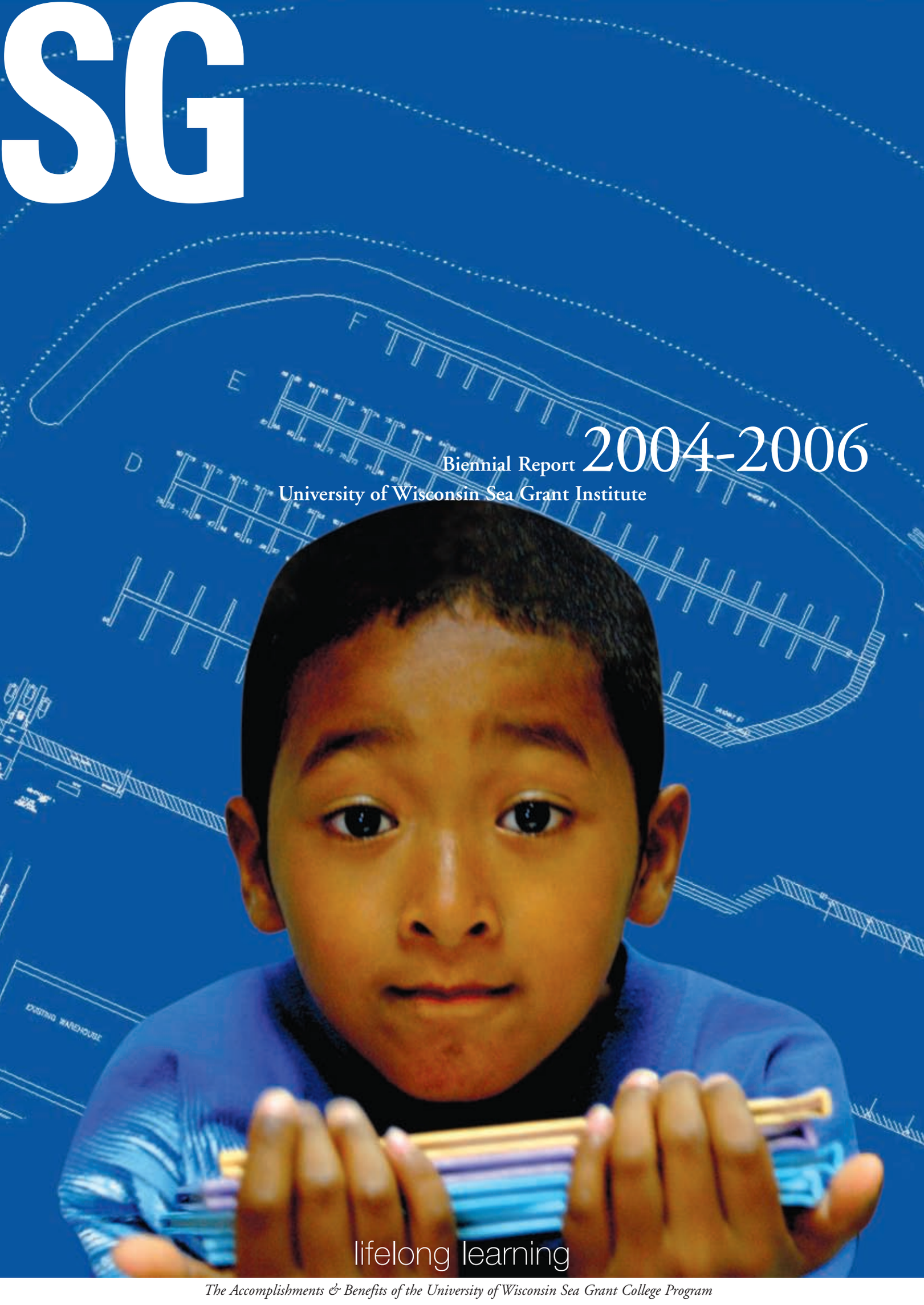
SG

Biennial Report 2004-2006

University of Wisconsin Sea Grant Institute



lifelong learning

The Accomplishments & Benefits of the University of Wisconsin Sea Grant College Program

Editor: **Stephen Wittman**
Writers: **John Karl**, **Kathleen Schmitt**, **Stephen Wittman**
Contributors: **Linda Campbell**, **Rich Dellinger**, **Tom Dellinger**, **Rich Hoops**, **Dan Marklein**, **Mary Lou Reeb**, **JoAnn Savoy**
Art Director/Designer: **Tina Yao**
Layout and Production: **Amy Kittleson**
Proofreader: **Gloria Gardner**

Sea Grant is a unique partnership with public and private sectors combining research, education and technology transfer for public service. Sea Grant is a national network of 30 university-based programs dedicated to enhancing the practical use and conservation of coastal, ocean and Great Lakes resources to create a sustainable economy and environment.

Publication No. **WISCU-Q-06-001** — Additional copies are available from:
Publications, UW Aquatic Sciences Center, 226 Goodnight Hall,
1975 Willow Drive, Madison, WI 53706-1177, USA Phone: (608) 263-3259
Email: *publications@aqua.wisc.edu* Web: *www.aqua.wisc.edu/publications*

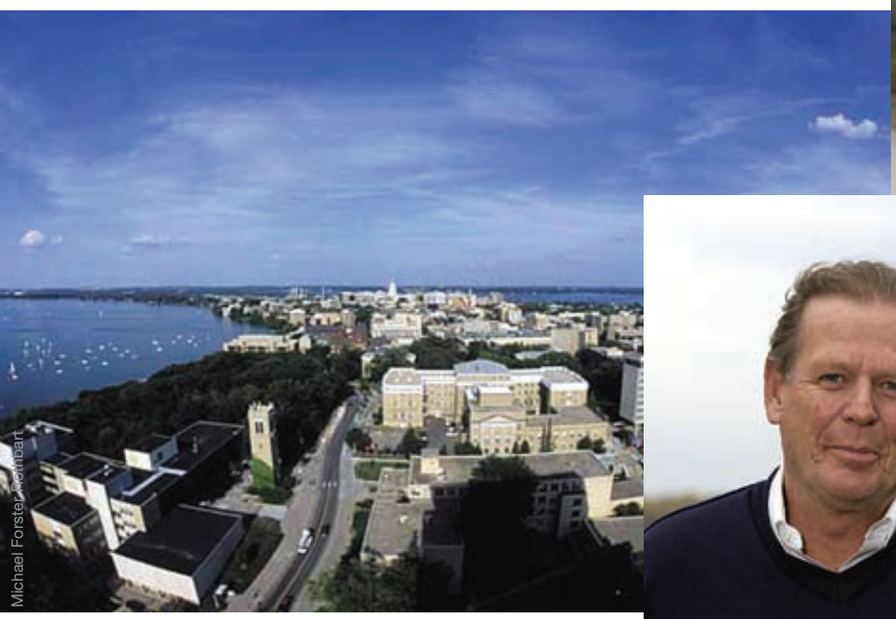
Funding provided by the the National Sea Grant College Program, National Oceanic & Atmospheric Administration, U.S. Department of Commerce (grant no. NA16RG2257, Project C/C-1)

First Printing: May 2006
Printed in the USA

Table of Contents:

Our alternate covers are photo collages of students at the Allied Drive Learning Center in Madison, Wisconsin *(read the story on page 23)* and the site blueprint for Green Bay's South Bay Marina *(story on page 12)*.

photos by Rich Dellinger


Michael Forster Rothbart


Bob Rashid

From the Director

We live on "the ocean planet," yet we would do well to remember just three percent of the world's water is fresh water—two-thirds of which is frozen in the polar ice caps and glaciers, and one third is underground. Just two one-hundredths of one percent of the world's water fills all our freshwater lakes, reservoirs and rivers.

Globally, more than 2 billion people face water supply shortages. By 2025, that number is expected to rise to 5.5 billion, or two-thirds of the world's population. Over a billion people today don't have access to clean drinking water, and more than 5 million die from waterborne diseases each year. Worldwide water use has increased sixfold over the last 70 years as the human population tripled. The costs of water infrastructure have risen dramatically as the quality of water in rivers, lakes and underground has deteriorated. And the world's population continues to grow larger.

Meanwhile, Wisconsin borders the largest freshwater system on Earth—the Great Lakes—and is blessed with an abundance of rivers, lakes and groundwater as well. Our state has a tradition of good stewardship of its natural resources and a storied history of water-related scientific endeavors. Nevertheless, Wisconsin's water resources are not isolated from the ever-increasing demands for water and general decline in the quantity and quality of available water supplies now confronting the rest of the world.

We face serious budgetary constraints at both state and federal levels. As we deal with the immediacy of budgetary shortfalls and other funding limitations, we must not lose sight of the severe long-term economic costs of neglecting our environment and natural resources, especially our aquatic resources.

In these tight fiscal times, programs like the National Sea Grant College Program make good sense—both fiscally and scientifically. It represents a federal-state partnership that leverages every federal dollar with local matching monies. Research money is awarded on a competitive basis and directed at only

Michael Forster Rothbart

Jeff Miller

"When the well is dry, we know the worth of water."—Benjamin Franklin

the most meritorious, strategically important projects. Each dollar is stretched further by a strong emphasis on education and outreach. In short, Sea Grant is an outstanding example of fiscal and scientific responsibility, not only in the academic world, but in the entire national research enterprise.

Furthermore, our Great Lakes Sea Grant Network provides broad avenues for regional collaboration and communication among university researchers, resource managers and resource users, including public water utilities, commercial and recreational fishing interests, the shipping industry, thermoelectric power producers, coastal property owners and myriad local, state, regional and federal government agencies.

The Sea Grant College Program is a vehicle for focusing the best available scientific minds on the nation's most pressing water-related issues and simultaneously recruiting and training the next generation of researchers and resource managers to deal with the water quality and quantity issues of the future.

Herein we present some highlights of the activities and accomplishments of the more than 100 faculty, staff and students on seven UW System campuses and two private universities that were involved in the 2004-06 Wisconsin Sea Grant College Program—just one of the 30 Sea Grant programs operating in every Great Lakes and coastal state, Hawaii, Puerto Rico and Guam. We hope you find our selection both interesting and informative.

Anders W. Andren
Director

Bob Rashid

producing significant impacts

University of Wisconsin Sea Grant Institute

Learning in the laboratory

In 2004, Sophomore **Lili Prahl** (right) was awarded a Sea Grant-administered Carl J. Weston Memorial Scholarship, which supports undergraduate students interested in Great Lakes and ocean issues. Working in the wildlife ecology laboratory of **William Karsov** at UW-Madison, Prahl investigated whether cadmium in water increases limb deformities in frogs that are also exposed to a parasite.

Each semester, five to seven undergraduate students in Karasov's lab do everything from cleaning tanks and feeding frogs to conducting research and presenting posters and talks at scientific meetings, Karasov said. Many of those students have been supported by Sea Grant funding.

Learning in the field. *Graduate student Jackson Gross (left) and Lili Prahl wade into wetlands to collect frog eggs. The eggs will be used to study the causes of increasing limb deformities among native species. Gross, who was supported on a Sea Grant-funded project for part of the 2004-06 biennium, takes a special interest in mentoring other students. "The only reason I'm here is because people stood up and helped me, and the only way I can give back is to do the same for other students," he says. In April 2005, five students who were mentored by Gross and who recived support from Wisconsin Sea Grant delivered presentations at the annual UW-Madison Undergraduate Research Symposium.*

Bob Rashid

Net gains. *Graduate student* ***Te-Hao Chen*** *and* ***Lili Prahl*** *assess a net full of frog eggs. Chen mentors undergraduate* ***Michelle Temez*** *(not pictured), who added a major in wildlife ecology to her Spanish major while working in Karasov's lab. Sea Grant funding also helped support undergraduate* ***Matt Meyer*** *(not pictured), who has worked in Karasov's lab for several years. Meyer plans to attend graduate school in aquatic toxicology or ecological toxicology in the fall of 2006. He says his experience helped him know what to expect. "I've learned a ton about research, and also about life as a researcher," Meyer said.*

Bob Rashid

The care and feeding of frogs used in research requires several hours every day. Sea Grant funding permits undergraduate research assistants to do some of the work, freeing time for graduate student ***Jackson Gross*** *to conduct experiments and write up the results. Gross and the students he mentors are looking at how cadmium and other heavy metal contaminants combine with pathogens to cause limb deformations and suppress growth and development in amphibians.*

"All of these opportunities, all these students I have, and everything that I've accomplished is made possible by Sea Grant support," Gross said. After receiving Sea Grant funding, Jackson received a prestigious STAR (Science to Achieve Results) Fellowship from the U.S. Environmental Protection Agency.

Sheltering Boats —
and Birds, Fish and Frogs

Marinas offer shelter and safety to boaters, but constructing them often means losing wildlife habitat. Places that provide fish and wildlife with shelter and food can be destroyed when shorelines are encased in rip rap, shallow areas are dredged, and trees are chopped down.

But building a marina can actually offer opportunities to create habitat, as UW Sea Grant Habitat Restoration Specialist **Victoria Harris** helped demonstrate with the South Bay Marina. Located immediately east of the mouth of the Fox River in Green Bay, the new marina features wetlands, natural beaches, rock reefs and ideal fish spawning grounds.

Harris' role in developing the marina was pivotal, according to **Chet McDonald**, co-owner of the McDonald Lumber Company, which owns the property and built the marina.

"Vicky really brought the ideas to us," he said. "She makes a good case for doing these things."

Harris' involvement began in the late 1990s, when she worked for the Wisconsin Department of Natural Resources (WDNR). She coordinated development of the Green Bay/Fox River Remedial Action Plan (RAP) and served on the RAP's Biota and Habitat Work Group, which was charged with identifying opportunities to preserve and restore wildlife habitat in the area.

When McDonald Lumber applied for a permit from the U.S. Army Corps of Engineers, the Corps sought input from the Biota and Habitat Work Group, which also includes representatives from the U.S. Fish and Wildlife Service, UW Sea Grant and UW-Green Bay. The group visited the proposed site and offered to work with McDonald Lumber to identify wildlife-friendly features that could be incorporated into the marina design.

The company readily embraced the idea, according to McDonald.

lifelong learning

www.seagrant.wisc.edu/frogs

In 2005, audiences of all ages visited 395,858 pages on the Frogs Web site.

"My students are studying the Gulf of Mexico and your Web site has served as a springboard for them to research and compare other bodies of water with the gulf."

—teacher, Alief Middle School, Houston, Texas

"I had been interested in this sort of thing for a long time," he said. "This was an opportunity to do something about it."

McDonald Lumber agreed to work with the habitat group in designing and constructing habitat features for the marina.

Shortly before accepting her current position with UW Sea Grant in 1999, Harris began researching habitat-friendly construction. She visited parks and marinas in Toronto, Hamilton, and Thunder Bay, Ont., where similar efforts had been made. She talked with project managers, collected detailed plans and studied reports on the sites. Based on this information, Harris sketched preliminary designs for the marina. She continued working with the habitat group, McDonald Lumber, and their consultant for several years as plans, designs, cost-estimates and, finally, construction were completed. She also helped raise money for the project by writing a successful proposal for a habitat enhancement grant.

Construction of the marina was completed in the spring of 2003, and it features a variety of habitat. Two narrow spits of rock "headlands" jut out from the marina, sheltering part of the shoreline from large waves and allowing sediment to collect and aquatic plants to grow. Such wetlands are nurseries for many species of fish, amphibians and birds. Deposits of cobble, gravel and sand in these sheltered waters make natural-looking beaches, which provide resting and foraging places for waterfowl and shorebirds.

Submerged "spawning stones," each two to five inches in diameter, were placed along the break wall to provide optimal spawning beds for walleye and bass. Nooks and crannies between the stones are deep enough to shelter eggs from wave action, yet shallow enough to allow well-oxygenated water to flow over the eggs. A wooded area once designated for a parking lot was left standing, providing resting places and foraging bases for migrating songbirds, raptors and roosting herons.

The South Bay Marina is now open and welcomes large power boats and sailboats at competitive rates. No charge for birds, fish and frogs. — JK

RESURRECTING LOST ISLANDS

Students in **Joy Zedler's** UW-Madison Adaptive Restoration class are lending a hand in restoring a chain of small islands in southern Green Bay. Known as the Cat Islands, they were washed away in the 1970s by the combined forces of high water levels, heavy storms and mainland shorelines hardened with rip rap.

Victoria Harris *(second from left),* UW Sea Grant's habitat restoration specialist, has spent nearly a decade working with the U.S. Army Corps of Engineers, Brown County Port Authority, U.S. Fish and Wildlife Service (USFWS), the Wisconsin Department of Natural Resources, and coastal engineers W.F. Baird & Associates to design a restoration plan for the island chain using navigation channel dredged materials.

With those blueprints nearly completed, Harris and USFWS Green Bay office team leader **Janet Smith** sought the help of Zedler and her students to draft a habitat restoration plan for the islands.

