economic importance to commercial aquaculture in the Great Lakes region and elsewhere.

NEW PROJECT (R/AQ-30): Steroid Regulation of the Stress Response in Salmonid Fishes

Terence P. Barry
Food Science
UW-Madison

Jeffrey A. Malison
Food Science
UW-Madison

4. Making aquaculture information available to the public

Aquaculture is the fastest-growing sector of the U.S. agricultural economy, and consumer demand for fish products continues to increase. Wisconsin's aquaculture industry needs more research and technical support if it is to continue to grow.

Since 1992, more than 3,000 people have received technical information and assistance through UW Sea Grant's aquaculture outreach programs, and the number of workshop participants is increasing. UW Sea Grant sponsors workshops on recirculating aquaculture systems, spawning techniques, feeding strategies, intensive rearing methods and the economic parameters for these topics.

UW Sea Grant's Advisory Services aquaculture specialist provides technical, on-site assistance to aquaculturists and demonstrates new techniques for domesticating yellow perch brood stock and intensive aquaculture strategies.

Advisory Services helps the Wisconsin Department of Agriculture, Trade and Consumer Protection and Wisconsin Aquaculture Association organize the annual state aquaculture conference.

CONTINUING PROJECT (R/AS-37): Aquaculture Development within the Great Lakes Region: The Sea Grant Initiative

Fred P. Binkowski
Center for Great Lakes Studies
UW-Milwaukee

5. Providing Financial Advice

The Advisory Services business specialist's work supports the Aquaculture for the Great Lakes Region thematic area. Advisory Services is creating financial models that compare costs of yellow perch production using three different rearing strategies: outdoor ponds, flow-through tanks and raceways, and recirculating systems.

Each financial analysis includes projections of expected revenues, and fixed and variable costs. These models will help fish farmers make wise management decisions.

CONTINUING PROJECT (A/AS-1): Advisory Services: Program Coordination and Field Offices

Allen H. Miller with Harvey Hoven
Sea Grant Institute
UW-Madison

# Chemical-Biological Interactions

Researchers recently have noted a class of chlorinated chemical compounds that disrupt normal endocrine functions in Great Lakes fish and wildlife. Affected animals suffer impaired developmental and reproductive ability.

## PROJECTS

Determining a Contaminant's Effect on Fish Development

Searching for a Natural Chemical that Acts Like Dioxin in Animal Tissue

Analyzing the Effect of Contaminants on Trout Genetics

1. Determining a contaminant's effect on fish development

Dioxin and related chemical pollutants that are found in the environment interfere with early life stage development in fish, but the mechanisms by which they act are not well understood.

In this project, researchers will evaluate the effects of dioxin-related chemicals on fish development. They also will examine the molecular mechanisms by which these effects occur. This group of chemicals, which binds to aryl hydrocarbon receptors (AhR), causes deformities in young fish. The researchers will work with zebrafish, a nearly transparent fish which is easy to work with and has a well-known developmental pattern.

Understanding the effects of dioxins in fish is important for understanding dioxin-related environmental risks. Zebrafish will provide a way of understanding dioxin's impact on fish development and revealing the molecular mechanisms of AhR-mediated toxicity.

CONTINUING PROJECT (R/MW-58): Ah Receptor-Mediated Developmental Toxicity in Zebrafish

Richard E. Peterson
School of Pharmacy
UW-Madison

Warren Heideman
School of Pharmacy
UW-Madison

2. Searching for a natural chemical that acts like dioxin in animal tissue

Dioxin is a well-known environmental contaminant that adversely affects fish and wildlife. But the biochemical mechanisms underlying the toxic response caused by dioxin are not fully understood. Researchers do know that dioxin's toxic effects are dependent on a particular aryl hydrocarbon receptor (AhR), which is ultimately responsible for inducing or repressing genetic commands.

To understand how dioxin disrupts the system, researchers first need to understand the proper operation of the AhR signaling system. A major unknown is the existence of an endogenous ligand or ligands for the AhR. Endogenous ligands are chemicals that occur naturally in animal tissue and activate the AhR. If such an endogenous ligand is isolated and identified, it could provide greater insight into AhR's normal biological functions.

In this project, researchers will identify an animal tissue that is a rich source of the ligand, purify it and identify its structure. Identifying the endogenous ligand for AhR in animal tissue and determining its normal functions will lead to a better understanding of how dioxin exposure results in toxicity.

Information gained from this project will lead to better dioxin risk-assessment techniques. Knowledge of the chemical structure of an endogenous AhR ligand could ultimately aid in developing AhR antagonists to counteract dioxin's toxic effects.

NEW PROJECT (R/MW-72): Identification of the Endogenous Ligand for the Aryl Hydrocarbon Receptor in Fish

Margaret Clagett-Dame
School of Pharmacy
UW-Madison

Richard E. Peterson
School of Pharmacy
UW-Madison

3. Analyzing the effect of contaminants on trout genetics

Polychlorinated dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs) and biphenyls (PCBs) are widespread chemical contaminants that pose a significant risk to the early life stage survival of lake trout in the Great Lakes. In this study, researchers will evaluate molecular changes that these chemicals cause and develop a test to measure the chemical contaminants.

