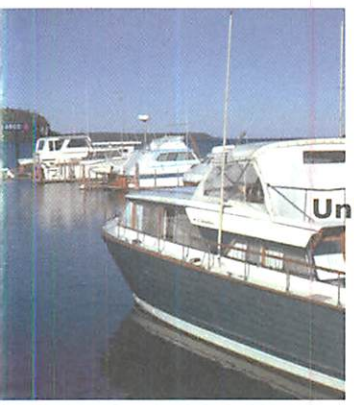

# University of Wisconsin Sea Grant Institute Program Directory

## 1998 2000

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mid-biennium report

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## TABLE OF CONTENTS

# 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 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 and the private sector.

More than 170 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 the academic community and coastal resource users and managers.

During 1998-2000, UW Sea Grant is supporting more than two dozen research, outreach, and education projects in nine thematic areas that address a host of issues and concerns: enhancing Great Lakes sport and commercial fisheries; improving freshwater aquaculture; analyzing the ecosystem effects of zebra mussels; exploring the potential of biotechnology and other advanced technologies for marine and Great Lakes applications; analyzing related socio-economic issues and advising coastal communities and businesses; enhancing safety for recreational scuba divers; investigating the cycling of toxic contaminants in Great Lakes systems; and developing strategies for pollution remediation.

The collapse of Lake Michigan's yellow perch fishery is receiving special attention from Sea Grant during the 1998-2000 biennium. The Illinois-Indiana and Michigan Sea Grant programs have joined UW Sea Grant in funding a coordinated perch research program involving more than a half-dozen university scientists.

Since its creation more than 30 years ago, Sea Grant has proven to be a sound investment. It has fostered scientific and technological developments essential to understanding, wisely using, and effectively managing the nation's marine and Great Lakes resources. Today, the established infrastructure of the national Sea Grant Network continues to transfer new technological and scientific insights from university laboratories to state, regional, and federal resource managers, the public, and industry.

# Lake Superior Initiative

Lake Superior is one of the Midwest's vital economic resources. It is also a unique and fragile ecosystem threatened by contaminants, exotic species, and human exploitation. Environmental protection and restoration of the lake are urgent, yet economic development is imperative for communities in the Lake Superior basin. Research in this thematic area fills critical gaps in our understanding of this major resource—and of the likely economic and environmental consequences of management decisions.

Several projects in this thematic area are deepening our understanding of population dynamics of the lakes' fisheries. Three projects are developing models to help us understand the complex processes that govern food webs, relationships between spawning stocks and recruitment, and management decision-making that integrates goals of maximizing present fishery values and sustaining fisheries over time. A fourth project is demonstrating the viability of a non-invasive DNA test for distinguishing among spawning populations. Other projects are examining ways that the recreational boating industry in the Apostle Islands has been changing and the mechanisms by which heavy metals enter the lake.

## Application of Microsatellite and Mhc Markers to Stock Identification in Lake Superior Lake Trout (R/LR-76)

Ruth Phillips, Biological Sciences, UW-Milwaukee

## Causes and Impediments of Lake Trout Recovery in Lake Superior (R/LR-77)

Michael Hansen, College of Natural Resources, UW-Stevens Point

## Fisheries and Food Web Dynamics in Lake Superior (R/LR-78)

James Kitchell, Center for Limnology, UW-Madison

## Watershed Export and Speciation of Trace Metals in the Lake Superior Basin (R/MW-77)

David Armstrong, Water Chemistry Program, UW-Madison
William Sonzogni, State Laboratory of Hygiene, UW-Madison

## Sustainability, Uncertainty and the Management of the Lake Superior Fisheries (R/PS-51)

Richard Bishop, Agricultural & Applied Economics, UW-Madison

## Analysis of Persistence and Change in Apostle Island Boating 1975-1997 (R/PS-53)

Thomas Heberlein, Rural Sociology, UW-Madison

## R/LR-76 Application of Microsatellite and Mhc Markers to Stock Identification in Lake Superior Lake Trout

Ruth Phillips

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 monitor the trout fishery better, managers need a way to tell the two fish apart at all ages.

In this project, researchers are identifying genetic markers to aid in stock identification and to distinguish between young lean trout and young siscowet trout. This work is leading to the development of a noninvasive DNA test—important because fish will not have to be killed to obtain genetic samples.

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

### Update

Microsatellites have been shown to be very sensitive genetic markers for animal populations, including fishes. Preliminary data from the microsatellite analysis of 15 major spawning populations of lake trout from different locations around Lake Superior indicate that this technique will be useful in distinguishing lean lake trout from siscowets. The results also show that several genetically distinct subpopulations exist for both morphotypes. Lean lake trout from adjacent regions tend to be closely related, but siscowets do not always group by region. It seems that other factors, including depth, may be important in determining where siscowets of similar genetic origin can be found. A workshop on stock identification using molecular and morphological techniques is planned for July 1999 and will focus on salmonids native to Wisconsin.

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## R/LR-77 Causes and Impediments of Lake Trout Recovery in Lake Superior

Michael Hansen

In March 1996, fishery managers on Lake Superior declared victory in the restoration of lake trout and decided to cease stocking after more than 35 years. Now fishery managers need tools that reliably predict the ability of wild trout populations to sustain themselves in the future.

Wild lake trout are currently declining in numbers, and the prospects for natural reproduction are uncertain. To respond to this situation effectively, fisheries managers urgently need to understand the dynamics of survival and recruitment.

This project is producing quantitative models that describe the principal mechanisms governing trout population dynamics in Lake Superior. The models help determine why the population of lake trout has declined in the last decade and to what extent wild lake trout contribute to the population. The models determine the significance of factors such as densities of wild and stocked lake trout, predators and competitors, and large-mesh gill-net fishing efforts. The results will enable management agencies to develop strategies of habitat enhancement and fishery regulation that will promote lake trout recovery.

## Update

The first step in developing a model of the relationships between spawning stocks and recruitment has been completed. Lake trout assessment data from more than 2,500 gill net lifts were assembled and reorganized by age instead of by length, which had previously limited the use of these data in stock-recruitment modeling. The first phase of modeling is focusing on Michigan waters of Lake Superior, so data for this area were recoded first. Future phases will expand the analysis to Minnesota and Wisconsin waters of the lake. In conjunction with this work, an analysis of gear saturation on gill net catches of lake trout was conducted to account for variations in the number of days between the setting and lifting of the nets. This analysis has been accepted for publication in the *North American Journal of Fisheries Management.*

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# R/LR-78 Fisheries and Food Web Dynamics in Lake Superior

James Kitchell

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

This project involves gathering data and providing tools to analyze Lake Superior fisheries. Researchers are developing 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.

## Update

Two workshops on the EcoSim model of the Lake Superior food web have been conducted in collaboration with the Lake Superior Technical Committee of the Great Lakes Fishery Commission. A summary of that modeling effort was presented at the 1998 conference of the International Association for Great Lakes Research. Two papers derived from this project were published in 1998, and three more have been submitted for publication.

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# R/MW-77 Watershed Export and Speciation of Trace Metals in the Lake Superior Basin

David Armstrong and William Sonzogni

Lake Superior is the cleanest of the Great Lakes, and people want to keep it that way by eliminating as many contaminants as possible. These include metals like lead, cadmium, arsenic, mercury, zinc, and others. Even at very low concentrations, some of these metals can exert toxic effects. However, toxicity is strongly dependent on the chemical and physical form (species) of the metal.

Watersheds are major reservoirs of metals, and rivers draining these watersheds are major sources of metals that enter Lake Superior. This project is assessing key factors controlling the mobility and fluxes of a dozen different metals in representative tributaries of Lake Superior. Researchers are studying trace metal transport and relationships to stream geochemistry, watershed characteristics, and hydrologic events. They are also examining the relative importance of natural and human-produced sources. The use of newly developed "ultra-clean" sampling and analysis methods is enabling the researchers to measure metal concentrations and forms present in tributaries throughout the Lake Superior Basin.

This information will aid regulators and managers in developing and enforcing realistic standards governing trace metal pollution in Lake Superior and elsewhere.

## Update

Field studies to date have focused on the collection of samples during key hydrologic regimes in each of six representative Lake Superior watersheds. Preliminary results indicate that 40%-70% of the annual export of many metals occurs during spring melt, with most of the remainder occurring during summer and fall events. These data indicate hydrologic events may dominate annual export loading, particularly for particle-associated metals but also for certain metals associated with dissolved organic carbon (DOC). The samples were subjected to a variety of chemical and physical separation techniques designed to elucidate the phase-association of a dozen environmentally relevant trace metals.

Experiments with DOC-associated metals demonstrated that the qualitative and quantitative association with DOC is strongly predicted by watershed characteristics. Speciation of silver and lead is highly coupled to colloidal iron. Related work shows that the fraction of

total metal that is labile, or "free," is frequently small. These results have important implications for short-term bioavailability; however, the longer-term fate of complexed metals is still open to question. Experiments now underway will address the availability of metals associated with particles and differentiate anthropogenic and background sources of metals during distinct hydrologic periods.

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## R/PS-51 Sustainability, Uncertainty and the Management of the Lake Superior Fisheries

Richard Bishop

Economic research informs public debate and decision-making on policies for Great Lakes fisheries. To date, economic models have focused almost exclusively upon efficiency, attempting to maximize 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 is building 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 sustainable fisheries.

### Update

This project's exploration of how making decisions on behalf of others might change a decision-maker's choice function is the subject of a journal paper now in review. It drew on fiduciary responsibilities articulated in U.S. trust law for insight into responsible decision-making under both risk and uncertainty, thus helping construct a conceptual framework that reconciles the goals of sustainability and efficiency under both circumstances. Researchers are currently simulating and evaluating alternative decision-making rules applicable to conditions of uncertainty. Use of equations from the EcoSim model of Lake Superior's fisheries, a product of UW Sea Grant-funded research, gives this bioeconomic model an unusual degree of realism. Interviews with Lake Superior fisheries managers have been conducted in preparation for a qualitative and descriptive case study of the role of uncertainty in their decisions.

# R/PS-53 Analysis of Persistence and Change in Apostle Island Boating 1975-1997

Thomas Heberlein

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 boaters in the Apostle Islands were surveyed in 1975 to learn what factors influenced their participation in recreational boating. They were surveyed again in 1985 and in 1997. Another group was surveyed in 1985 and in 1997, and a third group was surveyed only in 1997. Researchers are analyzing these three complex data sets and are collecting the secondary data necessary to help interpret observed changes.

As one of few long-term panel studies in the recreation research field, this project provides information about how people's recreational lives change as they age, reveals changes in how society regards and uses wilderness, and shows how recreational boaters have affected the Apostle Islands area and how that area has responded to suit the boating population.

Understanding the recreational choices made by this aging population will reveal what individual, societal, and site-related factors 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.

## Update

Data on boater behavior and perceptions have been collected, creating a database spanning 23 years, and an assessment of how boating tourism has influenced communities along Lake Superior's southern shore is now underway. Since 1975, information has been obtained on marina development, ice and gas sales, yacht club membership trends, and growth of the area's charter sailing fleet.

Preliminary analysis reveals several interesting trends:

- There are more visitors to the Apostle Islands now, but they feel less crowded than the 1985 visitors.
- The average age of Apostle Islands boaters has risen, but members of the baby boom generation constituted a smaller proportion of total visitors than expected.
- Boaters increasingly agree that the Apostle Islands are affected by humans and that the environment is damaged by overuse; yet their willingness to characterize the islands as a wilderness has remained constant.

# Yellow Perch Initiative

Yellow perch have long been a commercial and sport fishing favorite in Lake Michigan. For nearly a decade, however, populations have been drastically reduced, and the causes remain poorly understood. To address this problem, UW Sea Grant has joined forces with state, federal, and tribal agencies around Lake Michigan in an intensive research effort. In laboratory and field studies, researchers are examining the factors of growth rate, genetic condition, predators, and water temperature. They are also comparing eggs and larvae from several locations around the state to evaluate the relative importance of environmental and biological factors in the Lake Michigan decline.

## Recruitment Mechanisms in Yellow Perch (*Perca flavescens*): Interactions among Growth, Condition and Predation (R/LR-75)

Fred Binkowski, Great Lakes WATER Institute, UW-Milwaukee

## Recruitment Decline of Yellow Perch in Green Bay, Lake Michigan: Evaluation of Environmental Influences and Predation (R/EC-5)

Fred Binkowski, Great Lakes WATER Institute, UW-Milwaukee

## Early Life History of Perch (R/LR-74)

Fred Binkowski, Great Lakes WATER Institute, UW-Milwaukee

## R/LR-75 Recruitment Mechanisms in Yellow Perch (*Perca flavescens*): Interactions among Growth, Condition and Predation

Fred Binkowski

This project is examining several factors that may be responsible for the decade-old failure of yellow perch to survive to adulthood.