The students found that the island chain provides an excellent opportunity for adaptive restoration, testing a variety of restoration strategies on one island and using the most effective techniques on others. Because the newly constructed islands will be bare, the students gave highest priority to improving soil quality to support vegetation, using rocks, logs and trees to reduce erosion and wind.

Zedler hopes future classes can visit the site and continue to refine the restoration plan.

USDA Natural Resources Conservation Service, Romy Myszka

Elizabeth J. Czarapata, Wisconsin DNR

Sedges Under Seige

Since the 1800s, half of Wisconsin's primeval wetlands have been drained and filled in for agriculture, roads, houses and industry. Now the remaining wetlands have another threat—a pernicious, pushy invasive plant. UW-Madison restoration ecologist **Joy Zedler** is studying how this invader lays siege to Lake Michigan wetlands and drives out diversity.

Cattails blowing in the wind may be a familiar sight, but a closer look reveals they're not all alike. The native species typically grow straight, sparse leaves that leave room for other types of plants to thrive. But the hybrid *Typha x glauca*, a cross between native and invasive cattails, is less hospitable.

"The hybrid cattails form very dense stands that use all the light above ground, and below ground the rhizomes fill up all the space. Hardly anything can coexist with it," said Zedler, who was awarded Sea Grant funding to study the problem.

At risk, said Zedler, are sedge meadows, one of the region's most diverse types of wetland. The roots of native sedges, which are grass-like plants, form mounds that create nooks and crannies for other types of plants to live. They also provide excellent cover for birds and small animals.

The fluctuating water levels of the Great Lakes historically have sustained sedge meadows and kept cattails in check. Native cattails hug the waterline, while sedges grow just inland. Both plants prefer wet soil, and together they move upslope when water is high and recede when water levels drop.

But it's a different story with hybrid cattails, according to **Christin Frieswyk**, who received her doctorate working with Zedler. Using GIS technology to compare aerial photos of several Green Bay wetlands from the past 40 years, Frieswyk found that the sedge meadows had shrunk in recent years with the drop in Green Bay water levels. During the same time, hybrid cattail populations had expanded rather than receding like those of native cattails. Because they are much hardier and more aggressive, she explained, the hybrid cattails can withstand a broader range of water levels.

The cattails are gaining ground in areas with stable water levels as well. **Aaron Boers**, another graduate student in Zedler's lab, found that hybrid cattails thrive in the presence of abundant phosphorus, and they grow bigger and take up more of the nutrient when they are constantly flooded. A likely reason, according to Boers, is that flooding alters soil chemistry so that phosphorus previously locked up in the soil becomes available for uptake by plants.

It's a mechanism that has been researched in lake sediments and some wetland soils, but this is the first study to document it in invasive wetland plants. Scientists call it "internal eutrophication." It explains why cattails dominate the wetlands of Lake Ontario, which has had regulated water levels since the St. Lawrence Seaway opened in 1959.

The Nature Conservancy is putting Boers' research findings to immediate use as it works with a lake management association in southeastern Wisconsin.

above: Typha angustifolia, *native cattail*
left: sedge meadow; inset: Typha x glauca

from top: Aaron Boers, Christin Frieswyk and Joy Zedler

"Being able to work with university researchers is a great opportunity for us, so that we can incorporate the best science into our management decisions," said **Paul West,** an associate science director with The Nature Conservancy's Wisconsin chapter. "Aaron's work has helped us understand the specific mechanisms that drive cattail expansion. Now, when we work to change the management of the lake, we can keep in mind how water levels relate to phosphorus availability for the vegetation."

Once an area is taken over with hybrid cattails, it may be difficult to restore, the researchers say. Frieswyk found that soils under hybrid cattails had few seeds to regenerate sedge meadows. In fact, the most common seed found was purple loosestrife, another notorious invasive plant. According to Zedler, this is a red flag for wetland managers seeking to restore sedge meadows by simply removing hybrid cattails with fire or herbicides.

"You'd be trading one problem for another," she said.

Zedler will continue to look for ways to restore sedge meadows, using segments of the UW-Madison Arboretum as testing grounds. To aid the process, Frieswyk developed a formula that quantifies what species dominate a certain wetland and in what manner. Her formula—called a species dominance index—provides an objective way to track changes in wetlands and measure progress during restoration efforts.

The constant threat from invasive species can be daunting, but Zedler claims two rewards.

"Two marvelous students received excellent training through this Sea Grant study," she said. "They're becoming well equipped to solve the critical problems facing our wetlands." — KS

lifelong learning: Sea Grant alumni

"I felt very plugged in, even as a student, to the scientific issues and research going on in the Great Lakes, and these connections strongly influenced the success of my subsequent research career…"

—Prof. **Deborah Swackhamer**, Director, Water Resources Center, University of Minnesota, St. Paul

MANAGING A PUNGENT PROBLEM

A pesky summer visitor has shown up on Wisconsin's Lake Michigan shorelines the past six years. It's *Cladophora*, an algae that drives off beachgoers with a pungent, stinky stench as it decays in massive heaps along the shore.

Victoria Harris, UW Sea Grant's water quality specialist, has been working with colleagues around the state to gather information about the algae's resurgence in nearshore waters and answer questions from the public.

Harris says rotting *Cladophora* can exacerbate beach closings because it often harbors large numbers of *Escherichia coli* bacteria. Gulls like to eat the zebra mussels and other fauna snared by the algal mats, and gull fecal matter is loaded with the bacteria.

Harris presented her findings at a research and management workshop at the UW-Milwaukee Great Lakes WATER Institute, where scientists compared notes on what they've learned so far about the algae. Though no definitive cause has been identified, she says a myriad of interconnected conditions appear to be involved—a combination of low lake levels, increased light penetration of the water, a rise in available nutrients, favorable water temperatures and the form of shoreline substrate.

Zebra mussels, which invaded Lake Michigan around 1991, may be largely to blame by affecting water clarity and recirculating nutrients, according to Harris.

Following the research meeting, she helped organize and present her findings at a public forum with Wisconsin Department of Natural Resources (WDNR) staff to inform homeowners, beach managers and other concerned citizens about the algae and what can be done to manage it. Presently, she said, removing the algal mats from beaches and trying to control phosphorus inputs to the nearshore are the best way to handle the outbreaks. One outcome of the forum is that the WDNR is preparing a property owner's guide to *Cladophora* clean-up methods.

Harris has also led several field trips and made presentations on the topic at several other public meetings, distributing more than 500 copies of a *Cladophora* fact sheet produced by UW Sea Grant Communications. She has also discussed the problem at a press conference, international water resources seminar and an institute for environmental news media.

The *Cladophora* fact sheet is currently available as a free PDF download on the UW Aquatic Sciences Center's online "Publications Store" (*aqua.wisc.edu/publications*) and will be updated periodically as research on the algae progresses.

National Park Service

lifelong learning: Sea Grant alumni

"My Sea Grant experience as a graduate student provided the springboard for my professional career…Without the Sea Grant experience, I believe that it would have been nearly impossible to rise to my current position within EPA."

—**Lawrence Burkhard**, Research Chemist, U.S. Environmental Protection Agency, Duluth, Minnesota

Blame It on the Birds

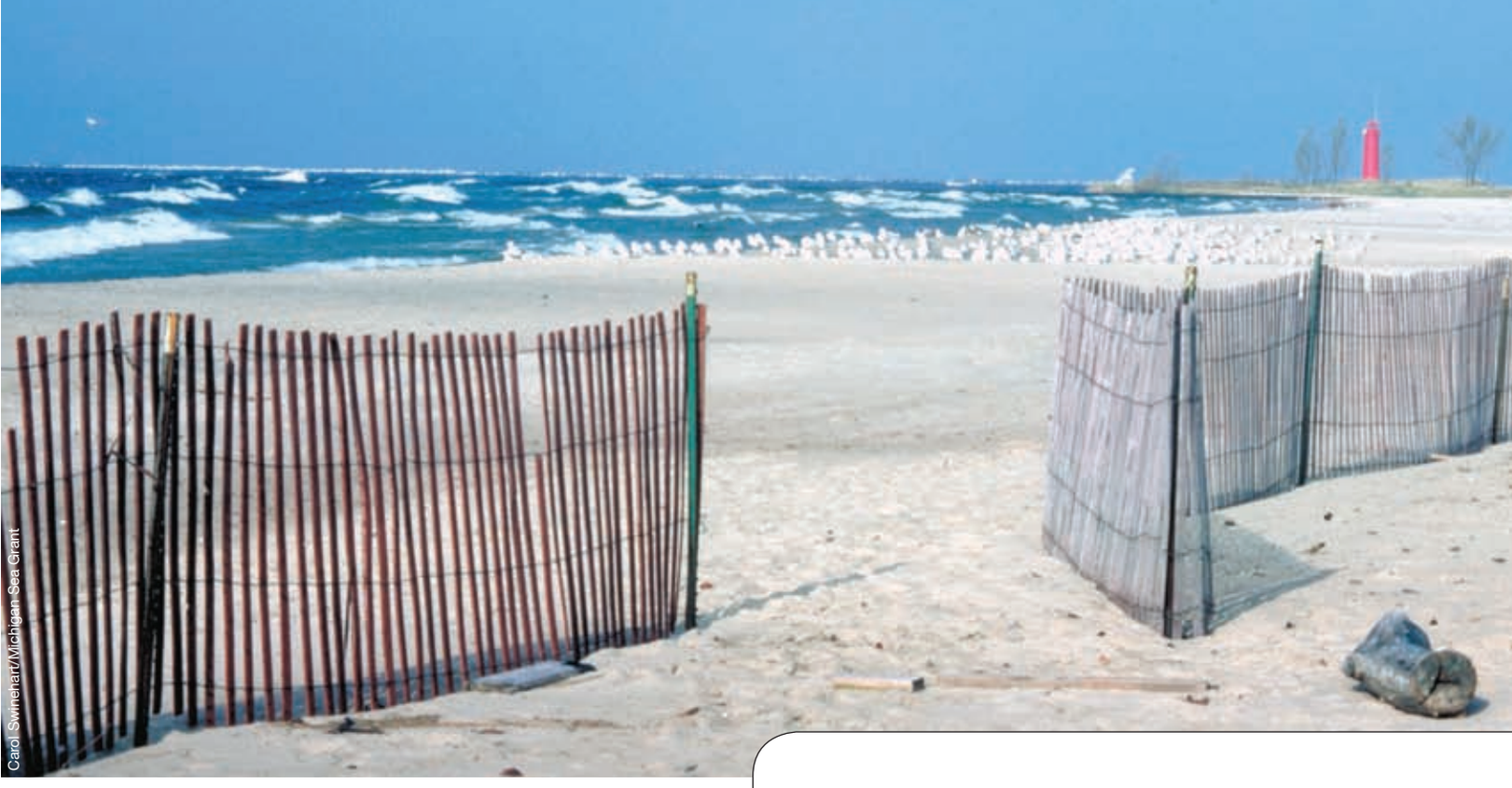
Many Wisconsin residents and tourists head to Lake Michigan beaches for relief from summer heat and humidity. But instead of running into the water, some beachgoers are running into bright red signs signaling closed beaches due to unsafe swimming conditions.

UW-Milwaukee environmental toxicologist **Sandra McLellan** is trying to find out why so many of these red signs are showing up. With Sea Grant support, McLellan is searching for the source of contaminants along the Lake Michigan coast, hoping to arm management agencies with better information to clean up beaches.

"This information is really important for decision makers," says McLellan. "It's very difficult to decide where to put financial resources to improve water quality if you don't know where the pollution is coming from."

Beach managers post closings when the amount of *Escherichia coli* in the water exceeds standards recommended by the U.S. Environmental Protection Agency. *E. coli* is a bacterium that causes minimal health risk to swimmers, but in high numbers it can indicate the presence of other dangerous bacteria and viruses that can sicken beachgoers. Although elevated *E. coli* numbers can be a good indicator of poor water quality, they tell nothing about the source of the contamination. So researchers in McLellan's lab at the UW-Milwaukee Great Lakes WATER Institute are trying to squeeze out as much information as they can from water samples taken along the coastline.

To find out if pollutants originate from humans, McLellan has been checking for resistance in *E. coli* to antibiotics, which people use and wild animals don't. Tracing the origins of nonhuman pollutants can be more challenging. Possible


Carol Swinehart/Michigan Sea Grant

sources range from gull droppings in the sand to rainwater that flows to beaches after running off lawns, farms, streets or construction sites, picking up animal waste, fertilizer, pesticides, trash and many other pollutants along the way. To weed through these possibilities, McLellan, a bacterial geneticist, looks for genetic markers in another species of indicator bacteria. Certain types of *Bacteroides* can be linked to fecal matter from specific host animals, such as cows or humans.

The investigative work doesn't end in the laboratory. McLellan routinely heads outside to confirm her findings. And often accompanying her on these scientific beachcombing trips are beach managers, city and county officials, and others who know the territory.

"That's why I think our research has been really successful to date," McLellan says, "because we're not doing it in a vacuum."

One success story is McLellan's study of Bradford Beach, Milwaukee's most frequently closed beach in 2004. She found that much of the *E. coli* came from seven stormwater outfalls scattered along the beach, as well as flocks of gulls that congregate along the shore (one gram of gull feces contains 340 million *E. coli* cells). These findings resulted in a joint effort with Milwaukee County to map the stormwater system and develop a proposal to relocate the outfalls away from Bradford Beach.

"We have limited funds, so our work needs to be very focused," said **Gary Mick**, director of Milwaukee County Environmental Services. "I don't know how we would address the problems at Bradford Beach without Sandra's ability to classify certain bacteria so we can tell where they're coming from."

One encouraging finding from McLellan's research is that poor water quality at beaches doesn't seem to be signaling that Lake Michigan as a whole is experiencing the same level of contamination.

"We've found that most of the *E. coli* we detect in these beach areas usually comes from a very localized source," she says. "That's good news because it means there are management practices that can be put in place to fix some of these problems."— KS

Beach Closing FACTS

- More of the nation's swimming beaches are being monitored more often as a result of the Beach Act of 2000, resulting in 20,000 beach closings or advisories nationwide in 2004, compared to 11,000 in 2000.
- Prior to 2002, Great Lakes beaches were rarely tested regularly outside of Milwaukee, Kenosha and Racine counties.
- More than 4,200 samples for *E. coli* were taken from popular swimming spots along the state's Great Lakes shoreline in 2005, of which 16 percent exceeded the acceptable amounts of *E. coli*, compared to 22 percent the year before.
- Urban beaches generally have poorer water quality—Milwaukee's South Shore Beach, for example, was closed more than half the time in 2005 due to excessive *E. coli* levels.
- McLellan's lab has found that localized pollution sources, rather than major regional contamination events like sewage overflows, are the major cause of elevated fecal indicator levels at Lake Michigan beaches.
- Ninety percent of fecal coliform bacteria dies 6-8 hours after entering Lake Michigan.
- The two top sources of *E. coli* at Wisconsin beaches are stormwater runoff and bird droppings. Agricultural runoff has not been identified as a significant source.
- The amount of *E. coli* in the droppings of one gull is equal to that in the droppings of 660 geese.
- *E. coli* can persist in moist sand until rainfall washes it into the lake, so sand grooming offers a short-term solution to reducing *E. coli* levels at beaches.

For more information, visit the UW-Milwaukee Great Lakes WATER Institute's Bacterial Genetics Research Laboratory Web site: *www.uwm.edu/Dept/GLWI/ecoli*.


John Lyons

TAKING TOXINS TO HEART

To understand the risk that exposure to dioxin and similar toxic chemicals pose to early life-stage survival of fish, it is essential to identify the most fundamentally important target organs and pathways of dioxin toxicity in fish embryos and larvae. That has been the focus of Sea Grant-funded studies by UW-Madison scientists **Richard Peterson** and **Warren Heideman** for the last four years.

During 2004-06, Peterson and Heideman realized several major advances in their research that have greatly increased our understanding of the impacts of both polychlorinated and polybrominated forms of dibenzo-p-dioxins, dibenzofurans and biphenyls, on wild fish populations.

One major finding was that heart malformation is one of the first adverse effects of dioxin exposure on the zebrafish embryo, including adverse effects on both heart morphology and the process that plays a key role in heart development. They also determined that dioxin contamination of zebrafish eggs can reduce the size of the embryo heart.

A key discovery, however, was that dioxin caused the ventricles of zebrafish embryo hearts to stop beating, resulting in a type of heart dysfunction called "ventricular standstill," which, they report, "could lead to the failure of larval fish recruitment into feral fish populations."

The World Health Organization has used Peterson and Heideman's research to set "relative potency factors," and it will be using their latest findings during the next update. Relative potency factors are used by regulatory agencies globally to assess the risk of recruitment failure in feral fish populations exposed to these classes of persistent organic pollutants.

What's that Fish?

A new Web site shows anglers or anyone with an itch for ichthyology how to identify what's dangling at the end of their lines.