The analysis of these genetic responses will result in a better understanding of dioxin-induced early life stage mortality in lake trout. The researchers have identified and are now characterizing a number of these molecular responses.

Evaluative tests for these chemicals use a technology that cannot predict the toxic potencies of these contaminants in fish. The researchers will develop a fish-specific chemical test, or "bioassay," that can determine concentration of toxic substances by monitoring their effect on fish cells under controlled conditions.

Current analyses of PCDDs, PCDFs and PCBs in environmental samples are quite costly — up to $1,500 per sample. The proposed bioassay would significantly reduce the cost of analysis, enabling state and federal agencies to greatly expand monitoring programs within current budgets.

CONTINUING PROJECT (R/BT-1): *In Vitro* Bioassay for Determination of Fish-Specific TCDD Equivalents by Assessment of TCDD-Regulated Genes

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UW-Madison

# Terrestrial-Aquatic Coupling

Coastal waters throughout the world are sites of intense biological, chemical, physical and geological activity. The effects of human activities on the aquatic environment are strongly felt and readily observed in these areas.

Within the next few decades, nearly half of the world's population will live within 100 miles of a coast. The Great Lakes aquatic systems are dominated by their coasts, and understanding the dynamic nature of these areas is crucial to proper management of Great Lakes resources.

## PROJECTS

The Importance of Wetlands to the Great Lakes Ecosystem

Studying the Role of Phosphorus in Lake Michigan Estuaries

Helping People Coexist with the Environment

## 1. The importance of wetlands to the Great Lakes ecosystem

Resource managers need to better understand the value of different types of coastal wetlands and to identify the "balanced" communities characteristic of healthy coastal wetlands as they are affected by activities in the watershed. Information on nutrient, sediment and contaminant movement through these systems is essential to understanding the role played by different estuarine/wetland types.

Information generated in this study will help local and regional resource managers and policy-makers work with wetland preservation and restoration, pollution remediation and non-point source pollution control.

This research project will assess how three distinct types of Great Lakes river/estuarine systems handle long-term loadings from upstream watersheds of Lake Michigan. The study will use naturally occurring radionuclides to quantify the relative effectiveness of different estuaries in trapping and retaining materials entering the system from upstream.

A secondary objective is to link these tracer studies of particle transport and retention to the fate of elements of biogeochemical importance (i.e., carbon, nitrogen and phosphorus) in these freshwater estuaries.

CONTINUING PROJECT (R/EC-2): Terrestrial-Aquatic Coupling, Particle Trapping and Nutrient Biogeochemistry in Land Margin Systems of the Great Lakes

David N. Edgington
Center for Great Lakes Studies
UW-Milwaukee

J. Val Klump
Center for Great Lakes Studies
UW-Milwaukee

## 2. Studying the role of phosphorus in Lake Michigan estuaries

Phosphorus is a critical nutrient for plankton, the tiny plants and animals that make up an important foundation of the food chain in aquatic environments. But little is known about the role biota plays in cycling phosphorus through an aquatic system.

An important recent change in Lake Michigan estuarine and harbor ecosystems has been the explosive growth of zebra mussel populations. Zebra mussels feed by filtering the water; in doing so, they remove nutrients — including phosphorus — from the water column. This might favor the growth of bottom-dwelling algae and plankton, which would still have a ready supply of phosphorus from bottom sediments. It also could have a significant impact on organisms higher in the food web, including fish.

This project will determine the distribution and extent of phosphorus deficiency in Green Bay and Milwaukee Harbor. Researchers will monitor the flow of phosphorus into these estuaries and study how the availability of phosphorus affects the growth rate and yield of phytoplankton.

NEW PROJECT (R/EC-4): Biological Assimilation of Phosphorus in Estuaries

Russell L. Cuhel
Center for Great Lakes Studies
UW-Madison

3. Helping people coexist with the environment

Sea Grant Advisory Services specialists will conduct several outreach efforts dealing with terrestrial-aquatic coupling issues.

The coastal engineering specialist is evaluating the risk of flood and erosion on coastal property for homeowners and builders, and is updating a coastal processes manual and offering natural hazards workshops.

The water quality specialist addresses a wide range of water quality issues in his work with the general public, industry and adult educators. Advisory Services also trains volunteers who monitor water quality in their local areas.

CONTINUING PROJECT (A/AS-1): Advisory Services: Program Coordination and Field Offices

Allen H. Miller with Philip Keillor and Kevin Fermanich
Sea Grant Institute
UW-Madison

# Sediment Remediation

UW Sea Grant's long history of research in the areas of microcontaminants and water quality has led scientists to find new ways to render persistent toxic contaminants harmless. These findings may be applied to the 41 Great Lakes "Areas of Concern" where contaminated sediments have been the cause of significant environmental degradation.