Researchers are assessing the fish's size, condition, growth rates, and survival to determine the causes and consequences of variation in these factors. The team is also developing an individual-based model of the interactions among perch size, growth, condition, and predator size and abundance. This model will be used to develop and test hypotheses about the effects of these factors on perch populations.

This study will provide much-needed insight into the dynamics of recruitment among yellow perch. With a better understanding of the factors limiting recovery of the perch population, fisheries managers will be able to address this serious problem more effectively.

### Update

A series of laboratory experiments was conducted to evaluate maternal and starvation effects on the condition of larval perch. Analysis of the results has just begun, but the experiment was a critical first step toward determining the cause of year-class failure of perch in Lake Michigan. Field sampling to determine hatch dates relative to spawning activity and to evaluate egg and larval development was also completed. Preliminary results suggest perch larvae were present early in the sampling season but dissipated quickly due to natural transport or mortality. Sampling later in the season indicated an increase in young-of-the-year abundance compared with recent years.

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## R/EC-5 Recruitment Decline of Yellow Perch in Green Bay, Lake Michigan: Evaluation of Environmental Influences and Predation

Fred Binkowski

While young yellow perch in greater Lake Michigan are failing to survive to adulthood, recruitment is still evident among yellow perch of Green Bay. Comparing the relatively successful Green Bay yellow perch to their counterparts in other Lake Michigan locations may be the best way to understand the recruitment failure observed in most of the lake.

Researchers are comparing the effects of temperature on egg survival, hatching success, sac-fry survival, and larval survival in perch from Green Bay with corresponding effects on perch from other locations. In the field, they are examining interactions of perch and their predators and comparing their relative abundance, growth, and survival. The investigators expect these comparisons to identify those factors that are responsible for widespread recruitment failure.

This knowledge may help fisheries managers aid the recovery of Lake Michigan's yellow perch population and better manage other fish species.

## Update

Nearly 8,500 perch were examined for age, size, sex, and reproductive ripeness during this year's field sampling and perch spawning assessment. Egg development and hatching dates for early, peak, and late spawning activity were evaluated through the deployment of baskets containing fertilized perch eggs. In addition, more than 31,000 larval and 37,000 young-of-the-year (YOY) perch were collected and recorded. All perch were counted for relative abundance estimates by age. A variable-mesh gill net survey also was conducted for determining the relationship between YOY perch and their predators.

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# R/LR-74-PD Early Life History of Perch

Fred Binkowski

Many proposed explanations for the decade-long failure of young Lake Michigan yellow perch to survive to adulthood involve biological factors in early life. However, it is very difficult to monitor egg and larval stages in the field. Laboratory investigations of perch eggs and larvae can determine whether differences in the quality of the gametes of perch populations from different areas influence their growth and survival.

Researchers are comparing the early life stages of perch from Lake Michigan, Green Bay, Lake Ontario, and the inland lake stock in laboratory experiments. They are examining fertility, hatching success, first feeding, swim bladder inflation, growth rates, survival, and other factors. They are also examining potential differences between hatchery and naturally spawned perch eggs. Finally, the team is establishing a captive broodstock of Lake Michigan strain yellow perch using the progeny of the Lake Michigan fish.

These investigations will help clarify whether the observed recruitment failure of Lake Michigan perch is related to factors that influence the survival and growth of the egg, larval, and post-larval stages. If differences in development are found between the strains of perch in this study, they may be traceable to contamination of parental populations. If, however, differences are not found, it will suggest that other, in-lake conditions are determining the different survival rates observed in the populations under study.

## Update

No problems have been found with the earliest life stages of Lake Michigan perch: fertility, hatching, and survival rates were roughly comparable with perch from the other locations. As they matured, however, Lake Michigan perch took twice as long as the other perch to advance from one food size to the next. This is probably related to the gape of the mouth, which determines when fish can progress to the next larger food size. However, it could be also be related to feeding behavior. Further analyses must be conducted before drawing firm conclusions. The captive broodstock was established, and the fish's sex ratios, growth rates, and survival rates are being measured. Also, 10,000 perch specimens have been preserved from this study. Investigators are currently examining these for swim bladder inflation, size at first feeding, growth rates, abnormal development, and other early life information.

# Nonindigenous Species

The Great Lakes have been invaded by at least 142 species of foreign plants and animals, but the recent invasion of zebra mussels has arguably had the widest impact. The mussels clog water intake pipes of power plants, industries, and municipalities. They also disrupt nutrient cycling, contaminant cycling, and habitat features. Projects in this thematic area focus on observing and modeling the effects of zebra mussels on ecosystems and on making the results of hundreds of other research projects available to the nation via a Web-based clearinghouse of research citations.

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

David Edgington, Great Lakes WATER Institute, UW-Milwaukee
Russell Cuhel, Great Lakes WATER Institute, UW-Milwaukee
Jerry Kaster, Great Lakes WATER Institute, UW-Milwaukee

## Transferring Sea Grant Zebra Mussel Research and Outreach Results to the Nation Using a World Wide Web Server and Compact Disks (A/AS-41)

Allen H. Miller, Sea Grant Institute, UW-Madison

## R/LR-63 The Effect of Zebra Mussel Infestation in Inland Lakes on Pelagic Benthic Coupling

David Edgington, Russell Cuhel, and Jerry Kaster

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 are investigating the effect zebra mussel infestations have on energy transfer between primary producers, like phytoplankton and plants, and higher-level consumers. Also, they are determining 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.

### Update

An intensive water-column study during 1996-97 provided a clear seasonal picture of plankton processes that can be expected to be affected by zebra mussel activity. A model for estimating primary production was developed that provided results consistent with observations prior to the zebra mussel colonization. Localized impacts attributable to zebra mussels were observed in 1998, but they generally were short-lived and no open-water evidence for systemic water quality change was found. However, interpretation of the mussel's influence was complicated by the effects of El Niño.

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## A/AS-41 Transferring Sea Grant Zebra Mussel Research and Outreach Results to the Nation Using a World Wide Web Server and Compact Disks

Allen H. Miller

To control the threat of zebra mussels, Eurasian ruffe, round goby, and other aquatic nonindigenous species (NIS) effectively, knowledge about these troublesome animals must reach the people who can facilitate control efforts. This project is transfering research and educational information on aquatic NIS from those who produce it to those who need it most—resource managers, industrial facilities operators, the public, and other water users in the United States, Canada, and elsewhere.

Project leaders are accomplishing this by expanding the Sea Grant nonindigenous species database (SGNIS) available on the Web at *www.ansc.purdue.edu/sgnis*. The research explores basic biology, effects on ecosystems, means of prevention, and costs and benefits of control strategies. Outreach efforts focus on the education of industrial facilities operators, resource managers, and the public.

The project ensures the scientific integrity and utility of all information added to the web site by submitting each document for review by recognized scientists. It will produce and market an updated compact disk of SGNIS information for industries, governments, and individuals that do not have access to the internet. This wealth of information will play a vital role in reducing the impact of nonindigenous species around the country.

## Update

Recent work has focused on adding papers and publications about zebra mussels from non-Sea Grant organizations and adding material on other species to the SGNIS Web site. UW Sea Grant's portion of this Great Lakes Sea Grant Network project consists of identifying appropriate articles on aquatic nonindigenous species for the Web site, obtaining permissions from authors and publishers, and preparing the digital citation. This has resulted in the addition of a dozen abstracts from the 1997 international zebra mussel conference and 127 abstracts from the 1996 conference, 11 articles from NOAA's Great Lakes Environmental Research Laboratory, 76 papers from the U.S. Army Corps of Engineers Waterways Experiment Station, and more than 240 articles from other nonindigenous species literature. A compact disk has been produced and is being marketed by Minnesota Sea Grant.

# Aquaculture for the Great Lakes Region

Commercial aquaculture has developed rapidly amid the abundant resources and existing markets of Wisconsin and the Great Lakes region. It has also become a vital part of the Great Lakes commercial fishing industry, which depends on hatchery production and fish stocking.

Studies in this area are expanding possibilities in the aquaculture industry and furthering our understanding of the physiology and reproductive functions of hatchery-raised fish. One major problem inhibiting productivity in hatcheries is that captive fish experience stress that limits growth rates and reduces reproductive efficiency. One project in this area is examining how steroid hormones can be used to decrease the stress response of rainbow trout and possibly other fish. Another is studying the stress responses of yellow perch and determining whether they can be mitigated by controlling tank cleanliness and water quality. Methods of increasing the slow growth rates of tank-reared walleye are also being developed.

Methods of converting waste material from fish processing plants into value-added products are being developed in another study, while the WATERS project continues to provide technical advice, general information, workshops, on-site consultations, and conferences on recirculating aquaculture systems (RAS) and other aquaculture issues.

## Steroid Regulation of the Stress Response and Immune Function in Salmonid Fishes (R/AQ-31)

Terence Barry, Food Science, UW-Madison
Jeffrey Malison, Food Science, UW-Madison

## Conversion of Fish Processing Waste and Underutilized Fish into Value-Added Protein Hydrogel (R/AQ-32)

Srinivasan Damodaran, Food Science, UW-Madison

## Mitigation of the Consequences of Stress in Yellow Perch Aquaculture (R/AQ-33-PD)

Jeffrey Malison, Food Science, UW-Madison

## The Production of Fast-Growing, Sterile Walleye Hybrids through Genetic and Endocrine Technologies (R/BT-10 )

Jeffrey Malison, Food Science, UW-Madison

## Wisconsin Aquaculture Technology Education and Research Services (WATERS) (A/AS-39)

Fred Binkowski, Great Lakes WATER Institute, UW-Milwaukee

# R/AQ-31 Steroid Regulation of the Stress Response and Immune Function in Salmonid Fishes

Terence Barry and Jeffrey Malison

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 are administering reproductive steroids to cultured coho salmon and rainbow trout. They are then measuring 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.

## Update

Work to date has shown that sex steroids are important regulators of the corticosteroid stress response in teleost fish. Estrogens increased and androgens decreased total stress-induced cortisol levels in immature rainbow trout. Levels of bioactive "free" cortisol, however, were not different between control and steroid-treated fish, suggesting that estrogens increase and androgens reduce the concentrations of serum cortisol binding proteins.

Estrogen administration markedly reduced lysozyme activity in the plasma of rainbow trout relative to control and androgen-treated fish. The gonadal steroid 17a,20b-dihydroxy-4-pregnen-3-one (17,20-P) increased cortisol levels in immature rainbow trout, suggesting that 17,20-P may contribute to the prespawning hypercortisolism observed in reproductively mature fish. Cortisol-metabolizing activity was measured in various tissues of rainbow trout and coho salmon.

Overall, cortisol-metabolizing activity was higher in rainbow trout than in coho salmon. Sexually mature fish of both species had lower cortisol metabolism than immature fish. Together these observations suggest that cortisol-metabolizing enzymes may buffer specific tissues against the immediate deleterious consequences of hypercortisolism. Furthermore, this protection may be greater in iteroparous than in semelparous fish, and it may decline during sexual maturity. Research is currently in progress to investigate the effects of 17,20-P on free cortisol concentrations and the effects of sex steroids on tissue-specific cortisol metabolism in both rainbow trout and coho salmon.

# R/AQ-32 Conversion of Fish Processing Waste and Underutilized Fish into Value-Added Protein Hydrogel

Srinivasan Damodaran

Fish industries in Wisconsin and throughout the United States are currently unable to use large portions of the fish they catch—up to 50% of a trawl may be trash fish by-catch. Furthermore, processing the marketable fish generates large amounts of protein-rich material that goes to waste.

This project is investigating ways in which by-catch and waste material might be converted into valuable products. Specifically, it is evaluating the possibility of producing hydrogel polymers from fish. These hydrogels would be extremely absorbent and could be used in diapers, removal of heavy metals from effluent, carriers for agricultural herbicides and pesticides, and other applications.

Researchers are synthesizing novel fish protein-based super-absorbent hydrogels, studying their water absorbing and heavy metal binding properties, and evaluating their ability to biodegrade.

The resulting technology could boost the economic vitality of the fish industry, creating valuable products from aquatic resources that are currently wasted.

## Update

A crude fish protein isolate has been achieved by extracting fish muscle with a dilute NaOH solution at pH 12, filtering the extract through a 5 mm sieve, and dialyzing the filtrate against water using a 6,000-8,000 m.w. cut-off membrane. Circular dichroism spectroscopy revealed that the isolated protein contained 43% β-sheet and 15.5% α-helix, the remainder being aperiodic structure.