John Lyons, a scientist in the Wisconsin Department of Natural Resources' Fish and Habitat Research Section; **Paul Hanson**, an assistant scientist and programmer at the UW-Madison Center for Limnology, and **Elizabeth White**, UW Sea Grant's publication editor, collaborated for more than five years to research, develop and publish the "Wisconsin Fishes" identification site.

Users can fish through more than 4,000 photos covering all 147 native species and 27 invasive species of fish that have taken up residence in Wisconsin. The photos show different angles, life stages, and body features—such as the snout shape of a slimy sculpin or the body patterning of a pirate perch. The site also includes a taxonomic key, an illustrated guide to fish anatomy and an illustrated glossary.

Lyons, a fisheries research scientist, said natural resource managers use the CD version of the site on their computer laptops to help them more accurately identify less common species they see in the field.

"The work we're doing as resource managers and researchers goes well beyond standard game fish," he said. "We have to understand and be able to identify the forage fish that support the game fish, and the threatened and endangered species we have to consider in our decision-making."

Due to publication costs and size, traditional print taxonomic keys typically use only a few images and descriptions are often abbreviated in technical language. They can be intimidating to many people and biologists often find them cumbersome. **James Kitchell**, director of the UW Center for Limnology, said the user-friendly "Wisconsin Fishes" Web site can help both audiences.

"This is a long-needed 'first of its kind' and will serve as an invaluable outreach resource available to many, many kinds of people," he said.

Lyons traveled all over Wisconsin and 12 other states, taking more than 15,000 photos, to provide the images he felt were needed to help people easily identify Wisconsin's fishes. The result is an identification system that relies primarily on quick, easy access to thousands of high-quality images.

According to White, one of the project's many challenges was organizing the data and photographs—a total of nearly 16,000 records—to make the site as accessible as possible.

"John knew what information was needed for easy identification, Paul knew the capabilities of the computer software, and I helped them organize the information so all the pieces fit together," she says.

Lyons, Hanson and White have submitted a paper for publication to share their experiences and recommendations with other agencies interested in developing online taxonomic systems. The "Wisconsin Fishes" site and a downloadable version of its companion CD can be found at *www.wiscfish.org*. The CD version of the site is also available for purchase at the UW Aquatic Sciences Center's online "Publications Store" (*aqua.wisc.edu/publications*).— KS

CORRODING HARBOR STEEL

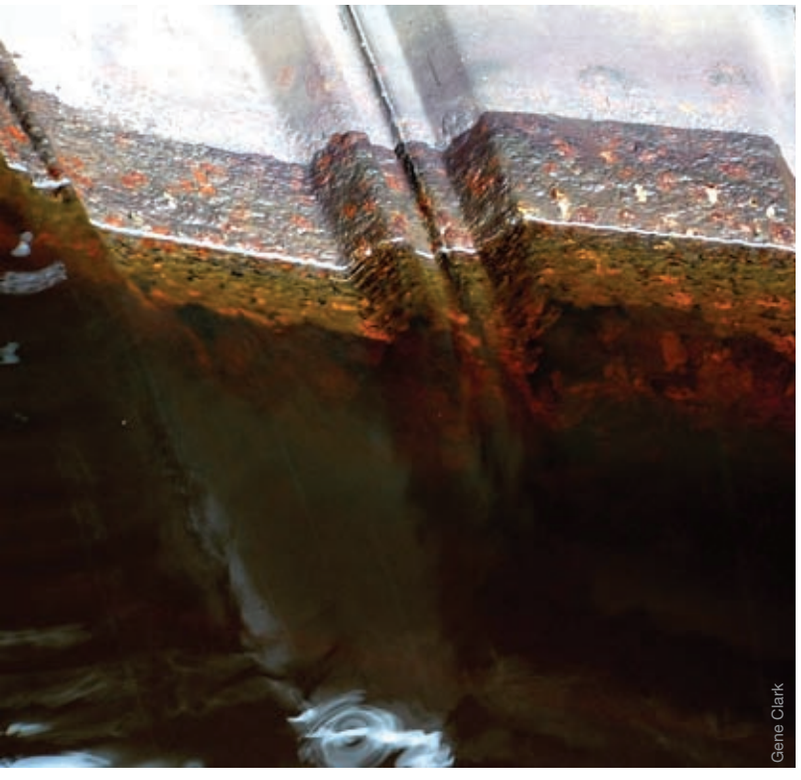
The accelerated corrosion problem at Duluth-Superior port facilities was the focus of a technical workshop in 2004 organized and cosponsored by the Wisconsin and Minnesota Sea Grant programs. More than 60 port officials, scientists and other interested parties participated in the workshop, which was designed to identify possible causes and feature research to address the problem.

The accelerated corrosion could have significant safety and financial implications for the port, which handles the largest total cargo volume in the Great Lakes. Thirteen miles of steel sheet piling are corroding around the harbor, and if the problem isn't addressed, the structural integrity of docks and loading facilities could be compromised.

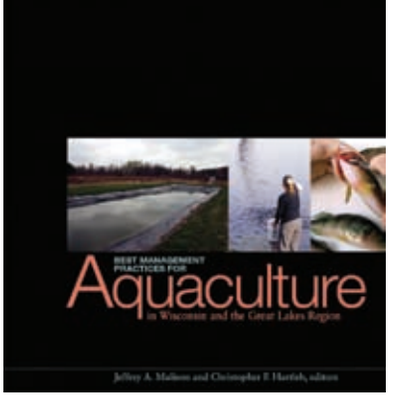
"This is potentially a very costly problem," said **James Sharrow**, facilities manager of the Duluth Seaway Port Authority. "We have about 90 to 100 million dollars of possible repairs in our harbor to steel that's being damaged by corrosion."

The problem continued to be a focus of Wisconsin Sea Grant coastal engineering outreach efforts during 2005. This work included making several presentations about the issue to officials and the public, developing a fact sheet, and sponsoring two new research studies to help characterize the problem and guide future studies.

For more information, see *seagrant.wisc.edu/coastalhazards* or contact **Gene Clark**, UW Sea Grant coastal engineering specialist.



Gene Clark



HELPING FISH FARMS GROW

Two new technical reports published by UW Sea Grant during 2004-06 may provide a significant boost to the development and growth of an environmentally sound and sustainable aquaculture industry in Wisconsin and the rest of the Upper Midwest.

Best Management Practices for Aquaculture in Wisconsin and the Great Lakes Region is a first-of-its-kind resource for helping aquaculturists operate their facilities in an environmentally friendly manner; assisting developers in the design, siting, construction and operation of new hatcheries and fish farms, and helping government agencies develop regulations that are uniform in their application yet not excessively restrictive. Edited by UW-Madison Aquaculture Program Director **Jeffrey Malison** and UW-Stevens Point Associate Professor of Biology **Christopher Hartleb**, this comprehensive, 125-page illustrated manual was developed with special funding from the Sea Grant National Marine Aquaculture Initiative.

Aquaculture Effluents and Waste By-Products: Characteristics, Potential Recovery and Beneficial Reuse, authored by UW-Milwaukee's **Steven Yeo** and **Frederick Binkowski** and Iowa State University's **Joseph Morris**, is a 47-page report that describes the characteristics of effluents and waste by-products of representative aquaculture systems in the North Central Region, including the relationship of these wastes to their dietary source and the aquaculture production process. Jointly published by Wisconsin Sea Grant and the North Central Regional Aquaculture Center with funding from the U.S. Department of Agriculture's Cooperative State Research, Education and Extension Service, this report also reviews various methods for wastewater and solids reduction and recovery for beneficial uses, and it recommends proactive measures that can be used to minimize the environmental impacts of aquaculture operations and to develop sustainable aquaculture practices in this region.

A MODEL OF FISH GROWTH

For nearly a decade now, UW Sea Grant Communications has facilitated technology transfer by marketing the popular Windows® version of the "Bioenergetics of Fish Growth" computer model.

During 2005 alone, more than 100 copies of the manual and software CD were sold at $75 each, primarily through the UW Aquatic Sciences Center's online Publications Store, bringing total sold since the model's debut in 1997 to well over 500, with a return of more than $35,000 on Sea Grant's substantial investment on model research and development.

Originally developed in the 1980s by Sea Grant-supported UW-Madison researchers to assess the growth and food consumption of Great Lakes predator and forage fish populations, this latest version of the model can be used to estimate growth and food consumption for many cold-, cool- and warm-water fish species and can be adjusted to a variety of stream, river or lake environments.

Today, the bioenergetics model is being used by fisheries managers, ecologists, limnologists, marine biologists and educators throughout the world.

University of Wisconsin Sea Grant Institute

connecting with people

lifelong learning: Sea Grant alumni

"…I hope that in the future as a librarian and community member I can help create many more opportunities such as this and learn as much from them...working on the outreach project for Allied Drive taught me much about planning and collaboration for community events, something not taught in coursework."

—**Stephanie Good**, Library Graduate Student Assistant, University of Wisconsin Water Resources Library, Madison

L to R: Molly Kliss, JoAnn Savoy, Ellsworth Rockerfeller, Tina Yao and Jodi Leslie

Wisconsin's Water Library for Kids

One fish, two fish, red fish, blue fish. — Dr. Seuss

From Dr. Seuss to a simple explanation of the water cycle, our newest Web site, Wisconsin's Water Library for Kids (*aqua.wisc.edu/waterlibrary/kids*), features children's books with an aquatic theme that have won awards or appeared on best books lists. Most books are for preschool through second grade, although there are also materials for older children. Besides fiction and nonfiction books, the library also has ideas and resources for story hours.

Users can browse recommended reading lists by topic (frogs, fish and fishing, Great Lakes, water pollution, etc.) and age group. Any adult Wisconsin resident can check out books online and pick them up at their local public library. Librarians, teachers, parents, grandparents and kids are particularly encouraged to surf the latest addition to Wisconsin's Water Library.

The site was constructed with the help of three graduate students enrolled in the UW School of Library and Information Studies Information Architecture course: **Molly Kliss**, **Jodi Leslie** and **Ellsworth Rockefeller**. **Tina Yao**, ASC Art Director, used pictures from the Water Library's Allied Drive story hours to design the site.

Reaching Young Readers

In 2003, the UW-Madison Water Resources Library became the first academic library in the UW System to make its collection directly accessible to all Wisconsin residents, earning it the South Central Library System's "Multitype Library of the Year" award in 2004.

But librarian **JoAnn Savoy** is not one to rest on laurels. That summer, along with other Aquatic Sciences Center staff, she began an effort to reach out to a more specific audience—children in Madison's southside Allied Drive neighborhood.

The neighborhood has the highest concentration of children of any urban neighborhood in Dane County, and many live in poverty. The neighborhood's students generally have the lowest state reading test scores in the Madison school district.

Armed with children's books purchased with a grant from the Friends of the UW-Madison Libraries, Savoy and ASC staff teamed up with the Boys and Girls Club of Dane County and the Madison School and Community Recreation program to hold several afternoon reading programs in the neighborhood.

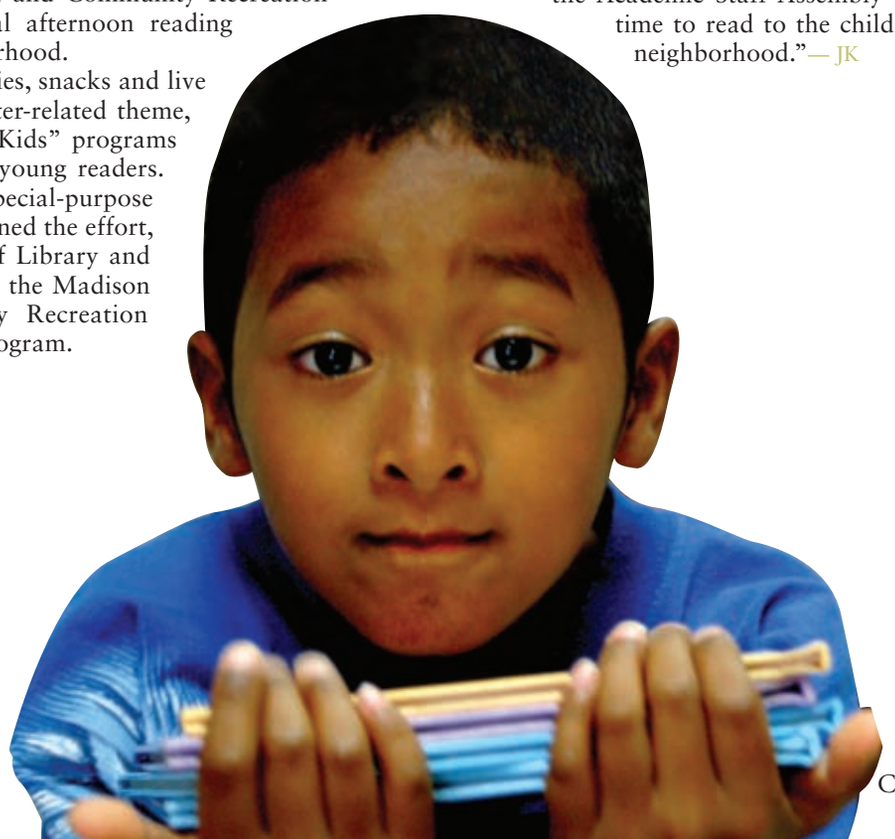
With art projects, movies, snacks and live animals all tied to a water-related theme, the "Water Critters for Kids" programs were a big hit with the young readers. Since then, six other special-purpose campus libraries have joined the effort, along with the School of Library and Information Studies, and the Madison School and Community Recreation Safe Haven Childcare Program.

Now, each month a different campus library hosts a reading hour with themes relating to their specialized topics. Last winter, staff at the Schwerdtfeger Library (Space Science and Engineering Center) talked to children about the science of snow; the Data and Program Library Service held a story hour about numbers.

Today, the program also includes the Primate Center Library, Steenbock Memorial Library (College of Agriculture and Life Sciences), School of Library and Informational Studies Library, and the Center for Instructional Materials and Computing.

"The children are not only improving their reading but also learning more about the university's research and fields of study," Savoy said. "It's kind of 'the Wisconsin idea' applied at the local community level."

In 2005, Savoy was among the staff and students of the Special Purposes Libraries Group lauded by the Executive Committee of the Academic Staff Assembly "for volunteering their time to read to the children of the Allied Drive neighborhood."— JK



photos by Bob Rashid and Rich Dellinger

lifelong learning: Sea Grant alumni

"My work in written communications helped greatly in my ability to deliver focused communications on highly technical subjects. The whole experience with "Earthwatch Radio" was tremendous. From interviewing skills, through writing and production on tight deadlines gave me significant experience in a disciplined work environment."

—**Paul Rome**, Chief Operating Officer, Imaging Acceptance Corporation, Warrenton, Virginia

VISUALIZING THE COAST

It can be difficult to convey all the complex changes that happen as coastal bluffs erode and recede, but the "dynamic and distributed" visualization and geographic information systems (GIS) work of **Stephen Ventura** and associates at the UW-Madison Land Information & Computer Graphics Facility is helping to bridge the gap between scientific understanding of these processes and public perception of coastal hazards.

"When coastal landowners see the 3-D animations of bluff erosion, they 'get it' in a way that scientists can't describe solely through the use of formulas and charts," the investigators report. "Conversely, this 'knowledge representation process' also helps scientists revise their theories and build better, more useful representations of coastal change."

This Sea Grant-funded project has helped to emphasize the role that imagery and animation have in public understanding and decision making about coastal erosion. This work is embodied in several Web sites, including "Bluff Erosion Visualization" (*mywebspace.wisc.edu/jdstone/web/coastal*), "Wisconsin's Lake Superior Coastal Mapping Portal" (*maps.aqua.wisc.edu/lscmp*) and "Wisconsin Coastal GIS Applications" (*coastal.lic.wisc.edu*).

UW Sea Grant GIS Specialist **David Hart** and project investigators also maintain the "Wisconsin County Web Mapping Sites" Web site (*coastal.lic.wisc.edu/wisconsin-ims/wisconsin-ims.htm*). Fifty-eight of Wisconsin's 72 county governments are developing interactive Web mapping sites, and this Web site provides direct access those that are available to the public. As of December 2005, 43 of these county Web mapping sites were accessible to the public, and the other 15 were still in development or limited to intranet or subscription access only.

SMART COASTAL PLANNING

"Smart growth" planning is essential to sustainable long-term development.

The Great Lakes Coastal Communities section of the online "Community Planning Resource" (CPR) provides a new toolkit for comprehensive planning and sustainable development along the Lake Michigan and Lake Superior coasts of Wisconsin. Prepared by UW Sea Grant Geographic Information Systems Specialist **David Hart**, the CPR includes hundreds of annotated resource pointers on coastal issues, natural hazards, laws and regulations, model plans and ordinances, training opportunities, maps and data, and news and current events. It also features a Web-adapted version of *A Guide to Planning for Coastal Communities in Wisconsin*, written in 2004 by the Bay-Lake Regional Planning Commission (see *planning.lic.wisc.edu/new_Coastal/ Coastal_ home.htm*).