## PROJECTS

A New Way to Destroy Toxic Organic Compounds

Genetically Designing Contaminant-Fighting Agents

1. A new way to destroy toxic organic compounds

Safely disposing of or destroying soil and sediment contaminated by toxic organic compounds is difficult, both from public policy and scientific standpoints. There is strong public resistance to incinerating toxins, but available remediation techniques are often costly or specific to only a narrow range of conditions. Some remediation options produce by-products even more hazardous than the original contaminant.

One remediation technique, $TiO_2$-mediated photocatalytic oxidation, successfully renders benign a wide variety of organic contaminants. One problem with this method, however, is that it is usually done in a liquid medium, where results occur too slowly for viable commercial application. This research project will adapt this oxidation technique to the gaseous state. The researchers propose that if organic contaminants can be rendered into vapor, this remediation approach can be applied more quickly and efficiently.

In a single reactor, researchers will use a method called supercritical fluid extraction (SFE) to separate organic contaminants from soil or sediment, vaporize them, then apply the oxidation technique. Researchers will evaluate the ability of such a reactor to combine SFE with $TiO_2$-mediated photocatalytic oxidation — and, they postulate, end up with an efficient, cost-effective new way to isolate and destroy soil- and sediment-bound toxic organic compounds.

CONTINUING PROJECT (R/MW-56): Coupled Extraction and Destruction of Organic Contaminants Using Supercritical Fluid Extraction and Photocatalytic Oxidation

Marc A. Anderson
Civil and Environmental Engineering
UW-Madison

Charles G. Hill
Chemical Engineering
UW-Madison

2. Genetically designing contaminant-fighting agents

Researchers have known for some time that some microorganisms can be used to render certain toxic contaminants benign. This is one example of bioremediation — the practice of using biological organisms to eliminate contaminants from the environment.

In this study, researchers will work to genetically design microbes for certain clean-up jobs. Specifically, they will examine factors that control anaerobic respiration in the microorganism *S. putrefaciens*, a native inhabitant of Great Lakes sediments. They hope to genetically endow these microbes with the ability to better degrade toxic pollutants.

The goal is to develop a new agent of bioremediation, one especially fit to attack toxic contaminants in oxygen-poor sediment. Such anoxic environments are characteristic of many contaminated areas around the Great Lakes.

CONTINUING PROJECT (R/BT-3): Biotechnological Approaches to Bioremediation: Microbial Oxidation of Organic Pollutants Coupled to Iron Reduction

Kenneth H. Nealson
Center for Great Lakes Studies
UW-Milwaukee

# Safety at Sea

As recreational boating and scuba diving continues to increase in popularity, the risks associated with these activities become more evident. Continued public awareness of the dangers of these sports is integral to reducing injuries and fatalities.

## PROJECTS

Improving Diver Safety

Long-Term Study of Recreational Scuba Divers

Promoting Boating Safety on the Great Lakes

Using Many Channels to Spread Diving Risk Information

1. Improving diver safety

Recreational, scientific, commercial and government divers sometimes engage in diving practices that carry significant physiological risks, such as bone necrosis and brain lesions associated with decompression sickness.

In this study, researchers will evaluate the high-risk diving behavior that provokes these sorts of injury in those who practice repetitive deep "bounce" dives. Divers who sustain limb bends decompression sickness can develop bone necrosis, known as dysbaric osteonecrosis (DON), in their long bones. The research will evaluate the use of delayed recompression treatment in preventing DON; continue to investigate DON prevalence in Maine scallop divers; and assess the risk of divers developing white-matter brain lesions and DON due to bounce dives.

Findings from this research will improve diving safety and efficiency by identifying diving practices with unacceptable risks, enhancing risk-prediction tools and recommending therapeutic interventions.

NEW PROJECT (R/NI-25): Diver Safety and Efficiency

Rudolf Tass Dueland
Veterinary Medicine
UW-Madison

2. Long-term study of recreational scuba divers

Ten years ago, a comprehensive UW Sea Grant survey of 300 recreational scuba divers queried them on their training, health status, experience, high-risk behavior patterns and personality traits.

This study will recontact these earlier respondents and conduct a follow-up survey. The study will reveal how the information gathered in the first study may be used to predict which factors lead people to drop out of scuba diving, or adhere to it as a longtime recreational activity. The study will also evaluate how physical and psychological traits might predict subsequent episodes of panic behavior and diving accidents.

Results of this study will be useful to diving instructors, professional diving organizations and certification bodies worldwide. The research findings should help improve the health and safety of recreational scuba divers.

NEW PROJECT (R/NI-26): Prediction of Adherence, Health Status and Diving Accidents in Recreational Scuba Divers: A Ten-Year Longitudinal Study

William P. Morgan
Kinesiology
UW-Madison

3. Promoting boating safety on the Great Lakes

Many boaters who have traditionally spent their hours on inland waters are now boating on the Great Lakes. Unfortunately, many of them lack experience with rapidly changing, potentially threatening weather and sea conditions.

UW Sea Grant's marine education specialist supports the Safety at Sea program area by instructing nearly 500 people a year about water safety. These programs include a 26-hour water safety course taught in conjunction with the U.S. Coast Guard Auxiliary and boating safety courses for both beginning and experienced boaters.