Because a random coil-like structure is highly preferable for a hydrogel polymer, further investigations will be carried out to find extraction conditions that would completely denature fish proteins, particularly actin and myosin. Also preliminary experiments to convert the protein isolate into a polyanionic polymer by derivatizing it with ethylenediamine-tetraacetic dianhydride resulted in a solution that spontaneously set into a gel. Cured and suspended in water, the gel did not dissolve but absorbed about 600 grams of water per gram of gel. The water uptake properties of this gel will receive systematic study.

## R/AQ-33-PD Mitigation of the Consequences of Stress in Yellow Perch Aquaculture

Jeffrey Malison

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 is generating baseline information for evaluating the influence of selected rearing, handling, and harvesting conditions 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.

### Update

To date, studies of the effect of fish culture procedures on stress suggest that neither growth nor stress responses in yellow perch were affected by different lighting spectra. However, stressors typical of intensive tank culture (e.g., tank cleaning and water quality assessments) resulted in slower growth and higher measures of stress (serum cortisol levels) compared with perch raised in conditions that minimized typical hatchery stressors. These findings indicate that tank-reared perch do not acclimate well to routine hatchery disturbances and require conditions that minimize such stressors.

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## R/BT-10 The Production of Fast-Growing, Sterile Walleye Hybrids through Genetic and Endocrine Technologies

Jeffrey Malison

The walleye is one of the most highly valued food and sport fish in the Great Lakes region. Because of its high market value and limited supply, this species is an excellent candidate for commercial aquaculture. However, the commercial production of food-size walleye is constrained by the fish's slow growth when reared under intensive culture conditions.

This project is investigating the potential of three technologies to be used in combination to produce walleye strains with significantly improved growth. Hybrids, monosex female populations, and genetic triploids (i.e., individuals with three sets of chromosomes) of other species have shown advantages in growth and survival rates, total size, docility, and adaptability.

Researchers are developing methods for producing monosex female hybrid walleye; they are developing and testing methods for inducing in them triploidy at high rates; and they are comparing the growth, feed conversion, and reproductive development of these hybrids to diploid hybrid and purebred walleye.

The resulting techniques will produce fish strains with significantly improved growth, thereby spurring the development of a commercial food-size walleye aquaculture industry. These technologies will also be useful tools for enhancing recreational fisheries in and around the Great Lakes.

**Update** Hydrostatic pressure shock methods to induce triploidy in a high percentage of hybrid walleye were successfully developed in the spring of 1998. Triploid and diploid hybrids and diploid purebred walleyes have been produced, and studies comparing the growth, performance, and reproductive development of these fish are under way. Two year-classes of a lake strain of female walleyes and one year-class of a river strain of saugers are being reared and should reach reproductive maturity in the spring of 1999. The saugers were treated at the juvenile stage with 17 α-methyltestosterone to induce partial sex inversion in the females, and present plans are to produce monosex female hybrid walleye next spring.

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## A/AS-39 Wisconsin's Aquaculture Technology Education Research Services (WATERS)

Fred Binkowski

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 practices.

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 implementing intensive aquaculture strategies.

Advisory Services also works with other state agencies and Wisconsin's aquaculture industry to develop and promote acquaculture in Wisconsin and other sites throughout North America.

## Update

The project investigator and associates have responded to more than 100 requests for aquaculture information and logged more than 17 hours of telephone discussions with 25 clients requesting assistance regarding commercial aquaculture in Wisconsin. The researcher also participated in several Wisconsin Aquaculture Industry Advisory Council meetings and served on the program committee for the 1998 State Aquaculture Conference. A total of 105 people attended two workshops on the recirculating aquaculture systems (RAS) for the intensive culturing of yellow perch organized by the researcher.

On-site technical assistance has been provided to two commercial aquaculture operations—a high school aquaculture class and the Red Lake, Minnesota, band of Chippewa Indians. Commercial-scale RAS units are currently being installed at the UW Aquaculture Institute and at Red Lake in a project jointly funded by Sea Grant and the Red Lake Chippewa. Also, one thousand of the 1996 year-class of Green Bay yellow perch are being maintained for a UW Sea Grant broodstock project.

# Chemical-Biological Interactions in Aquatic Species (Endocrine Disrupters)

Researchers have recently noted a class of chlorinated chemical compounds that disrupt normal endocrine functions in Great Lakes fish and wildlife. Low-level exposure to these chemicals has been implicated in toxicity of wildlife of the Great Lakes, the effects appearing most pronounced during early life stages. Research in this theme area seeks to provide fundamental information about exposure assessment, hazard identification, mechanism of actions, and dose-response assessment in fish and amphibians. The results will aid in characterizing the risk that low-level exposure to these chemicals poses to fish, amphibians, and other wildlife in early life stages. This, in turn, will help state and federal regulatory agencies set appropriate limits on environmental levels of these chemicals.

One project is examining the specific biochemical mechanisms by which dioxin and related chemicals cause toxic responses in fish. A related study is developing a means of producing large quantities of a biological compound thought to play a role in the receptor system that dioxin disrupts. The availability of such quantities will allow the researchers to examine the compound's chemical structure. A third study is raising leopard frogs under clean and contaminated conditions and developing biomarkers to determine how environmental contaminants affect the frogs' reproduction and development.

## Ah Receptor-Mediated Developmental Toxicity in Zebrafish (R/MW-58)

Richard Peterson, School of Pharmacy, UW-Madison
Warren Heideman, School of Pharmacy, UW-Madison

## Impact of Contaminants on Sexual Development and Reproduction of Amphibians in Great Lakes Ecosystems (R/MW-76)

William Karasov, Wildlife Ecology, UW-Madison

## Identification of the Endogenous Ligand for the Aryl Hydrocarbon Receptor (R/BT-11)

Richard Peterson, School of Pharmacy, UW-Madison
Margaret Clagett-Dame, School of Pharmacy, UW-Madison

## R/MW-58 Ah Receptor-Mediated Developmental Toxicity in Zebrafish

Richard Peterson and Warren Heideman

Dioxin and related pollutants 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 are evaluating the effects of dioxin-related chemicals on fish development. They are also examining the molecular mechanisms by which these effects occur. This group of chemicals, which binds to aryl hydrocarbon (Ah) receptors causes deformities in young fish. The researchers are working with zebrafish, a nearly transparent fish that is easy to work with and has a well-known developmental pattern.

Zebrafish are providing a way of understanding dioxin's impact on fish development and revealing the molecular mechanisms of Ah receptor-mediated toxicity. Understanding the effects of dioxins on zebrafish will lead to a better understanding of dioxin-related environmental risks.

### Update

A comparison of the most sensitive signs of developmental toxicity in zebrafish and rainbow trout has been completed. Cardiovascular dysfunction was found to be the primary adverse effect of dioxin exposure on development in both species, a partial validation of the zebrafish model. A paper describing these results is in press. The zebrafish Ah receptor, the molecular-level mechanism by which these contaminants cause developmental toxicity, has been cloned and now is being characterized.

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## R/MW-76 Impact of Contaminants on Sexual Development and Reproduction of Amphibians in Great Lakes Ecosystems

William Karasov

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 specific relationships have yet to be determined.

This investigation is determining whether amphibian diversity and abundance in the Green Bay ecosystem is notably low compared with similar sites elsewhere in Wisconsin. It is testing 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 are also checking for abnormal sex organs in amphibians raised in these waters. Results of this work will be used to assess the extent to which 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 will also provide landscape ecologists with information necessary to evaluate the effectiveness of wetland restoration efforts.

## Update

Work has progressed on three of four project objectives. Histological and functional biomarkers are being developed in a positive control experiment in which frogs are exposed to estrogen (β-estradiol). These biomarkers were used to assess the sexual development of ten distinct clutches of "clean" leopard frog eggs raised until the onset of metamorphosis in enclosures at two contaminated and two uncontaminated sites in the Green Bay ecosystem. Egg clutches were collected from one contaminated and two "clean" sites to test the hypothesis that chronic exposure to contaminants results in eggs with low viability.

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# R/BT-11 Identification of the Endogenous Ligand for the Aryl Hydrocarbon Receptor

Richard Peterson and Margaret Clagett-Dame

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 (Ah) receptor, 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 Ah receptor signaling system. A major unknown is the existence of an endogenous ligand or ligands for the Ah receptor. Endogenous ligands are chemicals that occur naturally in animal tissue and activate the Ah receptor. If such an endogenous ligand is isolated and identified, it could provide greater insight into Ah receptor's normal biological functions.

In this project, researchers are identifying an animal tissue that is a rich source of the ligand, purifying it, and identifying its structure. Identifying the endogenous ligand for the Ah receptor 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 techniques for assessing the dangers posed by dioxin. Knowledge of the chemical structure of an endogenous Ah receptor ligand could ultimately aid in developing Ah receptor antagonists to counteract dioxin's toxic effects.

## Update

A preparative source of endogenous ligand activity has been identified, and significant progress has been made in the extraction and purification of this activity. Methanolic extracts of 20 mg of pig or rat lung tissue have been found to generate a 4- to 10-fold increase in activity above background in the assay. Reporter cell response to this activity was blocked in a dose-dependent fashion by 3'-methoxy-4'nitroflavone, an Ah receptor antagonist. Acid treament of the extract results in another 5- to 10-fold increase in reporter gene activity. The researchers are convinced that the activity they have isolated is not dioxin or a related congener because—unlike those compounds—it is not soluble in pure hexane and is not stable to base treatment or over time at room temperature. The endogenous ligand activity from pig lung has been successfully purified on a small scale, and scaling up this purification step is now in progress.

# Terrestrial-Aquatic Coupling: Managing for Ecological Stability

Intense biological, chemical, physical, and geological activity characterizes coastal regions of the Great Lakes, and these regions signficantly influence the overall character of the lakes. Understanding the complex dynamics of these areas is crucial for effectively managing Great Lakes resources. UW Sea Grant's project in this area is examining how human activity may be altering the dynamics of the food web—specifically, how the relationship between biological producers (algae) and consumers (bacteria) may be changing.

## Net Heterotrophy/Autotrophy in Coastal and Offshore Lake Michigan (R/EC-6)

Russell Cuhel, Great Lakes WATER Insitute, UW-Milwaukee
J. Val Klump, Great Lakes WATER Institute, UW-Milwaukee
Carmen Aguilar, Great Lakes WATER Institute, UW-Milwaukee

# R/EC-6 Net Heterotrophy/Autotrophy in Coastal and Offshore Lake Michigan

Russell Cuhel, J. Val Klump, and Carmen Aguilar

The near-shore zone of Lake Michigan supports vigorous recreational and commercial activities. Spawning and early recruitment of yellow perch into the fishery occur in the same shallow areas now favored by zebra mussels. Additionally, urban and agricultural runoff, eroded soils, and treated sewage affect water quality in this region. These influences alter nutrient cycling and productivity regimes, possibly changing relationships between producers (photoautotrophs) and decomposers (heterotrophs).

In such a biophysically complex environment, direct measurements may be highly variable among sites. The net outcome for growth of suspended and benthic algae ($CO_2$ use and $O_2$ production) vs. bacterial consumption of organic matter ($O_2$ use, $CO_2$ production) should be recorded in dissolved gas concentrations. This may provide an integrative picture of microbial activity and ecosystem response to terrestrial inputs and exotic species invasion.

In this project, scientists are directly measuring rates of algal and bacterial growth in conjunction with dissolved gas signatures in coastal and offshore waters, with an emphasis on the relative importance of benthic vs. water column production.

Assessment of changes between near-shore/offshore and benthic/pelagic production and consumption will contribute insight into causes of persistently poor fisheries recruitment and consequences of introductions of undesirable species.

## Update

In connection with an intensive study of the onset and influence of the 1997-98 El Niño event, primary productivity, bacterial heterotrophic activity, and full nutrient and hydrographic data from 14 cruises were analyzed. These data showed thermal stratification of the lake occurred nearly a month earlier than usual, accompanied by early spawning of lake perch (Wisconsin Department of Natural Resources). Physiological indicators showed a much-shortened spring algal bloom, resulting in lower total productivity for the season. Bacterial activity, controlled largely by temperature, showed little temporal deviation from normal years. While large variations in nutrients and productivity were observed in tributaries of the Milwaukee harbor, harbor-area waters were remarkably clear of biomass turbity, implicating early zebra mussel activity as a major factor in near-shore water quality.

# The Science, Technology, and Economics of Water and Sediment Remediation

Significant environmental degradation has been identified in 41 Great Lakes Areas of Concern. Cleaning up these areas, however, has been fraught with technological and economic difficulties. Scientists in this thematic area are continuing UW Sea Grant's long history of research on microcontaminants and water quality. They are determining how natural processes such as sedimentation and currents have changed the concentrations of PCBs in Green Bay sediments during the last 10 years, and they are developing commercially viable methods of extracting the contamination from sediments and breaking it down into harmless substances.