Hart says development of the CPR has presented several opportunities for collaboration with other state and regional partners involved in comprehensive planning and "smart growth." During 2005, he began working with Wisconsin Department of Natural Resources (WDNR) Land Use Team to share information on computer tools to support planning, conservation and environmental protection and to apply them to coastal watersheds and communities. Hart is now exploring a possible exchange with the Michigan Sea Grant program to share the template and content of the CPR Web site and enhance it to address planning issues in Michigan. In return, Michigan State University would provide access to its highly successful "Citizen Planner" training program for developing workshops for planning commissioners in Wisconsin coastal counties.

PARTNERING FOR GROWTH

UW Sea Grant's Smart-Growth Extension Partnership project during 2004-06 provided 50 county conservationists and county board members of land and water conservation departments in the Great Lakes basin with key information on how to improve the quality and implementation of Land and Water Resource Management Plans.

"Plans that base nonpoint-source abatement activities on specific water quality objectives will help us achieve the goals of the Lake Michigan Lakewide Management Plan, Remedial Action Plans and Section 204 Basin Plans," says project leader **James Hurley**, UW Sea Grant's assistant director for research and outreach.

As part of this effort, UW Sea Grant Water Quality Specialist **Victoria Harris** presented future scenarios for Wisconsin water resources based on alternative urban, agricultural and lakeshore development patterns and land management practices to a conference on "East Central Wisconsin in 2050: The Future … Ours to Envision, Ours to Create." Harris also reported on the major conclusions and recommendations of the Waters of Wisconsin initiative. Sponsored by East Central Regional Planning Commission and UW-Extension, the conference was attended by 60 community officials, commission members and local agency staff.

The Smart Growth Extension Partnership is a program funded through NOAA Sea Grant by the U.S. Environmental Protection Agency.

Building Regional Consensus

Nonpoint-source pollution. Destruction of wetlands and other critical coastal habitat. Growing demands for Great Lakes water. Toxic chemical contaminants. Invading species and vanishing fisheries.

These and other key issues were summarized in nine overarching priorities for restoring and protecting the Great Lakes developed in 2003 by the Council of Great Lakes Governors (CGLG). But which are the most important? And what should be done to address them?

To find out, the Great Lakes Commission (GLC)—with funding from the National Sea Grant College Program—sponsored a series of eight workshops during 2004 to collect the comments and suggestions from resource users and managers, coastal residents, environmentalists, scientists, policymakers and the interested public in each Great Lakes state. Participants were asked about the major issues they believe need to be addressed as part of a basinwide restoration initiative and how current or new programs might be coordinated to achieve this.

Organized and hosted by each state's Sea Grant program in partnership with its governor's office and relevant state agencies, the aim of this unprecedented regionwide effort was to build consensus and unity of purpose in the continuing campaign to secure long-term, large-scale federal funding to restore and protect the Great Lakes.

Sea Grant was selected to conduct these workshops because of its reputation as a science-based, education-oriented, nonadvocacy program in grassroots contact with the full range of Great Lakes constituents.

To ensure consistency in outcomes, each workshop followed a similar format of brief presentations by the local Sea Grant director and representatives of the CGLG and GLC, followed by a series of focus group-style breakout sessions. Prepared in collaboration with GLC, the proceedings of each workshop were organized in a comparable manner, containing breakout group recommendations, lists of participants and all comments received. The proceedings of these workshops were subsequently provided to the region's governors, state and federal legislators, and the entire community of Great Lakes stakeholders.

Wisconsin Sea Grant played a leading role in organizing and hosting three such workshops, which were held in Duluth (in partnership with Minnesota Sea Grant), Green Bay and Milwaukee to ensure ample consideration of the different issues confronting western Lake Superior, Green Bay and southern Lake Michigan, respectively, and to minimize travel distances for potential participants as well. More than 200 people participated in these three workshops or submitted written comments. The proceedings of these and the other six workshops are available online at *www.glc.org/restwkshp*.

The emerging consensus on Great Lakes restoration and protection priorities has provided a solid basis for launching several bold congressional legislative and appropriations initiatives that, if approved, could provide as much as $5 billion for such efforts over a five-year period.

Restoration of the Great Lakes ecosystem has received increasing attention as an essential approach for securing a healthy environment and prosperous economy for Wisconsin and the rest of the region. These Sea Grant workshops provided advocates of federal restoration legislation with critical input on the issues deemed most important across the full spectrum of Great Lakes stakeholders at local, state and regional levels.

— SW

Gene Clark

Our Top Priorities

The top five restoration and protection priorities for Lakes Michigan and Superior identified by Wisconsin workshop participants were:

1. Ensure the sustainable use of water resources while confirming state authority over the use and diversions of Great Lakes waters.
2. Control pollution from diffuse sources into water, land and air.
3. Stop the introduction and spread of nonnative aquatic invasive species.
4. Enhance fish and wildlife by restoring and protecting habitats and coastal wetlands.
5. Adopt sustainable use practices that protect environmental resources and may enhance the recreational and commercial value of our Great Lakes.

Participants at all three workshops suggested that K-12, university and continuing education on Great Lakes issues should be either an explicit part of each of the governors' nine priorities, or perhaps added as a tenth priority.


John Karl

GENERATIONS IN SCHOOL

UW Sea Grant and the UW Center for Limnology have helped prove again you're never too old—or too young—to learn something new.

Limnology and Marine Science was one of 10 "majors" offered at the 2004 Grandparents University, a two-day workshop that gives children and their grandparents a chance to learn together on the UW campus.

James Lubner, UW Sea Grant's education outreach coordinator, challenged students to a game of "Great Lakes Jeopardy" and explained how researchers use remotely operated vehicles, or ROVs, to collect information underwater.

Philip Moy, UW Sea Grant's fisheries and aquatic invasive species specialist, introduced some of the Great Lakes' least desirable inhabitants, such as purple loosestrife, parasitic sea lampreys and zebra mussels. He gave each student—young and old alike—a set of Sea Grant invasive species watch cards so they could stay on the a lookout for those and other invasive aquatic species.

Later, **John Magnuson**, director emeritus of the UW Center for Limnology, took the students for a tour of Lake Mendota aboard the *R/V Limnos*, the university's 26-foot research trawler.

The Grandparents University is offered each summer as a collaborative effort of the Wisconsin Alumni Association and UW-Extension Family Living Programs.


John Karl

BUILDING EDUCATION EXCELLENCE

Wisconsin students, educators and citizens will soon have new opportunities to explore the science of the Great Lakes and their connection to the world's oceans. The National Science Foundation and National Oceanic & Atmospheric Administration (NOAA) recently announced approval of a $2.5 million grant for developing a Great Lakes Center for Ocean Sciences Education Excellence (COSEE)—the eighth in a national network of COSEEs.

UW Sea Grant Education Coordinator **James Lubner** is leading Wisconsin's involvement in the center, which will be supported by nearly $387,000 of the total grant.

"Public understanding of Great Lakes and ocean sciences is key to helping stakeholders make informed decisions on coastal and ocean management as well as personal stewardship issues," Lubner said. "The Great Lakes COSEE will engage the citizens of all ages in ways that promote a deeper understanding of our inland seas—the Great Lakes—and their influence on our quality of life and our national prosperity."

The Great Lakes COSEE will connect researchers, formal and informal educators, students in grades 4-10, and the general public to enhance scientific literacy and environmental stewardship.

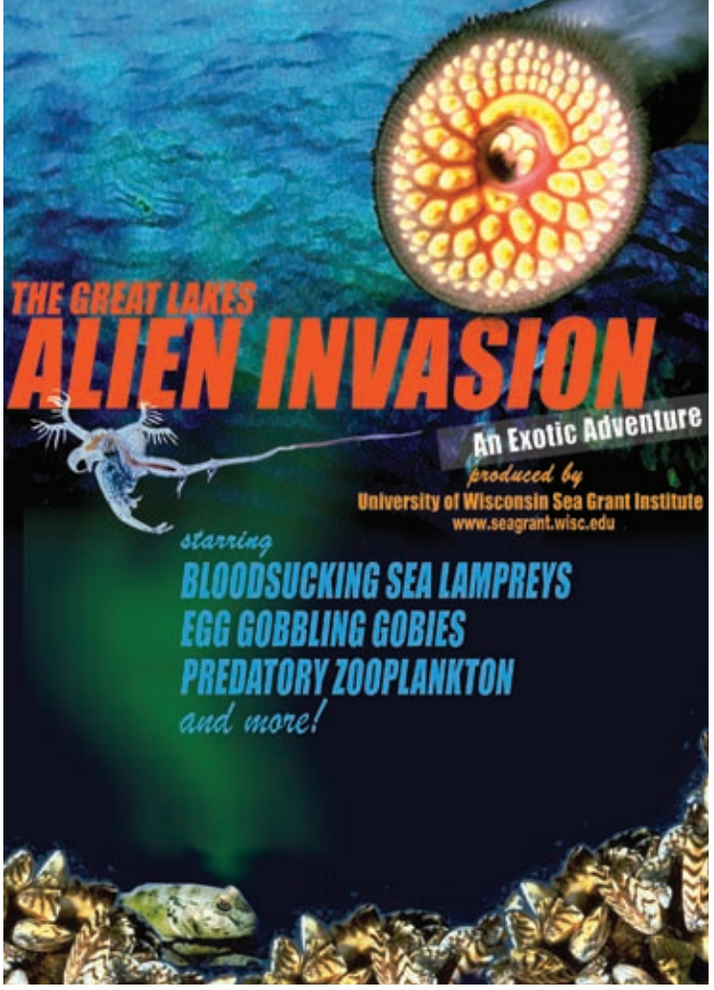
The five-year program will involve more than 2,000 teachers throughout the region who will develop working relationships with researchers, enhance their Great Lakes and ocean sciences knowledge, and develop new Great Lakes curriculum materials. More than 350 researchers will help educate a variety of audiences with on-shore and on-the-water seminars and workshops, according to Lubner.

COSEE Great Lakes is a collaborative effort of the Great Lakes Sea Grant Network, which also includes the Michigan, Illinois-Indiana, Minnesota, New York, Ohio and Pennsylvania Sea Grant programs.

lifelong learning: Sea Grant alumni

"The research trying to solubilize de-fatted fish protein was a great challenge. The work required integration of the fields in chemistry, biology, and engineering. The interdisciplinary experience amplified my knowledge, skills, and effectiveness in my later research activities."

—**Li Fu Chen**, Professor, Purdue University, West Lafayette, Indiana



HORROR SHOW ABOARD THE FERRY

For 53 years, the Badger car ferry has been safely carrying passengers as well as railroad cars and automobiles across Lake Michigan, but during the last two summers thousands of the ferry's passengers were taken by the "Great Lakes Alien Invasion."

The "invasion" is actually an interactive computer kiosk with a retro sci-fi, horror-flick look that recounts the pandemonium visited upon the Great Lakes by zebra mussels, round gobies, Eurasian ruffe and nine other "alien" invaders.

Developed by **Philip Moy**, **Tina Yao**, **Stephen Wittman** and **James Grandt**, the kiosk was designed to attract, entertain and educate the "captive audiences" aboard the ferry during its six four-hour daily trips across Lake Michigan from May to October.

During the 2004 and 2005 seasons, the computer's log indicates about 11,000 people viewed the kiosk aboard the ferry. From November through April of those years, it creeped out another 1,500 visitors to the Wisconsin Maritime Museum in Manitowoc.

"We're very excited to have the kiosk on board," said **Lynda Daugherty**, Badger director of media relations. "It's a great way for the passengers to become educated."

Daugherty said the kiosk fits in well with the company's "Cruise & Learn" program goal of providing entertaining, low-cost educational experiences aboard the landmark vessel during its four-hour trips across the lake.

The most popular pages on the kiosk are those explaining how aquatic invasive species affect us and how they can alter habitat. A page on the tenacious snakehead fish, which can live for days out of water, also attracted a great deal of passenger interest.

The success and innovativeness of "The Great Lakes Alien Invasion" kiosk earned it the first place "Judges Award for Outstanding Impacts in Individual Communications Projects" during the Sea Grant Week 2005 national conference last June in Camden-Rockport, Maine.

SHOCKING INVADERS

The Chicago Sanitary-Ship Canal Fish Dispersal Barrier is a high-profile aquatic invasive species (AIS) control and prevention effort that has attracted an increasing amount of public interest as three invasive species of Asian carp (bighead, silver and black) continue to spread up the Mississippi and Illinois rivers toward the Great Lakes via the Chicago Sanitary-Ship Canal.

The Dispersal Barrier Advisory Panel—a multiagency *ad hoc* advisory body that provides input and direction on the U.S. Army Corps of Engineers' electric barrier on the canal—is co-chaired by Wisconsin Sea Grant's AIS Specialist **Philip Moy**.

As the original barrier neared the end of its useful life in 2005, panel members were instrumental in obtaining appropriations of more than $9 million from both federal and state sources for construction of a second larger, longer-life electric barrier, which began in 2005 and is scheduled for completion in early 2006.

Moy also chairs monthly meetings of the Asian Carp Rapid Response Committee, formed at the request of the Great Lakes Fishery Commission to develop a response plan in the event Asian carp somehow get through the electric barrier.

HALTING INVASIVE BAIT

Hazard Analysis and Critical Control Point (HACCP) for the Baitfish Industry—an award-winning collaborative project of the Wisconsin, Minnesota, Michigan, Ohio and Pennsylvania Sea Grant programs that is designed to help prevent the spread of aquatic nuisance species (AIS) via baitfish operations and hatcheries—was continued during 2004-06 with a grant from the U.S. EPA's Great Lakes Protection Fund.

UW Sea Grant AIS specialist **Philip Moy** gave a presentation on HACCP to an audience of 50 at the Wisconsin Aquaculture Industry meeting in Stevens Point in March 2004 and held three more HACCP workshops in January 2005 that attracted a similar number of participants.

Moy also worked with the Wisconsin Bait Dealers Association to conduct a multistate HACCP workshop and with the Wisconsin Department of Natural Resources to arrange a HACCP workshop for its wardens and field staff.

lifelong learning: "Earthwatch Radio"

"I am a fisheries biologist with the U.S. Forest Service. . .I really appreciate the . . . brief summaries of current scientific findings. I share your work with my co-workers on the Nez Perce National Forest and use it for personal knowledge."

—**Wayne J. Paradis**, Fishery Biologist, Clearwater Ranger District

ASSISTING AQUACULTURE

During 2004-06, UW Sea Grant Aquaculture Outreach Specialist **Fred Binkowski** provided direct, one-to-one assistance and hands-on training to more than a dozen fledgling aquaculture businesses throughout Wisconsin, and supplied a variety of both general and specific aquaculture-related information to numerous other individuals.

Requests for information about sources for various species of fish and planning resources were typical. Intensive perch-rearing techniques was one of the principal topics of inquiry from within Wisconsin, other states and in some cases from Europe, according to Binkowski.

In 2004, he also worked with a number of American Indian groups and the regional office of the U.S. Department of the Interior Bureau of Indian Affairs to develop a consortium of yellow perch fingerling producers involving six reservations in Wisconsin (St. Croix, Red Cliff, Bad River, Lac Courte Oreilles, Menominee and Lac du Flambeau) and two in Minnesota (Red Lake and Leech Lake).

The Lac du Flambeau Tribal Hatchery in north-central Wisconsin has used larval lake sturgeon rearing techniques learned from Binkowski and his colleagues at the UW Great Lakes Wisconsin Aquatic Technology & Environmental Research Institute in Milwaukee to produce about 4,000 lake sturgeon from a 2005 year class. These fish will serve as the cornerstone of lake sturgeon rehabilitation efforts on the Lac du Flambeau reservation and will create the largest reservation population of lake sturgeon in the last 100 years.

During 2005, members of the Bad River Tribal Hatchery Program also visited the institute's Aquaculture Center for a hands-on demonstration of yellow perch spawning utilizing off-season captive broodstock. They plan to use these techniques to enhance their fish and wildlife conservation efforts on their reservation on the Wisconsin coast of Lake Superior, the Bad River and Chequamegon Bay.

STRATEGIC AQUACULTURE PLANNING

A federal Topical Advisory Team (TAT) spent the better part of two days conducting an intensive review of Wisconsin Sea Grant's aquaculture program in January 2006 at UW-Milwaukee's Great Lakes Wisconsin Aquatic Technology and Environmental Research Institute.

Led by **James McVey** of NOAA Sea Grant and **Ross Heath** of the Sea Grant National Review Panel, the TAT heard presentations from over a dozen state and regional aquaculture program constituents, including scientists, educators, outreach specialists and representatives of the Wisconsin Aquaculture Association, Lac du Flambeau Band of Lake Superior Chippewa Indians and the USDA's North Central Regional Aquaculture Center.

The TAT's official report is forthcoming, but its preliminary findings at the end of the review were that Wisconsin Sea Grant was focusing its efforts on the right species—yellow perch and lake sturgeon—and that the program should take a lead in coordinating aquaculture development at the regional level.