CONTINUING PROJECT (A/AS-1): Advisory Service: Program Coordination and Field Offices

Allen H. Miller with James Lubner
Sea Grant Institute
UW-Madison

4. Using many channels to spread diving risk information

The Communications Office supports the Safety at Sea program area by publicizing underreported risks of scuba diving and new recompression treatments discovered in past and present UW Sea Grant-funded studies. These studies examine high-risk diving practices that can result in brain and bone injury in recreational and commercial divers who practice deep "bounce" dives, and the psychological and physical factors that produce anxiety and might result in fatal panic episodes in certain divers.

Communications support includes producing fact sheets, posters and pamphlets for divers and diving instructors, developing news releases about research results, writing articles for diving magazines and facilitating other media relations in collaboration with the researchers. Information from these studies also will be made available through UW Sea Grant's Great Lakes shipwreck guides project, which targets divers as one of its audiences.

CONTINUING PROJECT (A/AS-2): Communications Office and Program Coordination

Stephen Wittman
Sea Grant Institute
UW-Madison

# Application of Innovative Technology

The full application of cutting-edge technologies like biotechnology, computer science and new materials synthesis is still being realized. Sea Grant is exploring these exciting research areas and encouraging scientists to apply them to aquatic environments. UW researchers are developing polymers for special marine uses, designing intelligent robot systems for complex under-water tasks, and applying the principles of genetic engineering to solve environmental and industrial problems.

## PROJECTS

Determining the Value of the Lake Michigan Salmonid Fishery

Analyzing Toxic Algae

Adding New Properties to Electrorheological Fluids

Searching for Bacterial Films that Repel Zebra Mussels

Designing Robots for Underwater Exploration

Putting High Technology to Practical Use

1. Determining the value of the Lake Michigan salmonid fishery

It isn't easy to measure the value of a recreational activity like fishing, camping or hiking. But an accurate economic model can help policy and resource managers determine the best practices for managing these nonmarket resources and experiences.

In this study, researchers will gather data from Lake Michigan salmon and trout anglers for the 1996 and 1997 fishing seasons. This information, combined with data from other sources, will help researchers build an economic model of angler activity in the area. Understanding the dynamic decisions of recreational anglers, fisheries managers can use this model to analyze the economic impact of various policy options for managing the Lake Michigan fishery to achieve maximum economic returns.

NEW PROJECT (R/PS-49): A Dynamic Economic Model of Recreation: An Application to Wisconsin's Southern Lake Michigan Salmon and Trout Fishery

R. William Provencher
Agricultural and Applied Economics
UW-Madison

Richard C. Bishop
Agricultural and Applied Economics
UW-Madison

2. Analyzing toxic algae

Frequent instances of water and seafood contamination by toxic algae point to a need to quickly analyze the toxins involved. Immunoassays — tests that analyze and identify toxic substances on the basis of their antigenic actions — are feasible for such purposes. However, wide application of immunoassays is hindered by low supply of immunochemical reagents, and antibodies for some of these toxins also are not available.

This research project will help resolve these problems by developing less costly but equally effective alternative methods for preparing needed reagents. The project also will work to develop antibodies for use as safe and effective vaccines.

Through comparative studies on how various antibodies interact with toxins and key receptors, researchers will learn more about how the targeted toxins work. The reagents generated also will be used for various collaborative studies with other scientists nationwide who are studying toxicology and the safety of seafood and drinking water.

CONTINUING PROJECT (R/BT-2): Immunochemical Studies on Selected Phycotoxins

Fun S. Chu
Food Microbiology and Toxicology
UW-Madison

3. Adding new properties to electrorheological fluids

Electrorheological (ER) fluids, used in the robotics and automotive industries, are composed of finely divided particles suspended in a carrier liquid, usually an insulating oil. When given a jolt of electricity, these special fluids can make a rapid transition from liquid to solid, and back to liquid again.

Electrorheological fluids show great potential for developing new stress-transfer devices. One problem in this area of technology, however, is that ER fluids currently cannot operate over a wide temperature range.

The research has identified how certain proteins may significantly enhance ER properties. A goal of this study is to isolate proteins found in hyperthermophilic bacteria, which require high temperatures for normal development. These proteins will be developed and tested for their ability to enhance the working temperature range of ER fluids.

CONTINUING PROJECT (R/BT-4): Enhanced Electrorheological Fluids Using Hyperthermophilic Biotechnology

Daniel J. Klingenberg
Chemical Engineering
UW-Madison

Kenneth H. Nealson
Center for Great Lakes Studies
UW-Milwaukee

4. Searching for bacterial films that repel zebra mussels

Zebra mussels are small freshwater mollusks that were accidentally introduced to the Great Lakes in the mid-1980s. They attach to the submerged surfaces of docks, boat hulls, pipes and other mollusks, causing extensive environmental and economic damage.

Bacteria play a little-understood role in making surfaces attractive or unattractive to zebra mussels and other similar invertebrates. Bacteria produce films, some of which appear to attract the mussels and others that repel them. Researchers speculate that these bacterial films might be what mussel larvae respond to when choosing a place to attach. This study will investigate what types of filmed and unfilmed surfaces are attractive and unattractive to zebra mussels. Bacterial material that inhibits zebra mussel attachment will be isolated and tested for its effect on several surface types.