## Changes in Patterns of PCB Contamination in Surficial Green Bay Sediments over the Past Decade: Applications to Sediment Remediation (R/MW-78 )

David Armstrong, Water Chemistry Program, UW-Madison
David Edgington, Great Lakes WATER Institute, UW-Milwaukee

## Degradation of Organic Contaminants in Sediments via Subcritical Water Extraction and Photocatalytic Oxidation over Supported Nanoparticulate Metal Oxides (R/MW-79)

Marc Anderson, Water Chemistry Program, UW-Madison

# R/MW-78 Changes in Patterns of PCB Contamination in Surficial Green Bay Sediments over the Past Decade: Applications to Sediment Remediation

David Armstrong and David Edgington

Remediation of Green Bay has been limited by the high cost of treating or removing PCB-contaminated sediments. Evidence from Sea Grant-supported work in 1990-1993 indicated that PCB levels in surficial (upper 3 cm) sediments were declining. Thus, levels should have declined over the past decade.

This project is determining whether concentrations of PCB levels have in fact continued to decline during this time. The researchers are assessing the distribution of PCBs in the bay, quantifying the reductions in amounts and concentrations during the last decade, and quantifying various factors that determine PCB fates.

With these data, the researchers will estimate the time required to reach "acceptable" sediment PCB levels through natural remediation. They will also estimate the amount of PCBs delivered to Green Bay by the Fox River over the last 10 years. This information is needed to calibrate the sediment transport models used to predict PCB export from the Fox River and to assess the benefits of efforts to remediate PCB contaminated sediments in the Fox River.

## Update

Project work so far has focused on acquiring new sediment samples from Green Bay to assess the amount of PCBs transported to the bay via the Fox River during the last decade. Box-core samples have been collected from eight stations on the bay, each providing 15 PCB samples from known, precise sediment depths. Entire cores were sectioned for radionuclide analysis, producing about 500 sediment samples. These data will be used to establish the time of deposition at various sediment depths. The project is also supporting a study by a water chemistry graduate student of the use of supercritical fluid extraction to recover contaminants from sediments.

# R/MW-79 Degradation of Organic Contaminants in Sediments via Subcritical Water Extraction and Photocatalytic Oxidation over Supported Nanoparticulate Metal Oxides

Marc Anderson

Several techniques—including supercritical fluid extraction, near critical water extraction, and thermal desorption—have proven to be effective in extracting organic contaminants such as PCBs from sediments. Once extracted, subsequent oxidation of the toxic organic compounds can be accomplished by various advanced oxidation techniques including photocatalytic oxidation.

$TiO_2$-mediated photocatalytic oxidation has proven to be highly effective in oxidizing most toxic organic compounds but has several limitations that are preventing widespread commercial use for water treatment. Foremost of these is the difficulty in illuminating a large amount of the catalyst surface that is in contact with the contaminant to be degraded. Most aqueous photocatalytic studies have employed slurries of extremely fine $TiO_2$ powder. The small particle size of the photocatalyst requires centrifugation or microfiltration to separate the catalyst from the treated liquid. Attempts to immobilize the catalyst on a support or to use pelletized catalysts in a fixed-bed reactor have met with limited success as a result of the inefficient use of the incident UV radiation. Often, the UV radiation is completely absorbed near the tube wall, resulting in bulk mass transfer limits from the interior of the reactor to the outer illuminated zone.

In this study, researchers postulate that a thin film of the catalyst material supported on UV transparent silica particles will improve reaction rates by increasing light penetration depth in the fixed-bed reactor, resulting in a greater effective surface area of the catalyst for reaction. Successful development of a light-efficient fixed-bed photocatalytic reactor system would be a major step toward commercial application of this promising technology.

## Update

A continuous-flow, packed-bed photocatalytic reactor system capable of achieving temperatures of 125°C and pressures of 50 atmospheres has been constructed and evaluated for the degradation of acetic acid and 2-chlorobiphenyl using a particulate $TiO_2$ catalyst. These studies establish baseline kinetic data for comparing future studies employing supported $TiO_2$ catalysts. Also, various support materials have been characterized by BET analysis for surface area and pore size distribution, and they are currently being used in UV light penetration studies. $TiO_2$ thin-film coating procedures and thickness characterization protocols are being developed as well.

# Safety at Sea

As recreational scuba diving continues to increase in popularity, the associated risks become more evident. Researchers in this area are developing methods of minimizing the frequency and severity of panic episodes and decompression sickness (also called the "bends") to help reduce diving injuries and fatalities.

## Diver Health and Safety: Minimizing Decompression Risk (R/NI-27)

Rudolf Tass Dueland, Veterinary Medicine, UW-Madison

## Prediction and Prevention of Stress Responses in Recreational Scuba Divers (R/NI-29)

William P. Morgan, UW-Madison

# R/NI-27 Diver Health and Safety: Minimizing Decompression Risk

Rudolf Tass Dueland

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 are evaluating 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 researchers are evaluating the use of delayed recompression treatment in preventing DON, continuing to investigate DON prevalence in Maine scallop divers, and assessing 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.

## Update

Using the UW sheep model, a series of experiments has been conducted to simulate the repetitive short deep dives and long shallow dives commonly practiced by recreational divers. Clinical manifestations of decompression sickness (DCS) and evaluation of underlying tissue injury via bone scans, magnetic resonance imaging and histology, especially in the sheep's bones and brains, will complete the project's assessment of the risks of these diving practices.

The U.S. Navy is funding an orthopedic surgeon to assist in this work. The monitoring of the dive profiles of Maine scallop divers, interrupted last season by inclement weather, resumed in November 1998. Two papers on the significant risk of dysbaric osteonecrosis (DON) in current scallop harvesting practices were presented in June. New research will evaluate delayed recompression treatment of "pain only" limb bends for preventing DON and the therapeutic efficacy of normobaric oxygen as first aid for DCS.

UW Hospitals & Clinics donated a replacement gamma camera for detecting DON in sheep. Presentations on this project's findings have been made to the U.S.-Japan Natural Resources Panel on Diving, Canadian military medical officers, and the Italian Undersea and Hyperbaric Medical Society. A member of the research team (Dr. Charles Lehner) has been invited by the Chinese Underwater Technology Center to participate in its DON research.

## R/NI-29 Prediction and Prevention of Stress Responses in Recreational Scuba Divers

William P. Morgan

The most common cause of death while scuba diving appears to be panic responses to stressful situations. Diving safety, therefore, can be significantly enhanced with a better understanding of the psychological and environmental conditions that precipitate panic and with proven methods of mitigating or avoiding panic episodes. This project will develop methods of quantifying stress responses in experienced scuba divers under controlled laboratory conditions and in natural environments. It will assess the usefulness of new technology for these studies, including hardware and software for measuring reaction and movement time, and recording systems for monitoring core body temperature. The project will also evaluate the effectiveness of several psychological interventions designed to reduce stress responses in experienced, recreational scuba divers. The knowledge gained from this work is expected to make diving safer for the millions of recreational scuba divers around the world, and possibly for military and industrial divers as well.

### Update

This project began in March 1999.

# Application of Innovative Technology to Aquatic Environments

Cutting-edge technologies like biotechnology, computer science, and synthesis of new materials suggest a host of new applications in many fields. Sea Grant is exploring these exciting research areas and encouraging scientists to apply them to aquatic environments. The range of explorations includes the following:

- Developing new biotechnology for detecting disease in trout and salmon
- Integrating diverse data about coastal zones to predict and manage erosion of coastal bluffs and its effects on water quality and to monitor better and understand nonpoint source pollution, shoreline land use, and other coastal processes.
- Developing dietary supplements from fish oils that may reduce risk of cancer, heart disease, and hypertension.
- Constructing economic models of recreational fishing patterns that will help managers evaluate policy options.
- Using innovative World Wide Web technology to present information on Lake Michigan's shipwrecks to a wide audience.

## Assessing the Risk of Whirling Disease Becoming Established in the Great Lakes: Field and Laboratory Evaluation of a Novel Polymerase Chain Reaction Diagnostic Assay (R/LR-80)

Daniel Sutherland, Biology & Microbiology, UW-La Crosse

## Interseasonal Comparisons of Static and Dynamic Economic Models of Recreational Salmonid Fishing on Lake Michigan (R/PS-52)

Bill Provencher, Agricultural & Applied Economics, UW-Madison
Richard Bishop, Agricultural & Applied Economics, UW-Madison

## Erosion Information System in Support of Coastal Zone Management and Science (R/NI-28)

Frank Scarpace, Civil & Environmental Engineering, UW-Madison
Alan Vonderohe, Civil & Environmental Engineering, UW-Madison

## Applications of Geographic Information Systems (GIS) to Coastal Zone Management: Building Local Capacity (A/AS-40)

Stephen Ventura, Land & Information Computer Graphics, UW-Madison

## Sailing through Death's Door: Multi-Media Site Guides to Wisconsin's Lake Michigan Shipwrecks (C/C-3)

Jefferson J. Gray, State Historical Society of Wisconsin
Stephen Wittman, Sea Grant Institute, UW-Madison

## Use of Fish Oils for the Production of Nutraceuticals Containing Omega-3 and Conjugated Linoleic Acid Residues (R/AQ-34-PD)

Charles G. Hill, Jr., Chemical Engineering, UW-Madison

# R/LR-80 Assessing the Risk of Whirling Disease Becoming Established in the Great Lakes: Field and Laboratory Evaluation of a Novel Polymerase Chain Reaction Diagnostic Assay

Daniel Sutherland

Whirling disease (WD) was once considered to be a problem only in fish hatcheries, but it has become a serious problem throughout populations of rainbow trout and cutthroat trout in the inter-mountain West, and 23 states are now known to have had fish infected with the parasite. Wisconsin waters are not yet infected, although WD recently has been detected in fish from the Au Sable and Manistee rivers in lower Michigan. Introduction of WD in Wisconsin and Minnesota would place at risk a multibillion-dollar annual Great Lakes sport fishery and a multimillion-dollar annual inland trout fishing industry. However, little is known about the potential for establishment of WD in Wisconsin.

Most information on WD deals with riverine environments. Virtually nothing is known about how *Myxobolus cerebralis* (Mc), the nonindigenous parasite that causes the disease, affects lake and reservoir salmonids. Likewise, the alternate host portion of the Mc life cycle in oligochaetes (the aquatic equivalent of earthworms) is poorly understood.

Researchers are evaluating the use of a new polymerase chain reaction assay for detecting the presence of Mc in salmon and trout from Wisconsin. They are sampling tributaries of Lakes Michigan and Superior for *Tubifex tubifex,* the only known oligochaete alternate host for Mc. They will also establish experimental infections of oligochaete alternate hosts.

This work will improve the capability of fish health specialists to diagnose fish for WD and will provide knowledge about the possible outcomes of WD becoming established in Wisconsin.

## Update

The first field season of this study focused on surveying salmonids from Lakes Michigan and Superior and their tributaries for the presence of *Myxobolus cerebralis*, the etiologic agent of whirling disease. Heads from 299 salmonids have been halved for examination, one half by the novel PCR assay and the other by standard diagnostic techniques. Sediment samples from the sites where the fish were caught have been screened for the oligochaetes *Tubifex tubifex*, the only known intermediate host for *M. cerebralis*. *T. tubifex* has been found in samples from Michigan's Au Sable and Manistee rivers and Spring Coulee Creek and will certainly be found in other locations as well. Fish from Wisconsin waters continue to test negative for *M. cerebralis*. Screening and identification of all oligochaetes is not yet complete.

## R/PS-52 Interseasonal Comparisons of Static and Dynamic Economic Models of Recreational Salmonid Fishing on Lake Michigan

Bill Provencher and Richard Bishop

It is not 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 non-market resources and experiences.

In this study, researchers will gather data from Lake Michigan salmon and trout anglers for the 1999 fishing season. This information, combined with data from other years and sources, will help researchers build an economic model of angler activity in the area. This model will help fisheries managers understand the activity of recreational anglers, enhancing their ability to analyze the economic impact of various policy options for managing the Lake Michigan fishery to achieve maximum economic returns.

### Update

To examine whether a simple static model is sufficient to capture the essential features of fishing trip decisions, a static model and a dynamic model for Lake Michigan salmon fishing trips were developed with data gathered in 1996. Empirical evidence strongly supports the hypothesis that a static Markov model is a better representation of angler behavior than a complex dynamic model. Empirical evidence from several approaches to capturing the heterogeneity of angler preferences—including one new to the literature on economies of recreational behavior—also suggests that recognizing this heterogeneity in angler preferences and motives greatly improves the quality of the model. Two journal articles based on this work are being prepared.