Specifically, the TAT recommended organizing a regional workshop to develop a strategic plan and regional "aquaculture research needs roadmap" for addressing yellow perch disease, nutrition and growth issues as well as "economics of scale" information needs regarding pond and recirculating aquaculture systems.

"I thought the workshop gave us many useful insights, and we look forward to the team's full report," said UW Sea Grant Director **Anders Andren**, who requested the review in response to a suggestion by a federal Program Assessment Team that an external review of the Wisconsin aquaculture program be conducted to provide advice on its future direction.

Other members of the TAT were Texas Sea Grant Director **Robert Stickney**, aquaculture entrepreneur **Dallas Weaver** and **Dorn Carlson**, the Wisconsin program officer at NOAA Sea Grant.

GATHERING FISH EXPERTS

UW Sea Grant Fisheries Specialist **Philip Moy** spent a significant portion of his time in 2004 to organizing and serving as general chair for the 2004 American Fisheries Society (AFS) conference held in Madison in August that year.

This highly successful AFS meeting attracted nearly 1,700 fisheries scientists and managers—the largest AFS meeting in the Midwest and third largest in AFS history.

For Moy, planning this conference meant organizing and chairing near-monthly meetings of a 23-member planning committee over a one-year period.

The conference featured three days of symposia and topical sessions, including one led by Moy on the threats posed to the Great Lakes by bighead and silver Asian carp in the Mississippi and Illinois rivers.

For a scientific conference, the event also attracted a significant amount of international as well as local media attention, including interviews with Moy by reporters from television Channel 5 News in Green Bay, *The London Financial Times*, *Milwaukee Journal Sentinel* and *Minneapolis Star Tribune*.

Thinking Spring for Spawning Fish in Fall

In the depths of winter in northeast Wisconsin, at Freedom High School some students—and some fish—are thinking spring. The school's aquaculture classes are carefully manipulating conditions in laboratory fish tanks to mimic the lengthening days and warming temperatures of spring to induce some 250 young yellow perch to spawn.

It's a challenging lesson in livestock reproduction and the latest ambition for **Kevin Champeau's** popular and highly successful aquaculture classes, where students learn everything from biology, math and business concepts to the hands-on skills of measuring dissolved oxygen and nitrogen, monitoring water temperature and cleaning slimy tanks. It's all part of the vigilance necessary for growing tiny fingerlings into meaty, marketable fish.

Champeau started the program 14 years ago, using a previously condemned classroom that he convinced the administration to "uncondemn."

"It didn't have much of anything," Champeau says. "It didn't have ventilation. We had to carry in our own water."

But Champeau persevered, and he now heads one of the largest and most successful of the 200 or so Wisconsin high schools offering aquaculture programs. Along the way, he has often turned to UW Sea Grant Aquaculture Specialist **Fred Binkowski** for advice, equipment and fish.

Binkowski helped develop the program's aquaculture curriculum, loaned water chillers and other equipment, and supplied fingerlings. In December 2005, he supplied the program's first large shipment of broodstock.

"Fred's always been there when we've needed him," Champeau said.

Binkowsi's expertise may soon prove valuable again, as Champeau and his students together learn the tricky techniques of spawning domestic broodstock.

It's a desirable subject to master because of all the lessons it teaches about the cycles of life and animal husbandry, Champeau says. And if he and his students are successful, they will venture into out-of-season spawning, a complex trick that most commercial aquaculture operations balk at it, according to Champeau.

"You have to manipulate nature," he says. "And any time you do that, it becomes a true science."

The only other facility to be doing it successfully, Champeau said, is Binkowski's Aquaculture Research Facility in Milwaukee.

Out-of-season spawning can provide a fish farmer with more batches of fingerlings throughout the year than would otherwise be available.

The technique involves fooling young fish into thinking it's spring and time to spawn, when it's actually, say, October. Champeau's class will do this by adjusting the laboratory light and the water temperature in the tank to elongate the changing seasons in nature. When fall rolls around in the real world, the days in the lab will lengthen, the water will warm, and the perch will spawn.

"It's a skill that not a lot of kids know," Champeau said. "So if I can give my kids that skill, they can put that on their resume as something they know that a lot of other people don't know."

If Champeau's track record is any indication, things will go well. His classes have proved highly popular with students. Many have found the real-life responsibility of raising fish more engaging than their more traditional academic classes. Some even put in extra time in the lab after school. Former student **Chad Kortz** now runs an aquaculture operation near Freedom with the help of a brother and a cousin who also took Champeau's courses.

Parents and the school administration have noticed. Four years ago, the community of Freedom backed a referendum on building the school a new 1,000-square-foot agricultural studies wing, which houses a two classrooms, a large laboratory, and two smaller labs. Champeau now has plenty of room—and water and ventilation—for teaching all the skills and knowledge that come with raising and breeding fish. — JK

***Kevin Champeau** instructs students **Ryan Kort** (above) and **Crystal Vande Hey** (right) in the art and science of raising fish at Freedom High School.*

PARTNERING FOR SAFETY

Posters and brochures are helping Lake Superior recreational boaters and anglers steer clear of commercial trap nets in an area off Bayfield County between Houghton Point and Madeline Island, thanks to a collaborative effort of local sport and commercial fishermen and UW Sea Grant's Lake Superior field office and Communications Office.

Commercial fishermen catch live whitefish in the traps, which are weighed down to sit on the lake bottom in waters 15 to 150 feet deep. Some net components can reach close to the surface, however, posing a potential hazard to recreational boaters as well as trolling anglers who don't know where they are located.

Al House, president of the Apostle Islands Sport Fishermen Association, said his group decided to meet with area commercial fishermen and discuss ways to work together to prevent incidents with the traps.

"Our group came away from the meeting knowing that the commercial fishermen felt these trap nets were important to their livelihood, and we respected that fact," House said. "We decided to find a way to reduce the number of conflicts that might happen between commercial and sport fishermen. Creating a poster showing the trap locations turned out to be the most popular idea."

House learned about Sea Grant in January 2004 when he attended the Lake Superior Fisheries Leadership Institute in Ashland. He subsequently contacted UW Sea Grant's Lake Superior Advisory Services Specialist **Gene Clark** at UW-Superior to find out if Sea Grant could offer assistance designing and printing the trap net poster. What House originally envisioned as a photocopied map ultimately became a color poster and accompanying brochure.

"Quite honestly, it was beyond our wildest expectations," he said.

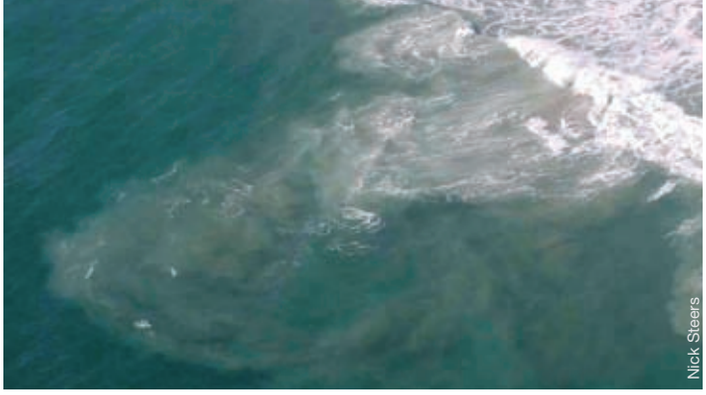
Over the next two years, some 60 posters and 800 brochures were produced and placed at area boat landings, Wisconsin Department of Natural Resources offices, bait shops, gas stations and sporting goods stores.

Besides an illustrations of the traps and how they are marked in the water, the poster also lists Geographical Positioning System (GPS) coordinates for each trap location. House said boaters and anglers need only enter these coordinates into their GPS navigation units to know when they are near one of the traps. Failing that, they will find the poster also provides advice on what to do if they do become entangled in a net.

lifelong learning: Sea Grant alumni

"Great start; gave me a feel for the real world."

—**Charles Morgan**, Environmental Planner, Planning Solutions, Inc., Honolulu, Hawaii



Nick Steers

AVOIDING THE RIP

In 2004, the National Sea Grant College Program joined with NOAA's National Weather Service and the U.S. Lifesaving Association to launch a nationwide campaign to create greater public awareness of the dangers of rip currents—an issue UW Sea Grant already had been addressing via leaflets, posters and annual news releases since 1999.

The Great Lakes Sea Grant Network was acutely aware of the need for such a campaign after seven people drowned in rip currents in early July 2003 in the Warren Dunes State Park area on Lake Michigan's southwestern coast. Because rip currents are generally associated with ocean beaches, many people are unaware that rip currents are also a common occurrence along many stretches of the Great Lakes shoreline. In fact, a UW Sea Grant survey of 14 public beaches along Wisconsin's Lake Michigan coast in 2003 had found that all but two reported that rip currents were a potential problem in their area.

Michigan Sea Grant played a major role in the national campaign, designing new rip current brochures and beach signs for distribution in all coastal areas. In April 2004, it hosted the region's first-ever conference on Great Lakes rip currents at St. Ignace, Mich., at which Coastal Engineering Specialist **Gene Clark** represented UW Sea Grant.

As part of the 2004 campaign, UW Sea Grant provided 17 of the new beach signs and 1,200 rip current brochures free of charge to the state's public beaches on Lake Michigan and Lake Superior, and "Earthwatch Radio" Producer **Rich Hoops** prepared a 40-second public service announcement on Great Lakes rip currents that was distributed to radio stations regionwide prior to the July 4th holiday weekend.

The program continues to provide free rip current signs and brochures to Wisconsin beaches on request and will be sending Spanish-language versions of both items to more than a dozen public beaches this year. English and Spanish versions of the rip current brochure can be downloaded free of charge on the Aquatic Sciences Center's online "Publications Store."

OVER 2.7 MILLION PRINTED

Wisconsin Sea Grant Communications originated the "Zebra Mussel Watch" card in 1992—about the time the biofouling invasive mollusk was first discovered in Lake Michigan—as a means of generating public awareness of the problem and enlisting the public's assistance in identifying and reporting zebra mussels at new locations.

In the 14 years since, the program has printed 2,737,390 "Zebra Mussel Watch" cards (an average of more than 195,000 per year) on behalf of various state and federal agencies, private companies and Sea Grant programs in 26 states and two Canadian provinces. The wallet-sized watch-card concept has been emulated by other Sea Grant programs and applied to other aquatic invasive species (AIS), including the Eurasian ruffe, round goby, spiny and fishhook waterfleas, purple loosestrife, Eurasian watermilfoil, and bighead and silver Asian carp.

During the last two years, UW Sea Grant distributed just over 405,000 "Zebra Mussel Watch" cards, of which 18 percent (about 73,000) were distributed in Wisconsin, 16 percent went to other Great Lakes states, and 66 percent went to other parts of the United States. Much of the distribution in Wisconsin resulted from requests generated by a full-page public service ad in the 2004 summer issue of *Wisconsin Trails* magazine as well as the program's annual offer to provide the cards free of charge to any and all interested chambers of commerce, UW-Extension offices, libraries and concerned government agencies statewide.

Also during 2004-06, the program distributed nearly 22,000 other AIS watch cards and related AIS information—such as Michigan Sea Grant's "Great Lakes Most Unwanted Aquatic Invasive Species" posters and the Minnesota Department of Natural Resources' *Field Guide to Aquatic Exotic Plants and Animals*, as well as its own *Protect Our Waters* brochure. Nearly 75 percent of this AIS information was distributed in Wisconsin and about 20 percent—mostly *Protect Our Waters* brochures—went to agencies and individuals in other Great Lakes states.

All of these AIS materials are available on the UW-Madison Aquatic Sciences Center's online "Publications Store," and single copies of each (except for the set of eight "most unwanted" posters) are provided free of charge.

LOTS OF FISHES SOLD

Wisconsin Sea Grant's "Great Lakes Fishes" poster continued to be a favorite catch regionwide during 2004-06, according to Publications Sales and Distribution Coordinator **Linda Campbell**.

Created in 2000 by Publications Editor **Elizabeth White**, the popular 26½- by 38½-inch color poster features beautiful and highly accurate illustrations of 35 Great Lakes fishes by famed wildlife artist **Joseph R. Tomelleri**. The poster was printed and distributed in cooperation with the Great Lakes Sea Grant Network with a retail price of just $5.

During the last biennium, Campbell said the program received 283 requests for a total of 674 copies of the poster – 34 percent of which went to Wisconsin residents and 58 percent to other Great Lakes states, with the remaining 8 percent mostly divided between residents of other states and Canada.

Similar proportions of another 1,057 copies of the poster have been ordered via the ASC "Publications Store" since it went online in 2003, bringing the total number of posters sold to date to 5,308.


SGNIS – California Dept. of Food and Agriculture

Documenting Aliens

The Sea Grant Non-Indigenous Species (SGNIS) Web site—a collaborative project of the Wisconsin and Illinois-Indiana Sea Grant programs—has served as Sea Grant's principal Web presence on aquatic invasive species (AIS) issues for nearly a decade, providing worldwide access to high-quality, science-based AIS information.

Coordinated by UW Sea Grant AIS Specialist **Philip Moy**, SGNIS (*www.sgnis.org*) now includes information on a dozen species of invasive aquatic plants and animals. Three species added during 2004 were the Asiatic clam (*Corbicula fluminea*), European rudd (*Scardinius erythrophthalmus*) and *Caulerpa taxifolia*, an alga believed to have been introduced via aquarium hobbyists. Five more invasive species on which Sea Grant-funded research is being conducted or that were common in other parts of the country—such as the European green crab (*Carcinus maenas*) and hydrilla (*Hydrilla verticillata*)—were added in 2005. Other species, such as the mitten crab, are now being researched and will be added during 2006, Moy said.

In addition, a committee of Sea Grant educators—co-chaired by **Robin Goettel** (Illinois-Indiana Sea Grant) and **Helen Domske** (New York Sea Grant)—was established in 2005 to plan and develop a refined SGNIS "Kids Page" based on the latest Instructional Design Strategies.

Recently redesigned to greatly decrease file loading time and accommodate different Web browsers, SGNIS computers at Purdue University logged over 3 million file transfers during 2004—up 88 percent from the previous year. Though accessed by users from 125 nations, the logs show two-thirds of the users were from the United States.

The SGNIS database currently contains more than 1,700 items related to AIS, including 922 completed research reports, 384 research and outreach papers in six conference proceedings, 91 issues of newsletters, a 109-slide image library, and 176 education and outreach publications. Users can search the SGNIS database via 49 keywords, 18 product types, and six user types.

SGNIS provides AIS materials from a variety of sources, such as the annual International Aquatic Nonindigenous Species Conference, the national Sea Grant network, NOAA environmental research labs, U.S. Army Corps of Engineers, U.S. Coast Guard and the U.S. Geological Survey's Florida Caribbean Science Center. To ensure users of the highest quality information, all research and outreach documents on SGNIS must pass a rigorous peer review process.

To date, contributions to SGNIS have been made by more than 100 organizations (including 20 different Sea Grant programs) and 148 professional scientific journals. — SW

lifelong learning: Sea Grant alumni

"My Sea Grant project involved public participation in land use/resource management planning. This experience helped me obtain my first federal job in Washington, D.C., developing a legislative proposal to protect natural heritage sites via state programs. My career evolved into more than 25 years in environmental information management."

—**Kathleen Gundry**, Program Manager, Science Applications International Corp., Falls Church, Virginia

John Karl

"My work on "Earthwatch Radio" as a graduate student introduced me to the wide range of issues that involve our rivers, lakes and oceans."

—**Kathleen Schmitt**, Science Writer, University of Wisconsin Aquatic Sciences Center, Madison, Wisconsin

TRACKING FORMER STUDENTS

Through the years, the Wisconsin Sea Grant program has supported nearly 500 students—28 percent of them women—helping 325 of them earn a master's degree and 211 earn a Ph.D.

"We believe that research and graduate education are inseparable," says UW Sea Grant Director **Anders W. Andren**. "Most of our program's investment in education is in funding research assistantships, which enable graduate students to work with faculty on Sea Grant-supported projects."

In observance of its upcoming 35th anniversary as a Sea Grant College, the UW Sea Grant Institute is conducting a systematic survey of former Sea Grant-supported graduate students to learn about their current employment and professional lives and how their Sea Grant experience benefited their careers. To date, all but 79 of these graduates have been located, and as of March 1, 2006, information about nearly 54 percent of them had been obtained.

The results show that these Wisconsin Sea Grant-trained graduates are national assets. They have moved into the executive suites of major corporations, become senior scientists in government laboratories, started their own businesses and become tenured professors. The survey shows that:

- These former students currently work in 36 of the 50 United States and in six foreign nations,
- 90 percent are in occupations related to their graduate work,
- 30 percent work in the private sector,
- 27 percent are employed in the public sector (17 percent federal, 7 percent state and 3 percent local government), and
- 43 percent hold positions in the academic sector.

The percentage of former students in the academic sector is notable for its multiplier effect as those in faculty positions continue to educate hundreds of additional students.