Information gained from this study could lead to the development of biological control agents that would prevent invertebrate organisms, including the zebra mussel, from attaching to such surfaces in the Great Lakes.

NEW PROJECT (R/BT-9): Bacteria and Their Extracellular Polymers in Settlement and Antifouling

James S. Maki
Biology
Marquette University

5. Designing robots for underwater exploration

Underwater exploration poses many hazards and complications for human divers. This research addresses motion planning for automatic and semiautomatic robots used for underwater exploration. The project goal is to develop robot systems capable of geometric reasoning and motion planning in an unknown, complex underwater environment. Such a robot probe would be able to fully explore any given underwater area or large object, such as a sunken ship.

The robot's decision-making processes will be based on real-time sensory data gathered by range sensors and cameras. In automatic mode, the robot vehicle will plan its own path. In semiautomatic mode, a human operator will command general trajectories and goals, while the robot avoids collisions based on sensor information.

This project will capitalize on past University of Wisconsin work in sensor-based robot motion research. By building on prior work, this project will produce theory and algorithms for sensor-based planning of underwater exploration tasks.

CONTINUING PROJECT (R/N1-20): Intelligent Robot System for Complex Underwater Exploration Tasks

Vladimir J. Lumelsky
Mechanical Engineering
UW-Madison

6. Putting high technology to practical use

UW Sea Grant's Geographic Information Systems (GIS) and fisheries specialists are using high technology to solve down-to-earth problems.

Spurred by recent state legislation, Wisconsin's 72 counties — plus many cities, villages and townships — are modernizing their land records. This systematic effort is providing an opportunity to apply new GIS computer technology to Great Lakes issues.

Through a cooperative program between UW Sea Grant Advisory Services and UW-Madison's Land Information and Computer Graphics Facility, Advisory Services' GIS specialist assists communities with developing and using computer-based systems. Among other benefits, GIS technology can help lakeshore regions to better manage the watersheds of Great Lakes tributaries under their jurisdiction and monitor soil erosion.

Advisory Services' fisheries specialist is updating computer software for estimating yellow perch abundance under alternative harvest options. Wisconsin Department of Natural Resources used the model in 1996 when making its recommendation to close commercial fishing and reduce the sport-fishing bag limit for yellow perch on Lake Michigan. This was an important first step in halting the population's decline and giving it a chance to recover.

CONTINUING PROJECT (A/AS-1): Advisory Services: Program Coordination and Field Offices

Allen H. Miller with David Hart and Clifford Kraft
Sea Grant Institute
UW-Madison

# Related Projects

Some projects do not fit cleanly into a specific thematic area, but are nonetheless integral to the UW Sea Grant program. The related projects listed here are part of the UW Sea Grant's Microcontaminants & Water Quality and Education subprograms. Two other related projects are funded by other sources; one involves sediment remediation, and the other is education-oriented.

## PROJECTS

How Pollution Hurts Green Bay Amphibians

How Fisheries Management Decisions Affect PCB Levels in Sport Fish

Monitoring the Health of Green Bay Amphibians

Dean John A. Knauss Marine Policy Fellowship Program

Determining the Best Ways to Clean Great Lakes Sediments

Teaching Educators About Global Change

RELATED PROJECTS

1. How pollution hurts Green Bay amphibians

Researchers agree that the Green Bay ecosystem suffers from pollution by toxins (such as polychlorinated biphenyls, or PCBs) and nutrients (the by-products of organic waste like sewage and agricultural runoff). Research also has established that such pollution negatively affects fish, mammals and birds in Green Bay and the Great Lakes. However, little is known about these pollutants' effects on amphibians.

Amphibians in Green Bay undoubtedly are exposed to contaminants when they eat contaminant-laden algae and invertebrates. Because of their highly permeable skin and their aquatic early development, amphibians might also be particularly susceptible to water-borne chemical pollutants via diffusion across their skin.

This investigation will measure contaminant levels in and determine survival rates of amphibian eggs, larvae and adults in Green Bay and its tributaries. The researchers will measure the rates at which toxins are accumulated by and purged from amphibians.

This project addresses an important gap in knowledge about the Green Bay ecosystem. Amphibian eggs, larvae and adults serve as prey for many fish, birds and mammals, and therefore play a role in transferring contaminants through the food web. Additionally, since little is known about amphibian ecotoxicology, it isn't clear whether regulations meant to protect birds and mammals are adequately protecting amphibians.

CONTINUING PROJECT (R/MW-54): Ecotoxicology of Amphibians in Green Bay

William H. Karasov
Wildlife Ecology
UW-Madison

2. How fisheries management decisions affect PCB levels in sport fish

After the manufacture of polychlorinated biphenyls (PCBs) was banned in 1976, the concentrations of these toxic industrial compounds in Lake Michigan fish steadily declined. In the last 20 years, PCB concentrations have decreased significantly. But while the rate of decline has slowed since the mid-1980s, none of the lake's fish species is completely free of PCB contamination.