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## R/NI-28 Erosion Information System in Support of Coastal Zone Management and Science

Frank Scarpace and Alan Vonderohe

Erosion and recession of coastal bluffs present tremendous problems in the management of developed coastline for property owners, zoning boards, and the insurance and banking industries. Coastal bluff erosion also affects water quality and sedimentation rates. Recent technological developments in geospatial information collection, processing, and presentation offer an unprecedented opportunity to update outdated tools for predicting natural coastal hazards and calculating inputs to models of water quality and sedimentation rates.

Researchers are working with the U.S. Army Corps of Engineers to develop effective, state-of-the-art technology that can be used to estimate and periodically re-estimate recent and long-term rates of coastal bluff recession with a minimum amount of uncertainty and error. They are also developing a prototype geographic information system (GIS) application and associated databases for analyzing recession rates of coastal bluffs.

This system will provide information and guidance to coastal planners and managers, coastal engineers, developers, homeowners, environmental scientists, contractors, and primary and secondary investors in coastal property and their agents.

## Update

Project work did not begin until summer 1998 due to a delay in project support funding from the U.S. Army Corps of Engineers. Meanwhile, the Wisconsin Department of Transportation agreed to a joint experiment using state-of-the-art global positioning system (GPS) technology. Using low-altitude GPS-controlled photography, X-Y-Z coordinates for 30 control points along a two-mile stretch of Lake Michigan coast were measured to millimeter precision. Preliminary results of the data analysis are very promising. Two frames of the panchromatic and color infrared imagery have been digitized so far, and digital elevation maps for a short segment of the coast have been produced.

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## A/AS-40 Applications of Geographical Information Systems (GIS) to Coastal Zone Management: Building Local Capacity

Stephen Ventura

Coastal communities and governmental agencies confront a host of problems unique to their geographical setting. Erosion from flooding and wave action often threaten the very land on which they exist. Urban and rural runoff and industrial and municipal discharges frequently degrade their water quality. These issues are of significant environmental and economic concern to coastal communities throughout Wisconsin and many other parts of the nation.

The emerging technologies known as geographical information systems (GIS) offer the possibility of monitoring and understanding these processes with unprecedented detail. This project is extending previous UW Sea Grant research into GIS applications to coastal management. It is developing models to enhance understanding and management of nonpoint source pollution, shoreline land use, shoreline recession, and floodplain mapping. Researchers are consulting with local governmental staff and domain experts to learn their needs. These collaborators will evaluate product prototypes, with local staff looking at ease of use and technical experts looking at accuracy and value of information.

The researchers will train local governmental officials and staff to use GIS and will evaluate and improve upon existing user interfaces based on feedback from these groups. The tools that result will provide more objective local planning, management, and regulatory decisions.

## Update

Project staff have worked closely with state and local government officials on the application of GIS to coastal management issues. These GIS applications can be thought of as illustrative "teaching models" that use local government databases to demonstrate how GIS can be applied to specific coastal issues.

The initial model applied GIS to shoreland management for an inland lake in northern Wisconsin. The next two models addressed coastal hazards issues on Lake Michigan—one in northern Sheboygan County and the other in southern Ozaukee County. In addition, project staff have assisted county officials with development of an agricultural riparian buffer application to reduce nonpoint source pollution of the Pigeon River, a Lake Michigan tributary.

Several coastal GIS demonstrations and training courses have been conducted, including a 16-hour introductory course attended by 11 people, three half-day coastal hazards courses attended by 20 people, and a day-long combination shoreland and coastal management course attended by seven. Both the shoreland management and coastal erosion courses were put on-line as part of the project's World Wide Web site (*www.lic.wisc.edu/coastgis/coastgis.htm*), and the training instructions and data sets have had over 150 "hits" so far this year.

Assistance was provided to officials from several coastal counties and municipalities, as well as to UW Sea Grant staff on using GIS for monitoring zebra mussel diffusion and visualizing Lake Michigan bathymetric data. Several presentations on coastal GIS research have been made at state and national workshops and conferences.

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## C/C-3 Sailing through Death's Door: Multi-Media Site Guides to Wisconsin's Lake Michigan Shipwrecks

Jefferson J. Gray and Stephen Wittman

People find shipwrecks fascinating. The Great Lakes hold about 5,000 well-preserved wrecks, and shipwreck preserves established in Michigan waters of the Great Lakes attract thousands of recreational scuba divers annually, bringing hundreds of thousands of dollars to the economies of adjacent coastal communities.

This project is developing a series of guides to Wisconsin's Lake Michigan shipwrecks. It will complement similar guides to Wisconsin's Lake Superior shipwrecks developed by project personnel, the online version of which is already averaging more than 100 visitors per day.

The project is making results from research on Wisconsin's Great Lakes shipwrecks more readily available to archeologists, recreational divers, educators, students, and the public in interesting, easy-to-use formats. Its goal is to foster improved stewardship and protection of Wisconsin's submerged cultural resources. It is hoped the project will help boost the economies of Lake Michigan coastal communities and benefit recreational divers, students, maritime museums, and others interested in Great Lakes historical maritime resources.

## Update

Reviews of dive guides and World Wide Web pages recently produced in a related project on Apostle Islands shipwrecks have been conducted with various user groups to obtain suggestions for improving the current project. The Great Lakes Association of Water Safety is working with project staff to evaluate and perhaps improve the cautionary information for divers used on the Lake Superior site guides. Text, videotape, still photos, maps, and illustrations for four Lake Michigan shipwrecks are currently being assembled, and new images of the wrecks are being obtained.

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# R/AQ-34 Use of Fish Oils for the Production of Nutraceuticals Containing Omega-3 and Conjugated Linoleic Acid Residues

Charles G. Hill, Jr.

Foods that incorporate both nutritional and other health benefits (e. g., preventive medicinal effects) are referred to as nutraceuticals. Ingestion of these foods may lead to reduced incidence of diseases, such as cancer and coronary heart disease. The health benefits of consuming omega-3 fatty acids and conjugated linoleic acids (CLA) are substantiated by an increasing body of scientific evidence. Combination of these substances in the same nutraceutical gives a value-added product with intriguing market potential for manufacturers of fish oils.

The researchers are investigating the technical feasibility of employing fish oil and corn oil as raw materials for production of acylglycerides (oils) enriched in residues of both omega-3 fatty acids and CLA. Rate expressions will be determined for both the (immobilized) enzyme-catalyzed reactions and the bioconversion (fermentation) step that are used in the process proposed for production of the indicated nutraceutical.

The resulting nutraceutical oils will have significant dietary implications for individuals who are high-risk candidates for cancer or cardiovascular or hypertensive problems. These oils may be incorporated into food products as bland oils or as powders in which the oil is encapsulated so that it disperses readily in the aqueous component of a variety of foods.

## Update

This project began in March 1999.

# General Outreach & Education Projects

Through its outreach and education projects, UW Sea Grant links the scientist's laboratory to the world at large. These projects ensure that research results reach the general public, policy analysts, resource managers, municipal officials, educators, and others. Eight Advisory Services specialists assist the public in areas from aquaculture to water safety. Communications staff research, write, and produce supporting materials across the range of UW Sea Grant's efforts. Earthwatch Radio, in collaboration with the Institute for Environmental Studies at UW-Madison, produces 260 programs each year on environmental issues, science, technology, and policy.

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

Allen H. Miller, Sea Grant Institute, UW-Madison

## Communications Office and Subprogram Coordination (C/C-1)

Stephen Wittman, Sea Grant Institute, UW-Madison

## Earthwatch Public Radio Program (C/C-2)

Richard Hoops, Sea Grant Institute, UW-Madison

## Special Marine Education Programs (E/E-1)

Mary Lou Reeb, Sea Grant Institute, UW-Madison

# A/AS-1 Advisory Services: Program Coordination and Field Offices

Allen H. Miller

UW Sea Grant Advisory Services specialists serve as a bridge between Great Lakes researchers and resource users. Eight specialists assist private and public organizations and individuals 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-Manitowoc. See below for descriptions of each specialist's area.

In addition to offering technical and hands-on support, Advisory Services specialists assist in many of the projects associated with UW Sea Grant's 1998-2000 research themes, including the Lake Superior Initiative, Nonindigenous Species, Aquaculture for the Great Lakes Region, Terrestrial-Aquatic Coupling, Safety at Sea, and Application of Innovative Technology. Advisory Services also offers summer courses for teachers and programs for the public.

## Aquaculture

Aquaculture is an emerging industry of growing importance to Wisconsin, the United States, and the world. More than 330 Wisconsin fish farmers raise fish for food products, stocking, bait, and for-fee fishing. With an estimated value of $10.5 million in 1997, the Wisconsin aquaculture industry is growing at an annual rate of about 12 percent, far ahead of the 4.2 percent growth rate of the poultry industry, the next fastest growing food industry.

On-site aquaculture services have been provided continually by UW Sea Grant Advisory Services to more than 100 Wisconsin businesses since the aquaculture program began in 1987. Hands-on workshops provide fish farmers with training and practical experience under the watchful eyes of skilled specialists, while regional workshops offer the industry specific technical information on individual fish species and methods. A recent effort, added in 1994-96, produces financial models of yellow perch production. The models compare three different rearing strategies: outdoor ponds, flow-through tanks and raceways, and more complex recirculating systems. Each financial analysis includes comparable projections of expected revenues and fixed and variable costs.

## Update

During 1998, initial set-up of a recirculating aquaculture system (RAS) was completed in both the WATER Institute and the Red Lake Indian Reservation, Minnesota. Several hands-on workshops were presented to state-wide audiences on RAS aquaculture for yellow perch. Other workshops addressed technical and economic issues of yellow perch stocking in Lake Michigan. Technical information, resource guides, and bibliographies were provided in response to more than 200 requests.

## Business

People in coastal communities of Wisconsin and other Great Lakes states are concerned about their local economies. Small businesses lack the resources and expertise to conduct financial studies to benefit their companies. In the past, the economic dimensions and annual changes of marine-related businesses located along the Lake Superior shoreline have not been well documented.

Concern for the Lake Superior coastal economy led UW Sea Grant Advisory Services to initiate systematic collection and analysis of annual business activity for 106 separate economic entities in 11 business sectors. The data have been very useful to businesses for evaluating trends and helping community officials plan further development. Yellow perch aquaculture is being fostered with an analysis of the economic parameters of yellow perch recirculating aquaculture systems (RAS).

One industry, commercial fishing, is changing rapidly. To assist in the transition, monthly catch records have been collected and analyzed since 1988 to document changes to the fishery and assist the 11 licensed fishers in planning harvesting strategies.

### Update

Monthly catch records for 1997 were analyzed for commercial fishermen on Lake Superior. Catch rates and effort were found to be stable during 1997. Monthly financial data from six yellow perch producers in Wisconsin, Michigan, and Minnesota are being collected for the yellow perch RAS project. An increasing number of inquiries from around the country concerning financial aspects of yellow perch RAS were answered. Workshops, presentations, and training sessions were offered on Great Lakes-related business development, sustainability, the economics of RAS for yellow perch aquaculture, and marketing strategies for lake herring and siscowet from Lake Superior.

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## Coastal Engineering

High and low water levels, storm waves, erosion and flooding are primary concerns for users of the Great Lakes and people who live or work along their shores. Contaminated sediment deposits lie in many harbors, rivers, and estuaries, damaging these ecosystems. The coastal engineering specialist provides technical knowledge on these issues and advises individuals, businesses, and agencies coping with these hazards.

### Update

The 1987 *Coastal Processes Manual* was revised. The second edition includes worksheets, graphics, tables, a glossary, and sources of more information. A mechanical dredging model has been incorporated into REMSIM, a remediation simulation software package. REMSIM helps policy makers develop an economic analysis of costs and benefits of sediment remediation. Web pages (*www.seagrant.wisc.edu/advisory/coastal_engr/*) were created to provide information on storm surges, flooding, and wave run-up as well as updates to the *Coastal Processes Manual*. Technical assistance and consultations on natural coastal hazards were presented to local authorities, policymakers, engineers, investors, and others.

## Fisheries

The Great Lakes fishery is constantly changing. Management of this dynamic fishery — often in the midst of competing demands — requires the very best tools and technology available. However, many fishery scientists have limited training in computer use and have difficulty keeping pace with developments related to the use of computer techniques in fishery management.

The Advisory Services fisheries specialist has developed a "user-friendly" biological model that provides fishery managers with population assessments and projections based on survey and catch data. This software is used for establishing quotas of yellow perch in Green Bay. It is based on a computer population assessment model developed by University of British Columbia fishery biologist Carl Walters.