The range of occupations held by these former students includes:

- President of a multimillion-dollar corporation providing information tools for chemists,
- Professor of music at UW-Stevens Point,
- Director of a National Oceanic & Atmospheric Administration environmental research laboratory,
- High school science teacher in Milwaukee,
- Published poet and author,
- President of a university in Canada,
- National Cancer Institute investigator,
- Editor-in-chief of *Limnology & Oceanography*, one of the top-ranked journals in the field,
- President of a fish farm with the largest indoor hatchery in Ohio, and
- Director of a $30 million federal research and development enterprise employing 120 Ph.D. scientists and 170 technical support personnel.

The final results of the completed survey will be published later this year, but as comments displayed throughout this report show, these former students believe their Sea Grant-supported work made direct, significant and long-lasting contributions to their career.

"If you're capable, and if science is something you enjoy, you can find work. But you have to be persistent. The person who's successful has failed as many times as anyone else, but he or she just keeps on going to get what he/she really wants out of life."
—Carol J. Lloyd

Student Work Springboard to 25-Year Career

While a Sea Grant-supported master's degree student in UW-Madison's Oceanography and Limnology program in the mid-1970s, **Carol Lloyd** (then Carol Welkie) was surprised by the degree of autonomy and responsibility she got. "We did everything for ourselves," she recalled. "We planned our research and wrote our proposals with a minimum of supervision."

A native of Alaska, Lloyd had jumped at the opportunity to work on an Alaskan underwater minerals exploration project with J.R. "Robby" Moore, then director of the Oceanography and Limnology program.

Awarded her Ph.D. in 1980, Lloyd's doctoral research focused on offshore geology and geophysics; now, as an geophysical associate with ExxonMobil Exploration Co., she is a technical specialist who uses state-of-the-art tools to mitigate the risk of drilling oil and gas prospects offshore in the Congo, and both on and offshore in South America.

"My experience as a Sea Grant graduate student was directly related to my obtaining my first position as research geophysicist for Exxon Production Research [EPR] Company in 1980," she said. "My graduate experience involved extensive field work in Alaska, the Great Lakes, Pacific and Gulf of Mexico. I built most of my own equipment for my Ph.D. dissertation using parts provided to me by industry sponsors. This data acquisition and engineering experience positioned me well for the Marine Research Group at EPR."

At EPR, Lloyd put those skills to full use. In her first assignment, she gathered geophysical data in the field. As part of the Marine Research Group, Lloyd designed, built and tested equipment for better seismic data acquisition and seismic "borehole" acquisition, which resulted in the awarding of three patents during that period in her career.

Next, she took on a data processing role, then moved to a position in data interpretation. From there, she moved to the Exxon Exploration Company, weathered a merger with Mobil, and obtained experience in the development and production parts of the new corporation. Now she's back in exploration.

"Most of my work has been in the marine environment, working offshore in the Gulf of Mexico, Venezuela, Brazil, Trinidad, Cook Inlet Alaska and West Africa," she said. "But I also have worked onshore in Wyoming, Trinidad, Venezuela and South Texas. Over the years, I have made major contributions to 17 oil discoveries and presented several papers at professional society meetings."

Lloyd says her experience as a Sea Grant-supported research assistant was the springboard for all of her professional work since she graduated from the program in 1980: "[As students], we ran our projects from beginning to end. All of our projects were interdisciplinary—if you were a geologist, you didn't just do the geology; you also had to integrate other disciplines, such as engineering, meterology and chemistry, and consider the effect of your research on the entire ecosystem. We maintained our own research boat on the Great Lakes, and we also had opportunities [to work] as visiting scientists with Scripps, Columbia University and the United States Geological Survey."

Lloyd believes that trends toward specialization in the sciences cut both ways. While it's necessary to keep up with rapidly developing technology, she sees a danger of losing the forest for the trees. That's why she values the integrated approach that her experience with Sea Grant taught her.

"I know people who interpret data but don't have the foggiest notion of how it was collected or processed," she says. "You really can't make a good interpretation unless you're aware of the big picture. Each step affects the quality of the data and alters the way that the data should be interpreted in order to make an informed decision."

Lloyd entered the oil industry during boom times yet persevered through the recession-plagued 1980s, a time when many of her colleagues were laid off. Through budget cuts and corporate downsizing, she attributes her continued success to tenacity as well as flexibility.

"I've never been discouraged," she says. "If you're capable and if science is something you enjoy, you can find work. But you have to be persistent. The person who's successful has failed as many times as anyone else, but he/she just keeps on going to get what he/she really wants out of life." — SW

lifelong learning: Sea Grant alumni

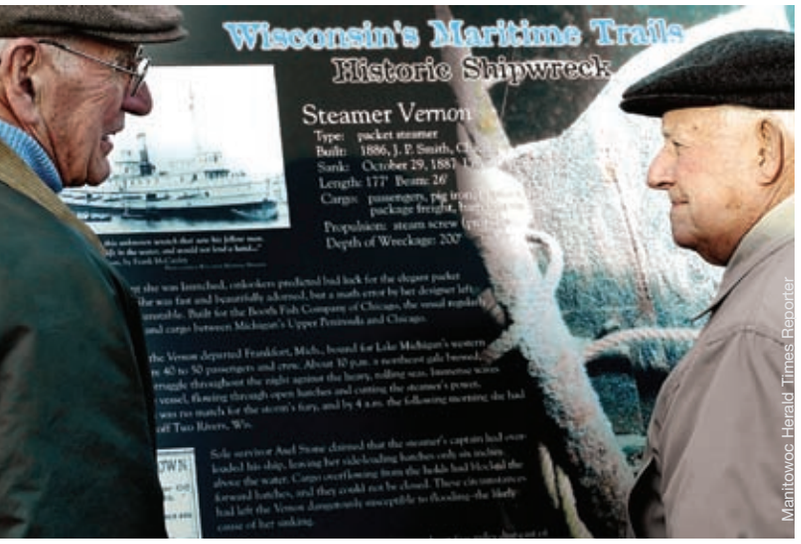
"The Sea Grant projects provided the research freedom that was essential in my development as a research scientist. I gained valuable experience in formulating hypotheses, developing research plans and conducting research. The skills I acquired through laboratory and field work have been invaluable."

—**Paul Doskey**, Scientist, U.S. Department of Energy Argonne National Laboratory, University of Chicago

ON THE TRAIL OF WISCONSIN MARITIME HISTORY

Time marches inexorably onward, but the days of wooden schooners and steamers on the Great Lakes grow more vivid each year, as "Wisconsin's Maritime Trails" help residents and visitors appreciate the state's rich maritime history.

Spearheaded by the Wisconsin Historical Society and enthusiastically supported by Wisconsin Sea Grant and other partners, the "trails" comprise maritime attractions winding above and below the waves along Wisconsin's Great Lakes coasts. During 2004-06, science writer **John Karl** worked with WHS underwater archaeologists **Catherine Green** and **Russell Green** (both now at the Thunder Bay National Marine Sanctuary in Alpena, Mich.), **Keith Meverden** and **Tamara Tompsen** to expand the trails in many ways.



Manitowoc Herald Times Reporter

The team developed and installed five interactive kiosks in museums in Manitowoc, Kenosha, Madison, Sturgeon Bay and on Madeline Island. Packaged in attractive wooden cabinets, the kiosks use touch-screen technology to allow visitors to explore Wisconsin shipwrecks, underwater archaeology, artifact conservation and scuba diving. A highlight is an interactive computer model of a Great Lakes three-masted schooner that allows visitors to explore the ship and its features.

A total of 10 roadside historical markers were developed and installed. The Reynolds Pier marker in Jacksonport describes two lumber schooners that wrecked in the heyday of Wisconsin's lumbering days. The Vernon marker commemorates an elegant packet steamer that fell victim to a storm off Two Rivers in 1887. The sign was installed in the Two Rivers Fishing Village. Six more markers are nearing completion and will be installed summer 2006.

The archaeologists provided more than 50 public presentations in these two years, and their work prompted nearly 40 radio interviews and newspaper and magazine articles.

These outreach efforts draw deeply upon the archaeological field work conducted by WHS underwater archaeologists, who have received significant support from Wisconsin Sea Grant for nearly two decades. During 2004-06, Wisconsin Historical Society archaeologists conducted field surveys and historical investigation on the schooners *Perry Hannah, Cecelia, Daniel Lyons* and the scow-schooner *Tennie & Laura*.

Archaeology and maritime history enthusiasts as well as divers followed the progress of this work on the popular daily Web journal, "Notes from the Field," (*www.maritimetrails.org/notes*). Using underwater images, historic photographs and journal entries, archaeologists explained how and why the field work was conducted.

Based on previous Sea Grant-supported archaeological research, the schooner *Hetty Taylor* was listed on the Wisconsin and National Register of Historic Places. Built in 1874 and wrecked off Sheboygan in 1880, the *Hetty Taylor* was a small coastal schooner of an unusually high-quality build, with many adornments unusual for this type of vessel. The *T.H. Camp*—a fish tug representing a hard-working, unglamorous type of Great Lakes vessel—was also listed.

Besides fostering public appreciation of Great Lakes history, the Maritime Trails are making a difference economically, according to **Jim Robinson**, owner of the Shoreline Resort in Gills Rock, which includes a marina, dive shop and a charter diving service. Robinson says "the Maritime Trails Program has been an excellent educational program for visitors to this area as well as local residents" and that "I personally have seen my business benefit from this program." Robinson has hired a full-time captain for his dive charters and he is adding a boat "to accommodate the increasing numbers of divers and visitors who are interested in the historical shipwrecks of this area."

Robinson is on the Board of Directors of the Door County Chamber of Commerce, which, he said, "feels this program is so beneficial that they include information and directions to the Maritime Trails in their literature."

In September 2004, Wisconsin's contributions to the Maritime Trails collaboration earned it a "Superior Program Award" from the Great Lakes Sea Grant Extension Program Leaders. In June 2005, the UW Sea Grant's "Wisconsin's Great Lakes Shipwrecks" Web site (*www.wisconsinshipwrecks.org*), a prominent component of the trails, was awarded First Place in Best Web-Based Outreach Efforts at the national Sea Grant Week conference in Camden-Rockport, Maine.

lifelong learning
diving online

www.wisconsinshipwrecks.org

Public access to and appreciation of Great Lakes shipwrecks and maritime history continued to be enhanced during the last biennium as a result of UW Sea Grant's award-winning underwater archaeology, shipwreck preservation and public education project.

Since the launch of this long-running project, an average of nearly 11,000 visitors per month have been accessing UW Sea Grant's "Wisconsin's Great Lakes Shipwrecks" Web site (*www.wisconsinshipwrecks.org*).

The shipwrecks Web site is a major component of the Wisconsin's Maritime Trails partnership between Wisconsin Historical Society (WHS) and UW Sea Grant.

PODCASTING A WIDER NET

Thanks to a new technology known as "podcasting," people all over the world are now tuning into Sea Grant's "Earthwatch Radio" program by way of the Internet.

"Love the Podcast, folks," reads an email from Rex Neville. "Comes through 'loud and clear' here in Christchurch, New Zealand."

"Earthwatch Radio" is a two-minute public service program about science and the environment produced since 1972 by the UW Sea Grant Institute in cooperation with the Gaylord Nelson Institute for Environmental Studies at UW-Madison. Producers **Richard Hoops** at UW Sea Grant and **Steve Pomplun** at the Nelson Institute work with a handful of staff and students writers to create and record 260 programs every year. Aired by some 120 commercial and public radio stations across North America, each program has, potentially, as many as a million listeners throughout North America.

With the help of podcasting, these audio programs now reach an entirely new and potentially huge audience online—and off.

Podcasting uses a technology known as RSS—an acronym for "Really Simple Syndication"—which allows people to easily download audio files to a variety of audio devices, such as the popular iPod, and listen to them at their convenience.

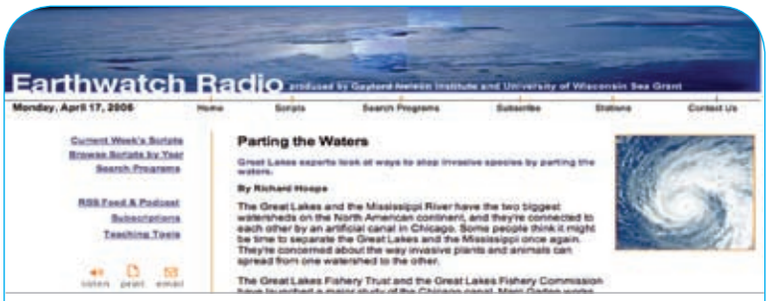
UW Sea Grant Web Developer **Rich Dellinger** created an RSS feed for "Earthwatch" in December 2004. Not only was Wisconsin the first Sea Grant program in the nation to apply this new technology, "Earthwatch" was among the first scientific/environmental programs to be listed in such online directories as *Podcast.net, iPodder.com* and *Apple.com/iTunes*.

A podcast feeding frenzy soon followed. By the end of 2005, UW Sea Grant Web servers had logged nearly 250,000 downloads of "Earthwatch" audio files. Some individual programs had been downloaded as many as 4,000 times. RSS can also deliver text, and the RSS feed for "Earthwatch" scripts was registering another 8,000 downloads monthly.

The program still continues to be distributed via a compact disc sent each month to "Earthwatch Radio" affiliates, including numerous operations in Wisconsin and the Great Lakes region. A global broadcaster—the World Radio Network, based in London—also carries "Earthwatch Radio" as a feature program that it broadcasts worldwide via satellite.

Check out "Earthwatch" for yourself—it's on the Web at *ewradio.org*.

*Student writer **Elizabeth Katt-Reinders** (left) and producer **Richard Hoops** witness the dawn of the podcasting age.*



lifelong learning "Earthwatch Radio"

ewradio.org/

"The 'Earthwatch Radio' scripts that I receive by email are topical and readable summaries of cutting-edge scientific research of environmental issues. I often find information in the Earthwatch scripts that is worth sharing with the staff and Commissioners of the IJC."
—**Frank Bevacqua**, Public Information Officer, International Joint Commission, Washington, D.C.

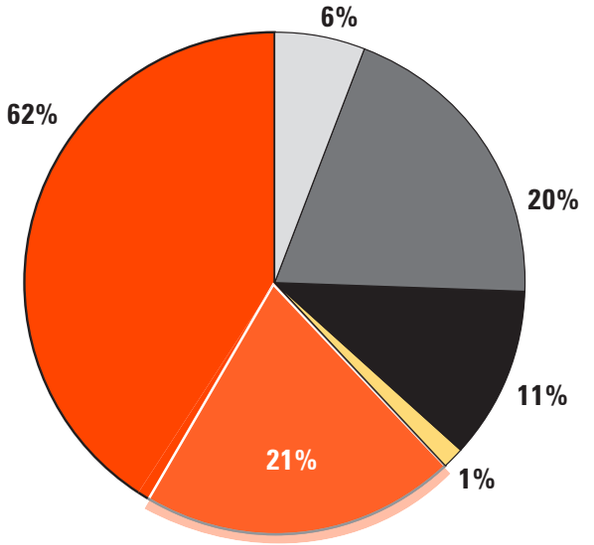
"It's a pleasure I have important information of 'Earthwatch Radio' everyday. I'm not a teacher but I use your scripts for knowing a lot of things about ecology themes and for practicing English in the night with a group of students. I think your scripts are extraordinary."
—**Edgar Ortiz Gongora**, Colombia, South America

"I am the science coordinator at a private school in Milwaukee. Your program has turned into my favorite daily e-mail. It is succinct—it provides enough information to present an overview to teachers and students who are studying that topic and also leads them to the more detailed sources."
—**Nicola De Torre**, Lower School Science Coordinator, University School of Milwaukee

University of Wisconsin Sea Grant Institute
managing for success

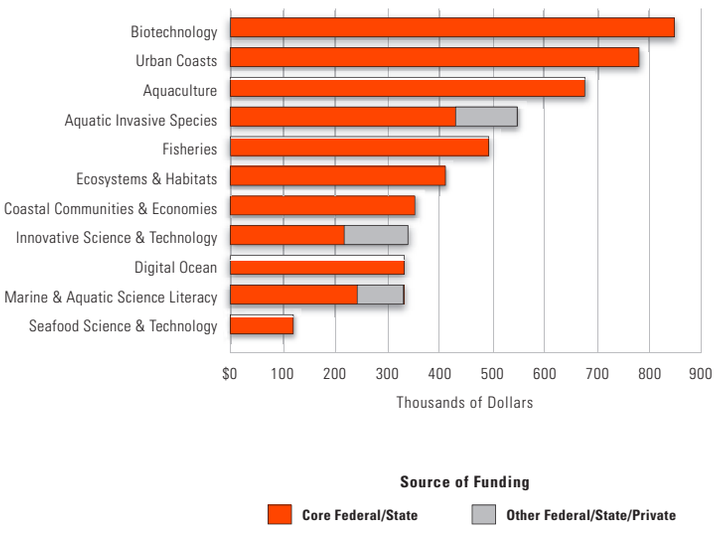
BUDGET OVERVIEW

Program Components 2004–2006



Thematic area funding FY 2004–2006

NOTE: Some projects address more than one theme.