Though concentrations of PCBs in Great Lakes trout, salmon and whitefish are now nearly static, these concentrations are highly variable. Most of the variability is explained by differences in species, growth rate, age, size and location. Ultimately, Great Lakes fish managers' decisions about stocking levels, species composition and harvest levels affect PCB concentrations in the sport harvest.

This research will assess the potential effects of fish management strategies on PCB concentrations in these fish species, and express these effects in terms of probability

distributions useful for analyzing risks and decisions. These findings and models then will be transferred to fisheries managers at a regional workshop.

CONTINUING PROJECT (R/MW-59): Microcontaminant Cycling in Great Lakes Food Webs

Stephen R. Carpenter
Center for Limnology
UW-Madison

3. Monitoring the health of Green Bay amphibians

Researchers suspect a relationship between water contamination and low amphibian diversity and abundance in the Green Bay ecosystem. Toxic polychlorinated biphenyls (PCBs) are particularly suspect, but the relationships have yet to be determined.

This investigation will test whether amphibian diversity and abundance in the Green Bay ecosystem is notably low compared with similar sites elsewhere in Wisconsin. It will test the hypothesis that chronic exposure of amphibian eggs to contaminants in water from Green Bay and its major tributary, the Fox River, reduces hatchability and survival of three particular species. Researchers will also check for abnormal sex organs in amphibians raised in these waters. Results of this work will be used to assess to what extent contaminants can explain the variation in amphibian species diversity and abundance in wetlands in the Green Bay ecosystem.

The work will enable managers at state and federal resource management agencies to address the question of whether amphibians, one of the least-studied classes of vertebrates, are adequately protected by regulations based on bird, mammal and fish species. The research also will provide landscape ecologists with information necessary to evaluate the effectiveness of wetland restoration efforts.

NEW PROJECT (R/MW-73): Status of Amphibians in the Green Bay Ecosystem: Evaluation by Bioassay, Biomarkers and Habitat

William H. Karasov
Wildlife Ecology
UW-Madison

4. Dean John A. Knauss Marine Policy Fellowship program

The Dean John A. Knauss Marine Policy Fellowship was established in 1979 to provide a unique educational experience for students who have an interest in marine, ocean and Great Lakes resources, and in the national policy decisions affecting those resources. This competitive program provides highly qualified graduate students one-year paid internships with hosts in the federal legislative or executive branches, or in other institutions in the Washington, D.C., area.

Over the last 15 years, 10 Wisconsin students have been selected to participate in the program. They have served with the U.S. Senate's Commerce, Science & Transportation Committee and Great Lakes Task Force, and the Office of Ocean & Marine Services in the National Oceanic & Atmospheric Administration, among others. In 1997, this project will

support Wisconsin student interns working with the National Oceanic & Atmospheric Administration's Damage Assessment Center and Sanctuaries & Reserves Division.

This project helps enrich the pool of graduates who are knowledgeable about and interested in careers in marine research and resource management by enabling them to apply their academic knowledge to public policy issues. Their presence, in turn, offers congressional staffers insight into academic research programs and resource issues pertaining to the Great Lakes and marine resources.

CONTINUING PROJECT (E/E-29): Dean John A. Knauss Marine Policy Fellowship Program

Mary Lou Reeb
Sea Grant Institute
UW-Madison

## Determining the best ways to clean Great Lakes sediments

The United States and Canada have identified over 40 heavily contaminated areas around the Great Lakes. Five of these "Areas of Concern" are in Wisconsin's Great Lakes harbors, and they need to be cleaned up. But sediment remediation is such an expensive project that officials are under pressure to minimize the amount of sediment treated. Those charged with preparing remedial action plans often do not know the extent of sediment contamination, nor do they have estimating tools for evaluating remediation technologies and costs.

UW Sea Grant is managing a cooperative effort involving researchers from UW-Green Bay, UW-Milwaukee, University of Minnesota-Duluth and University of Windsor in Ontario. Together they are developing tools that will enable decision makers to estimate the benefits and costs of cleaning contaminated sediments.

The project investigators are developing computer software that can be used to examine the costs and performance of sediment remediation technologies and associated activities and to estimate the effects of various policies and regulations on cost and performance.

NEW PROJECT: Costs and Benefits of Cleaning Up Contaminated Sediments in Great Lakes Areas of Concern

FUNDING SOURCES: Great Lakes Protection Fund and U.S. Environmental Protection Agency

Anders W. Andren with Philip Keillor
Sea Grant Institute
UW-Madison

6. Teaching educators about global change

The shift to a more holistic view of Earth has generated a new understanding of human relationships to the environment. Natural resource depletion, loss of biodiversity, atmospheric warming and spiraling human population growth are putting the planet's ecosystem in peril.

UW Sea Grant Advisory Services is conducting Global Environmental Change Education workshops for secondary and post-secondary teachers and adult educators who, in turn, teach others. The goal of this project is to produce a more scientifically literate, environmentally aware and technologically informed population that has the capacity to make wise decisions on challenging environmental issues.