In 1998–2000, Advisory Services continues to offer workshops on analytical techniques to fishery professionals throughout the country.

The fisheries specialist also provides the public, industry, and agency personnel with instruction, applied research, practical demonstration, field-testing, and consultation on fisheries problems and issues related to the Great Lakes.

## Update

The population model of yellow perch in Green Bay, used by the Wisconsin Department of Natural Resources to establish catch quotas, was revised based on data from the past year. A series of workshops on stocking yellow perch in Lake Michigan was conducted for 16 participants from academic, agency, sport, and commercial fishing groups.

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## Geographic Information Systems

Geographic information systems (GIS) bring together computer hardware and software, data, people, and organizations to collect, store, analyze, and disseminate information about areas of Earth. Examples of geospatial data commonly used in coastal management include measurements of and information about shoreline locations, regulatory zones on both the land and water sides of the shoreline, land ownership, bathymetry, coastal geomorphology, infrastructure, and habitat area. Geographic information systems provide the means to manage, integrate, and analyze these data, providing powerful information for solving complex planning and management problems. In cooperation with the Land Information and Computer Graphics Facility at UW-Madison, UW Sea Grant Advisory Services is teaching local government staff and officials to apply GIS and related spatial technologies to the sustainable management of Great Lakes coastal regions. A national Sea Grant GIS Web site (*www.lic.wisc.edu/coastgis/coastgis.htm*) helps disseminate information among Sea Grant researchers and specialists.

## Update

Two training sessions, "Introduction to Coastal GIS Applications" and "GIS for Coastal Erosion," were conducted for local government officials from coastal municipalities, counties, and agencies. The Ozaukee County Coastal Hazards GIS Project was demonstrated to the members of the Wisconsin Coastal Management Program. As part of a Corps of Engineers' project to assess potential damage from shore erosion, digital parcel mapping was integrated for the Lake Michigan counties and cities. Data continued to be acquired and integrated to enhance capabilities of GIS in coastal hazards damage assessment. Compact disks containing digital raster graphs for the Lake Michigan and Lake Superior coasts in Wisconsin and digital orthophotos for coastal sections of four counties were pressed and distributed. Another CD was created that demonstrates the application of GIS technology in managing coastal hazards and guiding future development on the shores of the Great Lakes. This disk includes a variety of existing GIS data sets compiled by county, regional, state, and federal agencies.

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## Marine Education

Advisory Services Specialists provide in-service training for K-12 teachers through courses and workshops on Great Lakes and ocean topics. Many of these programs are offered in cooperation with other organizations, including the Wisconsin Lake Schooner Education Association, the Schlitz Audubon Center, the Wisconsin Association for Environmental Education, and Project JASON. In a cooperative venture with the Wisconsin Department of Natural Resources (WDNR), Advisory Services staff also provide information about the Great Lakes to visitors in seven northeast Wisconsin state parks and forests.

## Update

UW Sea Grant's Education Specialist trained 220 teachers from across the U.S. on aquatic systems and biodiversity as part of Project JASON X (see p. 55). The teachers returned to their respective states to teach these curriculum activities to their own JASON teachers. Instruction in Lake Michigan's physical characteristics and aquatic life was presented to K-12 teachers as part of a week-long course called "Field Learning on Lake Michigan," conducted with the Wisconsin Lake Schooner Education Association. Wisconsin Sea Grant also cooperated with the Illinois-Indiana Sea Grant program in conducting a day-long "Exotic Species Day Camp" for educators at the John G. Shedd Aquarium in Chicago.

Advisory Services formed an educational partnership with the WDNR and the naturalists in five state parks, a state forest, and a field research station in northeast Wisconsin. UW Sea Grant instructed the naturalists with the latest scientifically-grounded information on

shoreline erosion, water quality, global climate change (especially atmospheric ozone depletion and UV light), fish of Lake Michigan and Green Bay, yellow perch, and invasive species.

In turn, naturalists incorporated this information into their visitor programs and developed an innovative technique of delivering information: while walking through the parks, they played the roles of early Door County settlers and commercial fishermen, discussing the changes they have "witnessed" during their many years in the parks.

The partnership also allowed park naturalists to purchase new educational tools and to increase the hours they were available during the tourist season. The partnership increased the delivery of Great Lakes information in the state parks in Door and Kewaunee Counties more than tenfold.

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## Non-Indigenous Species

Over the last 10 years, UW Sea Grant Advisory Services staff have monitored Great Lakes harbors and municipal and industrial water intakes, trained technical staff to collect and analyze samples, conducted an aggressive public education program, and assisted the Wisconsin Department of Natural Resources in the development of an inland waters monitoring program. All of this work has been targeted at *Dreissena polymorpha*—otherwise known as the zebra mussel. To extend educational efforts to reach industry and the general public in the upper Mississippi and Missouri river basins, Advisory Services is now focusing its efforts on disseminating the knowledge gained in the Great Lakes by developing a national peer-reviewed web site (*www.ansc.purdue.edu/sgnis/*) of research and outreach products from Sea Grant and other organizations called the Sea Grant Nonindigenous Species Site (SGNIS)

SGNIS is a project of the National Sea Grant College Program and is produced by the Illinois-Indiana, Michigan, and Wisconsin Sea Grant programs. It is a national information center that contains a comprehensive collection of research publications, education materials, and graphics produced by Sea Grant programs, other research institutions, and federal agencies on zebra mussels and other aquatic nuisance species. All materials available through the site have either appeared in professional science journals or have been through a rigorous scientific review to ensure the quality of the information provided. Links are provided to other sites that also focus on nonindigenous species.

## Update

Information on zebra mussels and other exotic species was presented to various state and local officials and educators. Work continued on the SGNIS Web site (*www.ansc.purdue.edu/sgnis*).

## Water Quality

The water quality specialist provides the public, industry, and agency personnel with instruction, applied research, practical demonstrations, field-testing, and consultation on water quality problems and issues related to the Great Lakes. The specialist assists in identifying water quality problems and researches, develops, and demonstrates practical solutions derived from university research. This project seeks to involve the public actively in educational efforts. A program of trained volunteers, Great Lakes Stewards, will be used to teach the public about water quality issues.

### Update

The specialist developed a plan for applying new technologies of landowner-based water resource protection and facilitated a citizens' Water Action Volunteer Program that involves community members in monitoring water quality in the Pigeon River. This included summarizing volunteers' data, presenting that data at a volunteer appreciation session, and integrating digital photographs of the monitoring sites as hot-links into an ArcView watershed project. The specialist also provided presentations, seminars, technical advice, and information to officials, educators, students, and others.

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## Water Safety

Water-based recreation, especially boating, is a very popular activity in Wisconsin—the state ranks sixth in the nation in the number of registered boats. Unfortunately, many boaters lack the experience needed to deal with the rapidly changing, potentially dangerous weather and sea conditions that can occur on the Great Lakes. In addition, the growing interest in owning and operating personal watercraft has led to an increased demand for education about the safe operation of these watercraft. To meet these needs, Advisory Services Specialists cooperate with the U.S. Coast Guard Auxiliary, the WDNR, community recreation departments, yacht clubs, and other interested organizations to conduct approved courses in boating safety. In addition, one- to two-hour programs on topics such as weather, rules of the road, and hypothermia and cold water safety are presented to law enforcement officials, fishing clubs, boat clubs, and other organizations.

### Update

Three boating safety classes were conducted in Superior for WDNR boater certification. Two others, designed specifically for young people, were presented in Milwaukee in cooperation with the WDNR, the U.S. Coast Guard Auxiliary, and the recreation departments of Wauwatosa and Greenfield-Greendale. A program on hypothermia and cold water safety was presented as part of an annual training and preparation program of the Milwaukee Police Department's Water Patrol Squad. Programs on marine weather were conducted at a monthly meeting of Salmon Unlimited-Racine and at a readiness training weekend for operations personnel of the Coast Guard Auxiliary. A ten-week Boating Skills and Seamanship course is being conducted in cooperation with the U.S. Coast Guard Auxiliary and the South Milwaukee Yacht Club.

## C/C-1 Communications Office and Subprogram Coordination

Stephen Wittman

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 editor, radio producer, science writer, two half-time student writers, and a part-time art director.

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 publications for technical, educational, and general audiences.

In addition to providing professional communications support to the UW Sea Grant program, Communications Office staff are directly involved in various projects associated with UW Sea Grant's 1998-2000 research theme areas, including the Lake Superior Initiative, the Yellow Perch Initiative, and Application of Innovative Technology.

### Update

Highlights for 1998 include producing of a coastal processes manual written by UW Sea Grant's coastal engineer, updating and reprinting a historic district walking tour guide in cooperation with a Lake Superior coastal community, and publishing Sea Grant's Guide to Marine Biotechnology on behalf of the National Sea Grant Office. Other activities included redesigning and expanding UW Sea Grant's "Fish of the Great Lakes" and "Earthwatch" Web sites and developing fact sheets dealing with the Lake Michigan yellow perch fishery, PCB contamination of Green Bay, and endocrine disrupters. Six news releases and five newsletters were also produced, and more than 9,000 Sea Grant publications distributed. Related activities included production of "Earthwatch Radio" (C/C-2) and the creation of seven plastic dive guides to Lake Superior shipwrecks (A/AS-38).

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## C/C-2 Earthwatch Public Service Radio Program

Richard Hoops

"Earthwatch" uses the wide-reaching medium of radio to give the public concise, objective, and timely information about science and the environment, especially in regard to the nation's Great Lakes and 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.

UW Sea Grant and the UW-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.

**Update** The Earthwatch principal investigator, Sea Grant science writer, and two student writers produced 130 two-minute radio programs during 1998. In addition, Earthwatch began publishing scripts and streaming audio recordings of the programs on the World Wide Web, and the Earthwatch principal investigator spoke at the December meeting of the American Geophysical Union on the use of radio to disseminate information on ocean science.

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## E/E-1 Special Marine Education Programs

Mary Lou Reeb

In the belief that education and research are inseparable, UW Sea Grant invests in assistantships that support students working on many Sea Grant projects. The 1998-2000 program supports 22 graduate and 39 undergraduate students.

This project also coordinates program-wide activities and community partnerships such as the Madison JASON Project (an annual high-tech international science education program adapted for Madison-area teachers and middle-school students). Special Marine Education Programs provide students with opportunities to go to sea, work at coastal research stations, and attend scientific meetings.

The Communications and Advisory Services subprograms also conduct a substantial amount of K-12 and public education activities. These include producing publications, videos, and other electronic media, enhancements to teacher training, workshops, conferences for out-of-school adults, and a series of radio programs (see Advisory Services, Communications Office, and Earthwatch Radio, above).

## Update

This project partially funded a seminar series on recent advances in limnology and oceanography (see "Recent Advances" below). The Sea Grant database was updated to include current information on all Wisconsin Sea Grant students (more than 400) supported over the last 30 years. In-kind support was provided for the "Madison JASON Project" (3,000 local area students and 60 teachers) and its Web site, including participation in the International "Year of the Ocean" (YOTO) by featuring Great Lakes fish on the "Madison JASON IX" Web site. (The site attracted more than 105,000 visitors in March 1998 alone.) An educational Great Lakes Fish poster was created and distributed to 500 elementary and secondary schools in the state and to 300 community centers serving predominantly minority families. Also, 15,000 postcards based on this poster were produced and distributed to the Madison-area community. The national Council for Advancement and Support of Education (CASE) awarded the "Madison JASON IX" Web site a gold medal in 1998, and the University & College Designers Association (UCDA) awarded the site its 1998 Award of Excellence.

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## E/E -31-SE Recent Advances in Limnology and Oceanography

Arthur Brooks

Each year since 1973, UW-Milwaukee's Center for Great Lakes Studies, with Sea Grant support, has invited a series of distinguished researchers to speak on topics in aquatic sciences, including aquaculture, global climate change, and the effects of non-indigenous species invasions. The series is the core of a graduate seminar course and enables Wisconsin faculty, students, and local professionals to exchange information with experts from other leading research institutions. It also provides a forum for public discussion of emerging Great Lakes and ocean issues.

The topics planned for the next three years of the seminar will be wide ranging, yet linked in many ways. The first year's seminars examined the role that the Great Lakes have played in the settlement and economic development of the region, the use and misuse of the natural resources, and means of restoring and rehabilitating the ecosystem. The seminars drew on the expertise of historians, economists, resource managers, and restoration ecologists.

The second (current) year is addressing the role of predation and competition in structuring the food web of the Great Lakes. Year three will feature topics on the application of models in Great Lakes research and management, the use of stable isotopes in freshwater research, or other timely topics that may arise at the turn of the millennium. The 1999 series, which began in February, is held Thursday evenings at the Center for Great Lakes Studies in the UW Great Lakes WATER Institute, 600 East Greenfield Avenue, Milwaukee.