CONSTITUENT-DRIVEN PRIORITIES

A lot of people help determine UW Sea Grant's program priorities.

As recommended by the last federal Program Assessment Team, the Wisconsin Sea Grant strategic planning process was modified in 2002 to rely more extensively on input from external advisory groups, research faculty, program outreach staff, and various local, state and regional constituencies.

With the endorsement of the UW Sea Grant Advisory Council, the program's existing strategic plan was first restructured in accordance with Sea Grant's 10 national themes, such as "Aquatic Invasive Species" and "Coastal Natural Hazards," and to incorporate as well UW-Madison's strategic goals, like "Advance Learning" and "Amplify the Wisconsin Idea."

The restructured strategic plan was then distributed to more than 450 individuals—including state and regional constituent groups; local, state and federal government officials, and university scientists, faculty and administrators—for review and comment. These comments and other feedback were used to update the UW Sea Grant's state and regional strategic priorities in each of the 10 Sea Grant national themes, which in turn became UW Sea Grant's 2004-06 Request for Proposals (RFP).

A similar process—this time including meetings with various constituent groups by individual outreach staff, followed by management team conference calls with constituent representatives in three program focus areas (Aquaculture, Aquatic Invasive Species and Geographic Information Systems)—was used again in 2004 to update UW Sea Grant's research, outreach and education priorities for its 2006-08 RFP. These strategic priorities also became a major criterion used by members of external review panels in recommending which project proposals to fund during both the 2004-06 and 2006-08 biennia.

This biennial strategic planning process helps guarantee Wisconsin Sea Grant is an up-to-date, national issues-oriented, constituent priorities-driven and fully integrated research, outreach and education program that also serves the goals and priorities of UW-Madison, its parent institution.

PROJECT REPORTING ONLINE

Since 2001, the interactive Project Reporting Online (iPRO) system has provided an easy, efficient way for Wisconsin Sea Grant principal investigators to manage their projects via an interactive Web interface. During 2004-06, UW Sea Grant Web Developer **Rich Dellinger** continued to refine and enhance the system based on user feedback.

One of the newest features permits principal investigators (PIs) and/or designated staff and students to submit project completion reports online, including accomplishments, benefits and student activities. Other recent improvements enable PIs to more easily submit required annual progress report information.

A Sea Grant project team led by Dellinger and Finance & Grants Administrator **Dan Marklein** also continued to develop the administrative side of iPRO. By February 2006, all project-related printed material (preproposal through final correspondence) had been converted to electronic format and uploaded to individual project files. In addition, all future administrative correspondence regarding projects will be posted electronically in iPRO.

Another new administrative feature was developed that generates automatic e-mail notices, such as annual report reminders, to selected individuals concerned with the project.

"iPRO facilitates continuous information exchange between investigators and program administration, education and outreach staff on project-related activity even after a project ends, thus creating a more complete, up-to-date record of project results," Dellinger said. "As a result of these enhancements, iPRO now serves as an electronic filing cabinet containing a complete record of all project information."

CAMPUS CLIMATE CHANGE

UW-Madison is committed to the principles of equity and diversity to promote respectful and supportive working and learning environments, and so is the UW-Madison Aquatic Sciences Center (ASC), administrative home of the UW Sea Grant Institute.

During 2004-06, the ASC was represented on the UW-Madison Graduate School's Equity & Diversity Committee by Assistant Director for Research & Outreach **James Hurley**, Publications Editor **Elizabeth White**, GIS Specialist **David Hart** and Art Director **Tina Yao**.

In September 2005, ASC Director **Anders W. Andren** established the center's own Equity and Diversity Committee to help promote diversity and a good working environment. Chaired by White, committee members include Hart, Yao, Radio Producer/Editor **Rich Hoops**, Science Writer **Kathleen Schmitt** and Graduate Student **Elizabeth Albertson**. By November, the committee had drafted an ASC Equity and Diversity Plan, elements of which have already been implemented.

As a matter of center policy, staff members are encouraged to participate in diversity and campus climate programs as part of their professional development. During 2004-06, Yao attended the UW-Madison Leadership Institute, a nine-month program aimed at building leadership for an inclusive campus community that affirms diverse world views. Librarian **JoAnn Savoy** participated in a series of programs on ways the library community can encourage diversity on campus; she also attended a workshop on understanding the history, culture and sovereignty of federally recognized American Indian bands and tribes in Wisconsin. And Program Assistants Supervisor **Terri Klousie** participated in an organizational effectiveness workshop that covered ways to improve work and learning climate.

In early 2006, the university offered a workshop on maintaining a sexual harassment-free workplace that was attended by everyone who supervises employees at the ASC. Library Project Assistant **Jodi Leslie** also participated in the workshop.

MARKETING ONLINE

The continued development of online marketing during 2004-06 has meant more Sea Grant publications distributed to more people at less cost.

Launched in February of 2003, the UW Aquatic Sciences Center's online "Publications Store" (*aqua.wisc.edu/publications*) has significantly increased distribution of Wisconsin Sea Grant and Water Resources program publications while lowering mailing costs and increasing cost-recovery sales all at the same time, according to Publications Sales & Distribution Coordinator **Linda Campbell**.

In response to online requests during 2005, the ASC Communications Office mailed out a total of 18,610 publications—4,943 fewer than the year before—while recording 7,367 downloads of online portable document files (PDFs), resulting in a net gain of 2,424 in publications distribution compared with the preceding 12 months.

Moreover, sales credits during the same period totaled $24,605—a 48 percent increase over the previous 12-month period. In addition, nearly 302,000 of UW Sea Grant's "Zebra Mussel Watch" cards were distributed in response to requests received via the "Publications Store" alone, Campbell said.

She added that by tracking distribution and sales, the system has helped her improve information marketing efforts and more precisely manage the center's publications and products inventory.

Appendices

Participating Institutions and Agencies, 2004-06 *(30)*

Harvard Medical School
Lawrence University
Marquette University
Michigan State University
North Carolina State University
The Ohio State University
Penn State University-Erie
Plattsburgh State University of New York
Purdue University
U.S. Environmental Protection Agency
U.S. Geological Survey
University of Illinois-Urbana
University of Michigan
University of Minnesota
University of North Carolina
University of Notre Dame
University of Puerto Rico
University of Vermont
University of Wisconsin-Extension
University of Wisconsin-Green Bay
University of Wisconsin-La Crosse
University of Wisconsin-Madison
University of Wisconsin-Manitowoc
University of Wisconsin-Milwaukee
University of Wisconsin-Stevens
Point University of Wisconsin-Superior
University of Wisconsin System
Wisconsin Coastal Management Program
Wisconsin Department of Natural Resources
Wisconsin Historical Society

Students Supported

2004-05: *22* graduate students, *27* undergraduate students
2005-06: *22* graduate students, *26* undergraduate students

Students Earning Master's Degrees *(16)*

Eric Auerbach, UW-Madison
Lisa Corradin, UW-Stevens Point
Stephanie Good, UW–Madison
Julie Hahm, UW–Madison
Jeffrey Jorgensen, UW-Madison
Gail Jurgella, UW-Madison
Dawn Karner, UW- Madison
Jennifer Koehler, UW-Madison
Brea Lemke, UW-Madison
Gemma May, UW-Madison
Yuliana Ng, UW–Madison
Diane Pansky, UW-Madison
Rachel Sohmer, UW-Madison
Justin Wanek, UW-Madison
Kim Weckerly, UW-Milwaukee
Jennifer Zeisloft, UW-Madison

Students Earning Doctorate Degrees *(10)*

Carola Blazquez, UW-Madison
Jeffrey Brownson, UW-Madison
Sara Carney, UW-Madison
Colin Crowley, UW–Madison
Christin Frieswyk, UW-Madison
Patrick Gorski, UW-Madison
Matthew Menne, UW-Madison
Amy Prasch, UW-Madison
Aaron Stegner, UW-Madison
Aifeng Yao, UW-Madison

Students Awarded Fellowships/Scholarships *(6)*

Dean John A. Knauss Marine Policy Fellowship
2004—Colleen Corrigan, UW-Madison
2005—Diane Pansky, UW-Madison

Sea Grant Industrial Fellowship
2004-06—Timothy J. Lee, UW-Madison

Carl J. Weston Memorial Undergraduate Scholarship
2004—Meghan Olson, UW-Madison
2005—Lili Prahl, UW-Madison

NOAA Coastal Services Management Fellowship
2004—Lindsay Anderson, UW-Madison

Staff Professional Awards 2004-06

AUXILIARY ANNUAL SERVICE PERFORMANCE AWARD from the U.S. Coast Guard for outstanding volunteer contribution of public education instruction (**James Lubner**)

AUXILIARY MEMBERSHIP SERVICE AWARD from U.S. Coast Guard in recognition of 25 years of dedicated service as a member of the U.S. Coast Guard Auxiliary (**James Lubner**)

CHRISTIE-LOFTUS AWARD from the U.S.-Canadian Great Lakes Fishery Commission for distinguished contributions to healthy Great Lakes ecosystems (**Philip Moy**)

COMMENDATION FROM THE EXECUTIVE COMMITTEE OF THE UW-MADISON ACADEMIC STAFF ASSEMBLY to the staff and students of the Special Purposes Libraries Group for volunteering their time to read to the children of the Allied Drive neighborhood (**JoAnn Savoy**)

EXCELLENCE IN DESIGN AWARD–RESEARCH PUBLICATIONS from the University and College Designers Association for *University of Wisconsin Sea Grant Institute 2002-04 Biennial Report* (**Tina Yao**)

EXCELLENCE IN DESIGN AWARD–RESEARCH PUBLICATIONS from the University and College Designers Association for *University of Wisconsin Sea Grant Institute 2004-06 Directory of Projects and People* (**Tina Yao**)

MULTITYPE LIBRARY OF THE YEAR AWARD from the Wisconsin South Central Library System for "Wisconsin's Water Library" project (**JoAnn Savoy**)

SEA GRANT WEEK 2005 FIRST PLACE AWARD IN WEB-BASED OUTREACH EFFORTS for "Wisconsin's Great Lakes Shipwrecks" Web site (**John Karl**, **Rich Dellinger**, **Tina Yao**)

SEA GRANT WEEK 2005 JUDGES AWARD FOR OUTSTANDING IMPACTS IN INDIVIDUAL COMMUNICATIONS PROJECTS for the "Great Lakes Alien Invasion" interactive computer kiosk project (**Philip Moy**, **James Grandt**, **Stephen Wittman**, **Tina Yao**)

SUPERIOR PROGRAM AWARD from the Great Lakes Sea Grant Network for "Diving into History: Research and Public Education on Wisconsin's Underwater Archaeological Resources" project (**John Karl**)

WILLIAM Q. WICK AWARD for Visionary Career Leadership from the Assembly of Sea Grant Extension Program Leaders (**Philip Keillor**)

Publications 2004-06

NEW TITLES ADDED—*44*
- *35* Science journal reprints
- *19* UW Sea Grant publications

PUBLICATIONS DISTRIBUTED ON REQUEST (all titles): *50,166*
95.5% UW Sea Grant publications
- *77%* Wisconsin residents
- *7%* other Great Lakes states residents
- *15%* U.S. residents
- *1%* foreign residents

PUBLICATION/PRODUCT SALES TOTAL: *$43,205*

Web Site Statistics

WISCONSIN SEA GRANT
www.seagrant.wisc.edu
Page views (2004): *3,507,983*
Page views (2005): *3,946,806*
Total (1/1/04–12/31/05): *7,454,789*
Average number of pages viewed per visit: *3*

Most Visited Web Sites—2005

WISCONSIN'S GREAT LAKES SHIPWRECKS
www.wisconsinshipwrecks.org
Total number of visits: *158,657*
Total page views: *497,208*
Ave. views per visit: *3.13* pages
Ave. visit: *11* minutes

A.S.C. PUBLICATIONS STORE
aqua.wisc.edu/publications
Total number of visits: *80,286*
Total page views: *247,643*
Ave. views per visit: *3.08* pages
Ave. visit: *14* minutes

WISCONSIN'S WATER LIBRARY
www.aqua.wisc.edu/waterlibrary
Total number of visits: *50,033*
Total page views: *103,471*
Ave. views per visit: *2.07* pages
Ave. visit: *15.25* minutes

Most Popular Downloads From Online Publications Store

Protect Our Waters aquatic invasive species brochure: *7,406*
Ice Fishing beginner's booklet: *5,197*
Watch Out for Trap Nets—Lake Michigan fact sheet/poster: *5,084*

Outreach & Education Activities

WORKSHOPS, PRESENTATIONS, COURSES & EXHIBITS—*310*
Total attendance/participants—*20,209* (ave. *65* per activity)
PROJECT PARTNERSHIPS—*795* (ave. *2.5* per project)

Principal Program Partners (33)

UNIVERSITY
Illinois-Indiana Sea Grant College Program
Michigan Sea Grant College Program
Minnesota Sea Grant College Program
North Carolina Sea Grant College Program
UW-Extension
UW Great Lakes WATER Institute
UW-Madison Center for Limnology
UW-Madison Gaylord Nelson Institute for Environmental Studies
UW-Madison Land Information & Computer Graphics Facility
Wisconsin Public Radio

STATE
Wisconsin Coastal Management Council
Wisconsin Coastal Management Program
Wisconsin Department of Natural Resources
Wisconsin Department of Tourism
Wisconsin Department of Transportation
Wisconsin Historical Society
Wisconsin Public Radio

REGIONAL
Council of Great Lakes Governors
Great Lakes Commission

FEDERAL
NOAA Great Lakes Environmental Research Laboratory
U.S. Army Corps of Engineers-Detroit District
U.S. Coast Guard
USDA North Central Regional Aquaculture Center
USEPA Great Lakes National Program Office
U.S. Fish and Wildlife Service
U.S. Geological Survey

PRIVATE
Apostle Islands Sport Fishermen Association
JASON Foundation for Education
Lake Michigan Car Ferry Co. (*SS Badger*)
McDonald Lumber & Warehousing Companies
Wisconsin Academy of Sciences, Arts & Letters
Wisconsin Aquaculture Association
Wisconsin Maritime Museum

Advisory Council Members 2004-06

ANDERS W. ANDREN (ex officio)
Professor, Environmental Chemistry & Technology
Director, Aquatic Sciences Center
University of Wisconsin-Madison

STEPHEN BRANDT
Director, Great Lakes Environmental Research Laboratory
National Oceanic & Atmospheric Administration
Ann Arbor, Michigan

RICHARD R. BURGESS
Professor, Oncology
McArdle Laboratory
University of Wisconsin-Madison

BEVERLY A. FRENCH
Partner, Orde Advertising, Inc.
West De Pere, Wisconsin

FRANCES C. GARB
Senior Academic Planner, Office of Academic Affairs
University of Wisconsin System
Madison, Wisconsin

HALLETT J. "BUD" HARRIS (chair)
Professor Emeritus, Natural & Applied Sciences
University of Wisconsin-Green Bay

REINHOLD HUTZ
Interim Associate Dean for Research
Research Services & Administration
University of Wisconsin-Milwaukee

LEE KERNEN
Citizen representative
Madison, Wisconsin

REUBEN H. LORENZ
Citizen representative
Madison, Wisconsin

LARRY J. MACDONALD
Owner, Apostle Islands Outfitters & General Store
Mayor of Bayfield, Wisconsin
Bayfield, Wisconsin

JOHN J. MAGNUSON
Professor Emeritus, Zoology
Center for Limnology
University of Wisconsin-Madison

KEVIN McSWEENEY
Professor, Soil Science & Environmental Studies
Director, School of Natural Resources
University of Wisconsin-Madison

DAVID T. MICHAUD
Principal Scientist, Environmental Department
Wisconsin Electric Power Company
Milwaukee, Wisconsin

NATHANIEL E. ROBINSON
Vice Chair, National Sea Grant Review Panel
Senior Advisor to the President, Wisconsin Technical College System
Madison, Wisconsin

LINDA L. WEIMER
Vice President for University Relations
University of Wisconsin System
Madison, Wisconsin

Advisory Committee on Outreach & Education, 2004-06

CARMEN AGUILAR (Research and Education)
Great Lakes WATER Institute
University of Wisconsin-Milwaukee

JEFF DUMEZ (Geographic Information Systems)
GIS/LIO Coordinator, Brown County
Green Bay, Wisconsin

KAREN GREEN (Education)
Metropolitan High School
Milwaukee, Wisconsin

LEE HAASCH (Charter Fishing)
Haasch Guide Service
Algoma, Wisconsin

AL HOUSE (Recreational Fishing)
Apostle Islands Sportfishing Association
Washburn, Wisconsin

JOHN KENNEDY (Water Quality)
Green Bay Metropolitan Sewerage District
Green Bay, Wisconsin

DAVID LEE (Coastal GIS)
Bayfield County Land Information Office
Washburn, Wisconsin

KONNIE LEMAY (Communications)
Lake Superior Magazine
Duluth, Minnesota

ANGIE TORNES (Nonprofit Organizations)
NPS, Rivers, Trails and Conservation Assistance
Milwaukee, Wisconsin

LARRY WAWRONOWICZ (Aquaculture)
Lac du Flambeau Band of Lake Superior Chippewa
Lac du Flambeau, Wisconsin

DAVE WENTLAND (Coastal Engineering)
Coastal Planning and Design
STS Consultants, Ltd
Green Bay, Wisconsin

JOHN WOLF (Aquaculture)
Alpine Farms
Sheboygan Falls, Wisconsin

ROY ZELLMER (Boating Safety)
Boating Safety Administrator
Wisconsin Dept. of Natural Resources
Madison, Wisconsin

Volume: *5,439* cubic miles (*22,684* km^3)

Water Surface Area: *94,250* square miles (*244,160* km^2)

Land Drainage Area: *201,460* square miles (*521,830* km^2)

Total Basin Area: *295,710* square miles (*765,990* km^2)

Shoreline Length: *10,210* miles (*17,017* km)

Islands: *35,000*

Age: *10,000* years

Outlet: St. Lawrence River

Basin Population: *33,191,365*

U.S. (1990)**:** *24,707,075*

Canada (1991)**:** *8,484,290*

A Great Lakes Almanac

Ten thousand years ago, the melting mile-thick glaciers of the Wisconsin Ice Age left a magnificent gift: five fantastic freshwater seas collectively known today as the Great Lakes. Unique among the world's large lakes because their basins are linked together and form one continuous drainage basin, these five lakes constitute the greatest freshwater system on Earth. The Great Lakes basin is about half the size of Alaska, encompassing an area 33,796 square miles larger than Texas.