CONTINUING PROJECT: Global Environmental Change Education Initiative

FUNDING SOURCES: Office of Global Programs, National Oceanic & Atmospheric Administration; NASA via U.S. Department of Agriculture, Agricultural Research Service; and Wisconsin Environmental Education Board

Allen H. Miller
Sea Grant Institute
UW-Madison

# General Support

The UW Sea Grant Institute staff promotes Sea Grant's mission of encouraging the stewardship and sustainable use of the nation's Great Lakes and ocean resources. Staff members publicize research results and related information in the media, in classrooms and in the field. In addition, institute staff help steer the program in appropriate and useful directions.

## PROJECTS

Using Science to Solve Problems

Communicating Research Results

Tuning In to Science

Offering Sea Grant-Related Education Opportunities

Charting the Course

Supporting the Special Needs of Research Projects

## 1. Using science to solve problems

The Great Lakes provide important economic and recreational opportunities that must be used wisely. UW Sea Grant Advisory Services specialists serve as a bridge between Great Lakes researchers and resource users by passing new research information on to the public.

The Advisory Services program employs eight specialists who provide statewide assistance in aquaculture, business, coastal engineering, fisheries, geographic information systems, marine education, nonindigenous species, water quality and water safety. The specialists are located at UW-Madison, UW-Milwaukee, UW-Green Bay, UW-Superior and UW Center-Manitowoc County.

In addition to providing technical and hands-on support to the public, Advisory Services specialists are involved in many of the projects associated with UW Sea Grant's 1996–98 research themes, including the Lake Superior Initiative, Nonindigenous Species, Aquaculture for the Great Lakes Region, Terrestrial-Aquatic Coupling, Safety at Sea, Application of Innovative Technology and related programs. Advisory Services also offers summer courses for teachers and programs for the public.

CONTINUING PROJECT (A/AS-1): Advisory Services: Program Coordination and Field Offices

Allen H. Miller
Sea Grant Institute
UW-Madison

## 2. Communicating research results

The goals of UW Sea Grant's Communications program are to enhance public appreciation for the value of Great Lakes' coastal and ocean resources; offer professional communications support to UW Sea Grant staff, specialists and researchers; and provide professional science communications experience to UW-Madison students via part-time employment as writers.

Led by UW Sea Grant's assistant director for communications, the office staff includes an art director, radio producer, science editor, science writer and two half-time student writers.

The Communications Office produces the UW Sea Grant Institute's bimonthly newsletter, *Littoral Drift*. It also annually distributes thousands of copies of science journal articles based on UW Sea Grant-funded research as well as hundreds of Sea Grant technical, public information and education publications.

In addition to providing general professional communications support to the UW Sea Grant program, Communications Office staff are directly involved in various projects associated

with UW Sea Grant's 1996-98 research theme areas, including the Lake Superior Initiative, Nonindigenous Species, Safety at Sea and Application of Innovative Technology.

CONTINUING PROJECT (A/AS-2): Communications Office and Program Coordination

Stephen Wittman
Sea Grant Institute
UW-Madison

3. Tuning in to science

"Earthwatch" uses the popular medium of radio to give the public concise, objective and timely information about science and the environment, especially in regard to the Great Lakes and the nation's marine resources. The program also raises public awareness about Sea Grant and its activities in Wisconsin and around the nation. "Earthwatch" has been cited repeatedly for excellence and received its most prestigious award at the 1992 "Earth Summit" in Rio de Janeiro, when the United Nations Environment Programme named "Earthwatch" to its "Global 500 Roll of Honour."

Sea Grant and the University of Wisconsin-Madison Institute for Environmental Studies jointly produce 10 two-minute "Earthwatch" programs every two weeks. These programs are distributed free of charge to more than 120 broadcast outlets in the eight Great Lakes states, the Canadian province of Ontario and elsewhere. "Earthwatch" is broadcast more than 660 times a week over these outlets. If this free public service airtime were purchased at commercial rates, it would cost more than $1 million a year — a payback of more than 22-to-1 on the federal Sea Grant investment.

CONTINUING PROJECT (A/AS-3): "Earthwatch" Public Service Radio Program

Richard Hoops
Sea Grant Institute
UW-Madison

4. Offering Sea Grant-related education opportunities

UW Sea Grant provides opportunities for graduate and undergraduate students to participate in all aspects of the program's activities. In the belief that graduate education and research are inseparable, most of the program's investment in education is in the form of research and project assistantships funded through individual research projects. The 1996-98 program will provide support for 32 graduate students who work as integral members of research projects in the various thematic areas. Through UW Sea Grant, students also receive special opportunities to go to sea, work at coastal research stations and attend scientific meetings.

UW Sea Grant also educates the public about ocean and Great Lakes issues, and provides training for anglers, boaters, coastal residents, K-12 teachers, port managers and aquaculturists.

UW Sea Grant also supports innovative educational activities that enhance public awareness of the Great Lakes and oceans, including cultural or artistic works dealing with the

marine environment, lecture series, workshops, films and museum exhibits. A number of these activities are special projects jointly funded with private foundations or corporations.