## Update

Approximately 30 people attended each of four seminars in 1998: "Ecosystem impacts of benthic grazing in a turbid system: The Hudson River" (Nina Caraco); "Ecology, physiology and character variation in an invertebrate predator: *Bythotrephes* in the Great Lakes" (John Lehman); "Biogeochemistry of the ribosome: Biological stoichiometry in ecosystems" (James Elser); and "Effects of fisheries and exotic species on the endemic fishes of Lake Victoria, East Africa" (Daniel Schindler).

Seminars in 1999 are titled: "The way it was: Pre-settlement conditions in southeastern Wisconsin and the Lake Michigan basin" (Robert Jeske); "The restoration of coastal wetlands: Surprising outcomes and their explanations" (Joy Zedler); "Mercury contamination of the Florida Everglades: What happens when wetlands and people meet?" (David Krabbenhoft); "Impact of urbanization on stream quality: Is restoration possible in developed wetlands?" (Li Wang); "The Colorado River flood: An experiment in restoration" (Richard Marzolf); and "Lake trout restoration in Lake Superior" (Michael Hansen).

## Update

Approximately 30 people attended each of four seminars in 1998: "Ecosystem impacts of benthic grazing in a turbid system: The Hudson River" (Nina Caraco); "Ecology, physiology and character variation in an invertebrate predator: *Bythotrephes* in the Great Lakes" (John Lehman); "Biogeochemistry of the ribosome: Biological stoichiometry in ecosystems" (James Elser); and "Effects of fisheries and exotic species on the endemic fishes of Lake Victoria, East Africa" (Daniel Schindler).

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# Related Projects

Projects listed here are integral to UW Sea Grant's objectives but receive funding from outside agencies or special competitions of the National Sea Grant College Program. They are conducted by Sea Grant staff and comprise outreach and educational projects on global change, coastal hazards, policy studies, limnology, and oceanography.

## Workshops on Natural Coastal Hazards to Development, Wisconsin Coastal Management Program

Philip Keillor, Sea Grant Institute, UW-Madison

## Operation Pathfinder: A National Pre-college Teachers' Partnership for Sustainable Ocean and Coastal Environments

James Lubner, Great Lakes WATER Institute, UW-Milwaukee
Allen H. Miller, Sea Grant Institute, UW-Madison

## The Dean John A. Knauss Marine Policy Fellowship Program

Mary Lou Reeb, Sea Grant Institute, UW-Madison

## Global Change Environmental Education Initiative

Allen H. Miller, Sea Grant Institute, UW-Madison

## Workshops on Natural Coastal Hazards to Development, Wisconsin Coastal Management Program

Philip Keillor

New technology and methods for predicting and managing shoreline erosion have emerged since UW Sea Grant conducted a series of workshops on the subject 10 years ago. In a series of new workshops, this project is updating professionals who have a stake in wise coastal development, including realtors, engineers, government regulators, and insurance executives. The workshops introduce methodology developed for the Wisconsin Department of Natural Resources and the Wisconsin Coastal Management Program for estimating recession rates along shorelines.

Funding Source: U.S. Department of Commerce via Wisconsin Department of Administration, Division of Energy and Intergovernmental Relations, Wisconsin Coastal Management Program.

### Update

Workshops were conducted at Milwaukee and at Superior, Wisconsin, in July 1998. Eight speakers at the workshops informed 75 participants about new developments in approaches to coastal erosion and flood hazards being developed by the Federal Emergency Management Agency. The workshops also introduced the second edition of the *Coastal Processes Manual*, recently published by UW Sea Grant. This completely rewritten manual replaces the manual and workbook written and published in 1987.

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## Operation Pathfinder: A National Pre-college Teachers' Partnership for Sustainable Ocean and Coastal Environments

James Lubner and Allen H. Miller

Operation Pathfinder is a course designed to increase awareness and understanding of oceanography, limnology, and coastal processes among elementary and middle-school minority teachers and teachers of minority students. The course is conducted by the Sea Grant Advisory Services program (see p. 48).

This annual, 14-day, three-credit graduate course attracts teachers from throughout the Great Lakes region. The teachers learn and develop strategies to incorporate these subjects into existing curricula. Course participants develop a thematic instructional unit to use in their classrooms. After the course, they lead at least one teacher training workshop or staff

development program and submit a journal article or present a paper at an education conference. Follow-up surveys ensure that participants are transferring knowledge they gain to the young people they teach and their colleagues, thus significantly multiplying the impact of this project.

Funding Source: U.S. Department of the Navy, Office of Naval Research via a research agreement with the University of Southern Mississippi Gulf Coast Research Laboratory.

**Update** The Operation Pathfinder course was conducted for 21 educators from four states. Housed on the UW-Milwaukee campus, participating teachers learned basic limnology and oceanography from scientists and from hands-on experiments on board the research vessel *Neeskay*. The educators will disseminate the knowledge they gained by training staff in their schools, publishing journal articles, and speaking at educators' meetings.

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## E/E-30 The Dean John A. Knauss Marine Policy Fellowship Program

Mary Lou Reeb

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 national policy decisions affecting those resources. This competitive program offers 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 19 years, 11 Wisconsin students have been selected to participate in the program. They have served with the U.S. Senate's Commerce, Science, and Transportation Committee, its Great Lakes Task Force, with the Office of Ocean and Marine Services in the National Oceanic and Atmospheric Administration, and with other hosts.

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 participation, in turn, helps congressional staffers learn about academic research programs and resource issues pertaining to the Great Lakes and marine resources.

Funding Source: National Sea Grant College Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

**Update** In 1999, this project is supporting Jeffery Ripp, a 1998 MS graduate of UW-Madison, interning with the Committee on Resources of the U.S. House of Representatives. Ripp is conducting background research on coastal and fisheries issues, other areas of marine policy, and the reauthorization of the National Oceanic and Atmospheric Administration (NOAA).

## Global Change Environmental Education Initiative

Allen H. Miller

The shift in the scientific study of Earth to a more holistic view has generated a deepened new understanding of the intricate relationships of many components of the environment, especially human activity. Depletion of resources, loss of biodiversity, increases in "greenhouse gases," and spiraling population growth have placed the Earth in peril. Even now, lifestyles are changing, and the cost of doing business is increasing as humans search for substitutes for vanishing natural resources and seek to correct past mistakes.

The goal of this project is to produce a more scientifically literate, aware, and technologically equipped population with the capacity to make wise decisions in our rapidly changing world. Advisory Services conducts Global Environmental Change Education workshops for K-12 teachers and adult educators. Each of these educators, in turn, teaches about 70 students each year, greatly magnifying the education effort throughout the Great Lakes. Web-based workshops are being developed to extend this program to additional Wisconsin educators more economically.

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.

### Update

A series of workshops, ranging from several hours to three days, were conducted throughout the state to promote scientific literacy about global environmental change among Wisconsin's educators. The workshops presented information about the nature and causes of environmental change, introduced techniques for teaching this information, and offered guidance on developing educational programs about global environmental change. Major topics included greenhouse gases and climate change, ozone depletion and related increases in ultraviolet radiation, degradation and depletion of resources, declines in biodiversity and ecosystem stability, and human health and population dynamics. As in Operation Pathfinder (see p. 60), the educators will disseminate the knowledge they gained by training staff in their schools, publishing journal articles, and speaking at educators' meetings.

Table 1. Project matrix

| Thematic Areas / Subprograms | Lake Superior Initiative | Yellow Perch | Nonindigenous Species | Aquaculture for the G.L. Region | Chemical-Biological Interactions | Terrestrial-Aquatic Coupling | Sediment Remediation | Safety at Sea | Application of Innovative Technology |
|---|---|---|---|---|---|---|---|---|---|
| Aquaculture | | | | R/AQ-31<br>R/AQ-32<br>R/AQ-33 | | | | | R/AQ-34 |
| Biotechnology | | | | R/BT-10 | R/BT-11<br>R/BT-12 | | | | |
| Estuarine & Coastal Processes | | R/EC-5 | | | | R/EC-6 | | | |
| Living Resources | R/LR-76<br>R/LR-77<br>R/LR-78 | R/LR-74<br>R/LR-75 | R/LR-63 | R/LR-80 | | | | | |
| Microcontaminants & Water Quality | R/MW-77 | | | | R/MW-58<br>R/MW-76 | | R/MW-78<br>R/MW-79 | | |
| Policy Studies | R/PS-51<br>R/PS-53 | | | | | | | | R/PS-52 |
| New Initiatives | | | | | | | | R/NI-27<br>R/NI-29 | R/NI-28 |
| Communications | | | | | | | | | C/C-3 |
| Advisory Services | | | A/AS-41 | A/AS-39 | | | | | A/AS-40 |

## Brief History of the Program

Established in 1968, the University of Wisconsin Sea Grant Program is a unique partnership of federal, state, university, and private sectors that reflects "The Wisconsin Idea" in action.

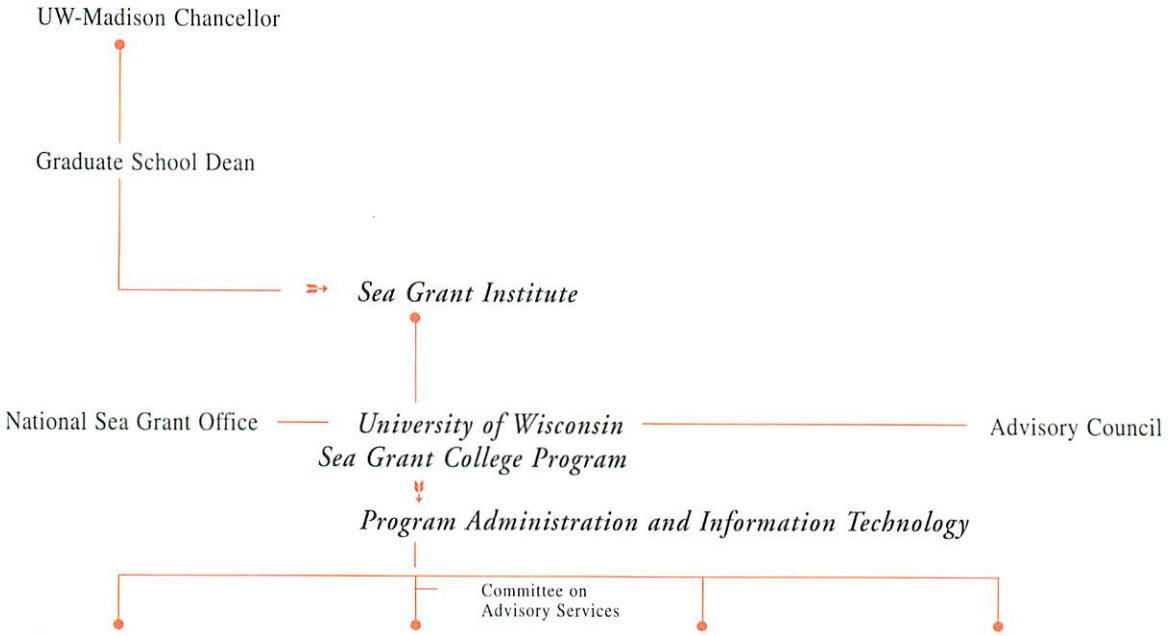
In October 1972, U.S. Secretary of Commerce Peter G. Peterson designated the University of Wisconsin a Sea Grant College for its "sustained excellence in research, education and public service dedicated to wise use of America's marine resources."

Policy and operational responsibilities for the University of Wisconsin Sea Grant College Program were formally transferred to University of Wisconsin-Madison under the University of Wisconsin System General Administrative Policy Paper #23 (GAPP #23) on December 1, 1978. At the same time, the Sea Grant Institute was created as an academic unit under the UW-Madison Graduate School. The institute was assigned the responsibility for administering the Sea Grant College Program for the UW System. The director of the UW Sea Grant College Program serves as director of the Sea Grant Institute and reports to the dean of the Graduate School at UW-Madison (see the organizational chart on the next page). Though the Sea Grant Institute is headquartered on the Madison campus, the Wisconsin Sea Grant College Program is UW System-wide and statewide in scope.

The University of Wisconsin Sea Grant Advisory Council (p. 73), appointed by the chancellor of the UW-Madison campus, provides policy guidance within established institutional goals, approves the overall program plan and budget, and participates in program planning and the selection of subject areas within which project proposals are solicited. The council brings a wide variety of viewpoints to the program; its members represent other units of the university system, state and local government, industry, and the public—which ensures the accountability of the program to users and participants. In 1992, the University of Wisconsin Sea Grant Committee on Advisory Services (p. 74) was formed to provide additional guidance on the direction of the program's outreach efforts.