From the westernmost tip of Lake Superior at Duluth, Minn., to the easternmost tip of Lake Ontario at Watertown, N.Y., the five lakes stretch a thousand miles across the heartland of both the United States and Canada. Coupled with the St. Lawrence River, they create a 2,000-mile-long waterway that ultimately connects the Great Plains to the Atlantic Ocean. Officially dubbed “the nation's fourth seacoast,” the U.S. Great Lakes shoreline alone totals more than 4,500 miles—longer than the U.S. East and Gulf coasts combined. As seen from space, the Great Lakes constitute one of the most identifiable features of the North American continent as well as planet Earth.

The Great Lakes today hold an estimated six quadrillion gallons of water—a fifth of all the drinkable water on the surface of Earth. The combined total surface area of just the lakes nearly equals that of Oregon.

The awesome sizes of the Great Lakes amaze just about everyone seeing them for the first time. These lakes not only look like oceans, they often seem to behave like oceans. They have coastal currents—including dangerous rip currents—and occasional large tide-like changes in coastal water levels called seiches (pronounced "say-shez") caused by prolonged strong winds and passing storms. Like the oceans, the lakes also moderate the temperature of the air and increase the amount of rain or snow that falls on the lands surrounding them.

Some of the world's largest grain shipping ports are located on the Great Lakes, and oceangoing ships as well as 1,000-foot-long “lakers” ply their waters. Sailors who have weathered storms on the Great Lakes give these inland seas the same healthy respect they give the other Seven Seas and perhaps a measure more when the icy gales of November blow, because the lakes’ fresh water freezes more quickly than ocean saltwater, and a heavy coat of ice can easily capsize and sink a ship. The lakes' water is usually cold to begin with, because the Great Lakes lie across the 45th Parallel, halfway to the North Pole from the Equator and just 1,200 miles from the Arctic Circle—less than the distance between New York City and Miami.

Coupled with the vast forest, agricultural and mineral resources of the area, the abundant supply of water and cheap transportation afforded by the Great Lakes were major factors in the region becoming the population and industrial core of both the United States and Canada.

Volumes measured at low water datum • Land drainage area for Lake Huron includes the St. Marys River; land drainage area for Lake Erie includes the St. Clair-Detroit river system; land drainage area for Lake Ontario includes the Niagara River • Shoreline lengths include islands • Total shoreline length is greater than the sum of the shoreline lengths for the lakes because it includes the connecting channels (except the St. Lawrence River) • United States 1990 and Canadian 1991 population census data were collected on different watershed boundaries and are not directly comparable to previous years • Almanac photos from U.S. Environmental Protection Agency, Visualizing the Great Lakes Image Collection.

Elevation: *600* feet (*183* m) above sea level

Length: *350* miles (*563* km)

Breadth: *160* miles (*257* km)

Average Depth: *483* feet (*147* m)

Maximum Depth: *1,332* feet (*406* m)

Volume: *2,900* cubic miles (*12,100* km^3)

Water Surface Area: *31,700* square miles (*82,100* km^2)

Land Drainage Area: *49,300* square miles (*127,700* km^2)

Total Basin Area: *81,000* square miles (*209,800* km^2)

Shoreline Length: *2,726* miles (*4,385* km)

Water Retention Time: *191* years

Outlet: St. Marys River

Basin Population: *607,121*

U.S. (1990): *425,548*

Canada (1991): *181,573*

Lake Superior

The greatest of the Great Lakes, Lake Superior is the northernmost and westernmost Great Lake—and the biggest, the deepest, the coldest and the most pristine. Ninety percent of the lake's shoreline is forested, much of it still wilderness. Lake Superior is bounded on the north by Ontario, on the west by Minnesota and on the south by Wisconsin and Michigan's Upper Peninsula.

Roughly the same shape and slightly larger than South Carolina, Lake Superior has the largest of surface area of any freshwater lake in the world. Only Lake Baikal in Siberia and Lake Tanganyika in East Africa contain greater volumes of fresh water.

Its name comes from early French explorers who labeled it *le lac superieur*, meaning "the uppermost lake." According to Chippewa (Objibwe) Indian lore, it is protected by *Nanabijou*, "Spirit of the Deep Sea Water."

Superior's water retention time—the time it takes for all the water now in the lake to be replaced by new water—is the longest of any of the Great Lakes, which makes Superior the most vulnerable to long-term water pollution. Think of it this way: if the lake were to become polluted today, and all pollution stopped tomorrow, it would take nearly 200 years before its waters would again be as pure as they were yesterday.

Elevation: *577* feet (*176* m) above sea level
Length: *206* miles (*332* km)
Breadth: *183* miles (*245* km)
Average Depth: *195* feet (*59* m)
Maximum Depth: *750* feet (*229* m)
Volume: *850* cubic miles (*3,540* km^3)
Water Surface Area: *23,000* square miles (*59,600* km^2)
Land Drainage Area: *51,700* square miles (*134,100* km^2)
Total Basin Area: *74,700* square miles (*193,700* km^2)
Shoreline Length: *3,827* miles (*6,157* km)
Water Retention Time: *22* years
Outlet: St. Clair River
Basin Population: *2,694,154*
U.S. (1990): *1,502,687*
Canada (1991): *1,191,467*

Lake Huron

The second-largest Great Lake, Lake Huron is the fifth-largest freshwater lake in the world. It is only slightly smaller than West Virginia in size, and it contains more than 30,000 islands. Its name comes from early French explorers, who dubbed it *Lac des Hurons* ("Lake of the Huron Indians").

Lake Huron mainly functions as a conveyer within the Great Lakes system, carrying both water and ships from the other two upper lakes to the urban and industrial centers along the lower two lakes. Bordered by the Province of Ontario and the State of Michigan, about two-thirds of the lake's watershed is still covered by forests, making the region a major forest industry area. Some of the world's largest nickel reserves are located in Ontario just north of the lake.

Along the northeast side of Lake Huron is Georgian Bay, created by the limestone spines of the Bruce Peninsula and Manitoulin Island. Though called a bay, it is so large that it has been nicknamed "the Sixth Great Lake." The bay's waters are nearly as unspoiled as those of Lake Superior, and its shoreline rivals Superior's in rugged beauty.

At the northwest corner of Lake Huron are the Straits of Mackinac, a deep trench of water that joins Lake Huron with Lake Michigan. Because this deep channel equalizes the water levels of these two Great Lakes, Michigan and Huron are essentially two parts of the same lake. Spanning these straits to connect Michigan's lower and upper peninsulas is the five-mile-long Mackinac Bridge—the third longest suspension bridge in the world.

Elevation: *577* feet (*176* m) above sea level

Length: *307* miles (*494* km)

Breadth: *118* miles (*190* km)

Average Depth: *279* feet (*85* m)

Maximum Depth: *925* feet (*282* m)

Volume: *1,180* cubic miles (*4,920* km^3)

Water Surface Area: *22,300* square miles (*57,800* km^2)

Land Drainage Area: *45,600* square miles (*118,000* km^2)

Total Basin Area: *67,900* square miles (*175,800* km^2)

Shoreline Length: *1,638* miles (*2,633* km)

Water Retention Time: *99* years

Outlet: Straits of Mackinac

Basin Population: *10,057,026* (all U.S.)

Lake Michigan

Lake Michigan is the third largest Great Lake and the sixth largest lake in the world. Bordered by Wisconsin, Illinois, Indiana and Michigan, it is the only Great Lake that lies entirely within the boundaries of the United States. Lake Michigan covers an area is about half the size of Tennessee.

Its name comes from the Algonkian Indian word for it, *Michigami* (or *Misschiganin*), meaning "large body of water."

This long, narrow lake is a natural cul-de-sac. Only a relatively small amount of water flows out the bottleneck at the straits between Michigan and Huron, which is why Lake Michigan has such a long water retention time. Coupled with the large numbers of industries and people living along its shoreline—particularly in the heavily urbanized Milwaukee-Chicago-Gary tri-state crescent along its southwestern shore—Lake Michigan's long water retention time is why pollution of the lake is a special concern.

Lake Michigan has the largest sport fishery on the Great Lakes, valued at more than $250 million annually. Besides its world-class trout and salmon fisheries, the lake also supports a modest commercial fishery, with nearly four million pounds of whitefish harvested annually.

The largest lakeshore dunes in the world are also found along Lake Michigan, attracting millions of people annually to the lake's numerous beaches, coastal state parks and national lakeshores.

Elevation: *569* feet (*173* m) above sea level
Length: *241* miles (*388* km)
Breadth: *57* miles (*92* km)
Average Depth: *62* feet (*19* m)
Maximum Depth: *210* feet (*64* m)
Volume: *116* cubic miles (*484* km^3)
Water Surface Area: *9,910* square miles (*25,700* km^2)
Land Drainage Area: *30,140* square miles (*78,000* km^2)
Total Basin Area: *40,050* square miles (*103,700* km^2)
Shoreline Length: *871* miles (*1,402* km)
Water Retention Time: *2.6* years
Outlet: Niagara River/Welland Canal
Basin Population: *11,682,169*
U.S. (1990): *10,017,530*
Canada (1991): *1,664,639*

Lake Erie

Lake Erie is the fourth-largest Great Lake and the world's twelfth largest freshwater lake. Bordered by Michigan, Ohio, Pennsylvania, New York and Ontario, Erie is slightly larger than the state of Vermont in area. Its name comes from the Erie ("People of the Panther") nation of Native Americans who once inhabited its southern shores.

Because of its saucer-like shallowness, Lake Erie has a reputation among sailors of being quick to "kick up her heels," raising waves of frightening size in even a modest gale.

Erie may be the most used, and perhaps the most loved lake of the five. Erie forms part of the top of the U.S. "industrial crescent." A majority of U.S. and Canadian cars are made in this region, and it is a principal steel-producing area.

The lake also supports the second-largest sport fishery on the Great Lakes, and its walleye fishery is considered to be one of the best in the world.

Erie's water quality problems were legend during the environmental movement of the late 1960s, when this "dead" Great Lake became a national symbol of the effects of pollution and neglect. Fortunately, Lake Erie's water retention time is less than three years—the shortest of all the Great Lakes—and the lake was quick to respond to U.S. and Canadian efforts to improve waste treatment and reduce pollution.

At Erie's eastern tip, near Buffalo, N.Y., its water flows north into the Niagara River, racing downstream at 750,000 gallons per second. In a 35-mile stretch between Lake Erie and Lake Ontario, the river elevation drops 326 feet, nearly 200 feet of it all at once—at Niagara Falls, one of North America's most famous geographic features and one of the natural wonders of the world.

Elevation: *243* feet (*74* m) above sea level

Length: *193* miles (*311* km)

Breadth: *53* miles (*85* km)

Average Depth: *283* feet (*86* m)

Maximum Depth: *802* feet (*244* m)

Volume: *393* cubic miles (*1,640* km^3)

Water Surface Area: *7,340* square miles (*18,960* km^2)

Land Drainage Area: *24,720* square miles (*64,030* km^2)

Total Basin Area: *32,060* square miles (*82,990* km^2)

Shoreline Length: *712* miles (*1,146* km)

Water Retention Time: *6* years

Outlet: St. Lawrence River

Basin Population: *8,150,895*

U.S. (1990): *2,704,284*

Canada (1991): *5,446,611*

Lake Ontario

The opposite of Lake Superior in many ways, Lake Ontario is the easternmost, lowest in elevation, and smallest Great Lake. In surface area, it is about the size of New Jersey. Its name originated with the local Iroquois Indians' word for "a beautiful lake"—which it still is.

Ontario is the third deepest Great Lake after Lakes Superior and Michigan. It is bordered on the south by New York and by the Province of Ontario on the north. Canada's commercial, industrial and population heartland is centered in this area, mostly around Toronto on the lake's northwestern shores. About two-thirds of Canada's steel is produced here.

At the northeastern tip of the lake, its waters empty into the St. Lawrence River for a 1,200-mile journey to the Atlantic Ocean. Sliding around the beautiful Thousand Islands, the St. Lawrence moves northeast toward Montreal. This part of the river contains seven locks that were the keys to unlocking the Great Lakes to the world by creating the famous St. Lawrence Seaway. Opened in 1959, these Seaway locks lift and lower ships a total of 225 feet and give oceangoing ships easy access to the Great Lakes and their ports.

Sources

"Gifts of the Glaciers," University of Wisconsin Sea Grant Institute Web site (*www.seagrant.wisc.edu/communications/greatlakes/glacialgift*), 1998.

"Great Lakes Fact Sheet No. 1: Physical Features And Population," U.S. Environmental Protection Agency and Environment Canada, *The Great Lakes: An Environmental Atlas and Resource Book*, 3rd edition, 1995.

Elevation, average depth and retention time figures from *Extension Bulletins E-1866-70*, Michigan Sea Grant College Program, Cooperative Extension Service, Michigan State University, E. Lansing, Mich., 1985.

All other figures from *Coordinated Great Lakes Physical Data*, Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, May, 1992.

Key Contacts

Administration

Director
Anders W. Andren, (608) 262-0905

Assistant Director for
Research & Outreach
James Hurley, (608) 262-1136
hurley@aqua.wisc.edu

Assistant Director for
Administration & Information
Mary Lou Reeb, (608) 263-3296
mlreeb@aqua.wisc.edu

Finance and Grants Administrator
Daniel Marklein, (608) 263-3252
marklein@aqua.wisc.edu

Communications Manager
Stephen Wittman, (608) 263-5371
swittman@aqua.wisc.edu

Advisory Services Specialists

Aquaculture
Fred Binkowski, UW–Milwaukee
(414) 382-1723, *sturgeon@uwm.edu*

Coastal Engineering
Gene Clark, UW–Superior
(715) 394-8472, *grclark@aqua.wisc.edu*

Fisheries & Aquatic Invasive Species
Philip Moy, UW–Manitowoc
(920) 683-4697, *pmoy@aqua.wisc.edu*

Geographic Information Systems
David Hart, UW–Madison
(608) 262-6515, *dhart@aqua.wisc.edu*

Marine Safety & Education
James Lubner, UW–Milwaukee
(414) 227-3291, *jflubner@aqua.wisc.edu*

Water Quality & Habitat Restoration
Victoria Harris, UW–Green Bay
(920) 465-2795, *harrisv@aqua.wisc.edu*

Communications

Communications Office
(608) 263-3259

"Earthwatch Radio"
Richard Hoops, (608) 263-3149
earthwatch.radio@aqua.wisc.edu

News Media Contact
Stephen Wittman, (608) 263-5371
swittman@aqua.wisc.edu

Publications Requests
Linda Campbell, (608) 263-3259
publications@aqua.wisc.edu

Water Resources Library

Librarian
JoAnn Savoy, (608) 262-3069
askwater@aqua.wisc.edu

University of Wisconsin
Sea Grant Institute
Aquatic Sciences Center
Goodnight Hall, 2nd Floor
1975 Willow Drive
Madison, WI 53706-1177

Phone: (608) 262-0905
Fax: (608) 262-0591
info@seagrant.wisc.edu
www.seagrant.wisc.edu


SCIENCE FOR THE SUSTAINABLE USE OF WISCONSIN'S GREAT LAKES RESOURCES www.seagrant.wisc.edu