A substantial amount of K-12 and public education activities are carried out in the Communications and Advisory Services subprograms via publications, video and other electronic media, teacher training enhancements, radio programs, displays, workshops and conferences for adults.

Community-based partnership projects, such as the JASON Project (an annual high-tech international science education program adapted for Madison-area teachers and middle-school students), are also coordinated directly through Special Marine Education Programs.

CONTINUING PROJECT (E/E-1): Special Marine Education Programs

Mary Lou Reeb
Sea Grant Institute
UW-Madison

5. Charting the course

Management of the University of Wisconsin Sea Grant College Program includes program planning, project and subprogram evaluation, proposal development, research coordination and leadership for the program as a whole. Effective management requires a high level of integration of research, education and outreach activities, and high professional standards of performance.

Maximum program impact requires coordination with related programs. Wisconsin Sea Grant actively seeks ways to collaborate with other Sea Grant programs in cooperative research, outreach and education partnerships. UW Sea Grant also fosters effective liaisons and collaborative efforts with state, federal and private industry sources of support. These supporters are key to maintaining the program's viability.

Throughout its 25-year history, the Wisconsin Sea Grant program has remained responsive and accountable to the public and user groups it serves through strong university, community and societal interaction. Although UW Sea Grant's research perspective focuses on long-term needs and goals, the program is administered with flexibility that leaves its research priorities open to emerging fields and areas of concern.

CONTINUING PROJECTS (M/SGA-1 and M/SGA-2): Program Development and Program Management

Anders W. Andren
Sea Grant Institute
UW-Madison

6. Supporting the special needs of research projects

Many UW Sea Grant studies of the Great Lakes require the use of small boats, specialized technical assistance and reliable research vessels equipped with specialized oceanographic equipment. This project funds ship time and related field support for UW Sea Grant projects that require field work on lakes Michigan and Superior. To minimize expenses, field work for several projects often is conducted simultaneously on each boating expedition.

CONTINUING PROJECT (M/SGA-3): Ship Time in Support of Sea Grant Research Projects

Anders W. Andren
Sea Grant Institute
UW-Madison

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Advisory Council

Committee on Advisory Services

*Communications*

**Administration & Program Support:**
Publications
Media Relations
Photo/Graphics Library

**Public Information:**
Publications
World Wide Web
Newsletters

**Earthwatch Public Service Radio Program**

*Advisory Services*

**Administration / Coordination**

**Field Offices:**
Green Bay
Manitowoc
Milwaukee
Superior

**Specialists:**
Aquaculture
Business Management
Coastal Engineering
Fisheries
Geographic Information Systems
Global Change Education
Marine Education
Nonindigenous Species
Water Quality
Water Safety

*Research*

**Living Resources**

**Biotechnology**

**Estuarine & Coastal Processes**

**Microcontaminants & Water Quality**

**Aquaculture & Seafood Technology**

**Policy Studies**

**New Initiatives**

*Education*

**Graduate Assistants**

**Undergraduate Assistants**

**Course Development**

**Seminar Speakers**

**Field Experience**

**Public Education**

**K-12 Education**

**Organizational Units and Departments Involved in the 1996–98 University of Wisconsin Sea Grant College Program**

University of Wisconsin-Madison
Agricultural Economics
Animal Health & Biomedical Sciences
Aquaculture Research Center
Biotechnology Center
Biotron
Center for Health Sciences
Center for Limnology
Chemical Engineering
Civil & Environmental Engineering
College of Agricultural & Life Sciences
College of Engineering
College of Letters and Science
Environmental Toxicology Center
Food Microbiology & Toxicology
Food Science
Graduate School
Institute for Environmental Studies
Kinesiology
Land Information & Computer Graphics Facility
Mechanical Engineering
Medical School
Oceanography & Limnology Graduate Program
Preventive Medicine
Radiology
Research Animal Resources Center
Sea Grant Institute
School of Education
School of Natural Resources
School of Pharmacy
School of Veterinary Medicine
State Laboratory of Hygiene
Statistics
Surgical Sciences
Water Chemistry Program
Water Resources Center
Water Resources Management Program
Wildlife Ecology
Zoology

University of Wisconsin-Extension
Cooperative Extension

University of Wisconsin-Green Bay
Natural & Applied Sciences
Sea Grant Advisory Services

University of Wisconsin-La Crosse
Biology & Microbiology

University of Wisconsin Center-Manitowoc County
Sea Grant Advisory Services

University of Wisconsin-Milwaukee
Aquaculture Institute
Biological Sciences
Center for Great Lakes Studies
Geosciences
Graduate School
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University of Wisconsin-Stevens Point
College of Natural Resources

University of Wisconsin-Superior
Sea Grant Advisory Services

University of Wisconsin System
Great Lakes Research Facility

Illinois State University
Agriculture

Laval University
Biology

Marquette University
Biology

Medical University of South Carolina
Biochemistry & Molecular Biology

Purdue University
Forestry & Natural Resources
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Foods and Nutrition
Agricultural Economics

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