The University of Wisconsin program has historically emphasized research on micro-contaminants and water quality, fishery and ecosystem dynamics, and estuarine systems and management. Though many of the program's coordinated research activities center on the resources and problems of the Great Lakes, much of Wisconsin Sea Grant's research and outreach activities are national, some international, in scope. In this proposal for 1998-2000, we build on these strengths and present some new and exciting directions to carry us into the 21st century.

# Organizational Chart




*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:**
Superior
Green Bay
Manitowoc
Milwaukee

**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**

# Overview of Program Planning & Development

The University of Wisconsin Sea Grant College Program's development and proposal process is a complex but collegial one that involves six separate groups, four of which are within the University of Wisconsin System. These are: (1) the faculty, staff, and students of the University of Wisconsin campuses and other private colleges and universities in the state; (2) the Sea Grant Institute; (3) Sea Grant subprogram coordinators; (4) the Sea Grant Advisory Council; (5) the National Sea Grant Office (NSGO), National Oceanic & Atmospheric Administration (NOAA); and (6) outside reviewers/advisors. The process, detailed on page 71, depicts a sequence of steps or functions that requires more than a year to complete.

Although there is a beginning and an end to the process, it is iterative, with one, several, or all of the groups providing feedback to the program planning stage throughout different steps. As the program development and proposal process progresses, the various groups enter and reenter the decision-making process. This interaction among the various groups provides not only accountability and an effective system of checks and balances but also a richness and synergistic effect that adds breadth and vigor to Wisconsin's Sea Grant Program.

After research, education, and outreach goals are formulated at the various program and subprogram planning meetings, the Sea Grant Institute solicits new project proposals for inclusion in the institutional proposal by means of a "Call for Proposals." This document includes detailed subprogram goal statements and is circulated throughout the University of Wisconsin System and to private colleges and universities in Wisconsin (more than 500 copies mailed). It emphasizes that it is the responsibility of interested investigators to contact the appropriate research coordinator and/or the institute director to discuss his/her research ideas prior to submitting a pre-proposal. Faculty members are also invited to submit research ideas on subjects outside the scope of the existing subprograms. Such "new initiatives," as they are called, often bring innovations and new direction to the program.

The "Call for Proposals for 1998-2000" clearly described the Sea Grant mission, the goals and priorities for each subprogram, and the areas of particular interest to the program. It stressed that Lake Superior issues, marine biotechnology, the ecosystem impacts of nonindigenous species, Lake Michigan's yellow perch fishery, and sediment remediation problems were high priority.

Each prospective investigator then submitted a brief pre-proposal describing his/her project, including specific objectives and the resources required to carry them out. Institute staff, the subprogram coordinator(s) and Advisory Council members evaluated each pre-proposal on the basis of its relevance to Sea Grant goals, potential applicability to Great Lakes and ocean resources, and its originality and likelihood of success. Given a positive review, prospective investigators were encouraged to submit full proposals. In some cases, prospective

investigators were asked to revise their proposal concept before submitting full proposals. Although no proposal was rejected at this stage, prospective investigators whose pre-proposals did not meet Sea Grant criteria were not encouraged to submit full proposals. (For the 1998-2000 biennium, 83 pre-proposals were received, 35 [42%] were encouraged, and 33 complete proposals were received.) At this point, all prospective principal investigators were invited to attend a January 1997 workshop in Madison to discuss subprogram priorities, thematic area possibilities, and proposal writing strategies. Principal investigators were encouraged to study the list of encouraged pre-proposals so that alliances could be formed. Thematic area coordinators were also selected at this workshop.

After submission, full proposals were sent out by the subprogram coordinators for national review by experts at other universities, in government laboratories and agencies, in industry, and within the University of Wisconsin System. Most of these reviews were solicited from peers, but user reviews were also solicited for projects that potentially have direct application to resource management or business development. Names for potential reviewers were provided by principal investigators, subprogram coordinators, the NSGO, and UW Sea Grant staff. Subprogram coordinators did not participate in any way in the review or evaluation of their own proposals. For our 1998-2000 proposals, we also conducted an evaluation by an outside review panel. The panel consisted of Professor Joseph DePinto, State University of New York-Buffalo; Professor James Cowan, University of Southern Alabama; Dr. William Graham (formerly of NSGO); and Mr. Carlos Fetterolf, a member of the Sea Grant National Review Panel. The Technical Review Panel meeting was also attended by Dr. Leon Cammen (NSGO program monitor) and UW Sea Grant Advisory Council members. Recommendations made at this meeting were incorporated into our omnibus proposal decision-making process.

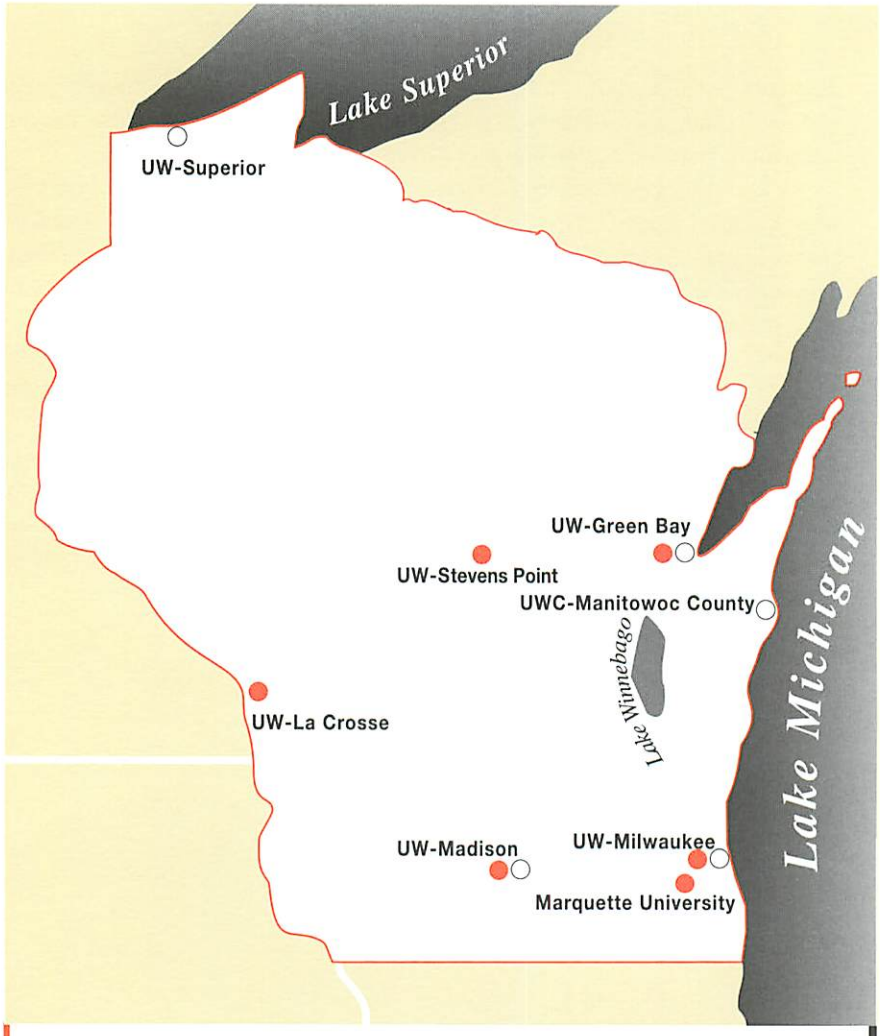
The primary criteria for proposal inclusion for the 1998-2000 omnibus competition were: (1) an excellent peer review (no proposal was included that had less than an average score of 2.0 on a 1-5 descending scale); (2) a coherent "fit" into a subprogram or thematic area as prescribed by strategic planning efforts; (3) recommendation by the outside review panel; (4) recommendation by the subprogram coordinator; and (5) available funding. Secondary criteria included the geographic distribution of the investigators, new investigator development, and potential for further initiatives. After careful consideration of these criteria (i.e., peer and user reviews, coordinator evaluations, outside reviewers and advisors, individual Advisory Council members, and Sea Grant Program staff), the proposed program plan was presented by UW Sea Grant staff to the Advisory Council for its review on October 13, 1997. After discussion, the council approved the proposed institutional program and budget for the 1998-2000 biennium.

Due to continuing budget constraints, many full proposals that receive high scientific and overall relevance reviews frequently cannot be included. For the 1998-2000 biennium, for example, 18 of the 33 new proposals submitted to the UW Sea Grant Institute were put in

Category 1 (= "high priority"). Six proposals were put in Category 2 (= "fund if dollars are available"). Thus, approximately 21 percent of the original pre-proposal ideas were ultimately accepted for inclusion as new, Category 1 projects in the 1998-2000 program.

We also ranked the Category 2 projects in terms of program priority. We have tried to include as many proposals from this category into the 1998-2000 omnibus proposal as our financial status allowed. That is, once we received the exact target dollar figure from the National Sea Grant Office, we examined in detail each proposed project budget in Categories 1 and 2, corrected any mistakes in the budgets submitted by the principal investigators, and negotiated a smaller budget if that was possible without compromising the integrity of the proposed research. We thus determined that we were able to include all Category 1 proposals and the top-ranked Category 2 proposal.

We are confident that the overall University of Wisconsin Sea Grant College Program organization and operation, coupled with the program development and proposal process described above, ensure that the Wisconsin program continues to be well-balanced and addresses important state, national, and international marine resource problems and opportunities, ensuring that the program is of exceptionally high scientific quality.




UNIVERSITY OF WISCONSIN SEA GRANT COLLEGE PROGRAM

| ● UW campuses and private universities with Sea Grant projects | ○ UW Sea Grant Advisory Services field offices |
|---|---|

## General Proposal Process Cycle

September—Initial program planning meeting involving subprogram coordinators and UW Sea Grant Advisory Council.

October—Call for Proposals distributed statewide to public and private university chancellors, college deans, department chairs, research program directors, grant administrators, past and present principal investigators, UW Sea Grant subprogram coordinators, Advisory Council members, and, on request, to individual faculty members.

November—Development and submission of pre-proposals.

December—Pre-proposal screening by subprogram coordinators, Advisory Council members, and UW Sea Grant management staff. Invitations for full proposals & proposal submission guidelines sent to principal investigators for selected pre-proposals.

January—Overview and question-and-answer meeting with potential principal investigators.

March—Draft project summaries requested from potential new principal investigators.

April—Project summaries sent to subprogram coordinators along with instructions for peer review, including sample cover letter & necessary forms (project review form, conflict of interest, etc.).

June—Deadline for submission of new proposals.

June-August—New project proposals peer-reviewed.

August—Deadline for submission of progress reports for continuing projects. Core program plans (Administration, Advisory Services, Communications, and Education) submitted to program director.

October—Selection of top-ranked, high-priority projects in Technical Review Panel meetings involving UW Sea Grant's federal program monitor, invited external advisors, presentations by UW Sea Grant research subprogram coordinators and staff, and UW Sea Grant Advisory Council observers. UW Sea Grant Advisory Council meets to review and approve proposed program. Program director makes preliminary submission to National Sea Grant Office (Letter of Intent) for review and approval.

November—Acceptance letters with preliminary (semifinal) budgets and rejection letters sent to all principal investigators.

December—Omnibus institutional proposal delivered to NSGO for grant processing.

# Organizational Units and Departments Involved in the 1998-2000 Program

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Great Lakes Wisconsin Aquatic Technology &
Environmental Research Institute

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

**University of Wisconsin-Milwaukee**
Aquaculture Institute
Biological Sciences
Center for Great Lakes Studies
Geosciences
Graduate School
Great Lakes WATER Institute
Sea Grant Advisory Services

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

**University of Wisconsin-La Crosse**
Biology & Microbiology

**University of Wisconsin-Manitowoc**
Sea Grant Advisory Services

**University of Wisconsin-Stevens Point**
College of Natural Resources

**University of Wisconsin-Superior**
Sea Grant Advisory Services

**Marquette University**
Biology

**Medical University of South Carolina**
Biochemistry & Molecular Biology

**Purdue University**
Illinois-Indiana Sea Grant College Program

**Rensselaer Polytechnic Institute**
Darrin Freshwater Institute

**State Historical Society of Wisconsin**
Underwater Archeology

**University of Michigan**
Sea Grant College Program

**University of Minnesota**
Sea Grant Program

**University of Texas-Austin**
Marine Science Institute

**University of Vermont**
School of Natural Resources

**Woods Hole Oceanographic Institution**
Biology

**U.S. Geological Survey**
Upper Mississippi Science Center

**U.S. Fish & Wildlife Service**
La Crosse Fish Health Center

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## Nonindigenous Species

vacant

## Lake Superior Initiative

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