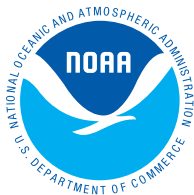


NATIONAL STORIES SEA GRANT 2010



NATIONAL SEA GRANT PROGRAM WRITES THE BOOK ON COMBATING INVASIVE SPECIES

By Moira Harrington, Wisconsin Sea Grant

All good books have a defined beginning, middle and end. The opening chapter of the nation's coastal environments is a read on economic plenty, recreational pleasure and natural beauty. Increasingly, though, invasive species have brought about some nasty plot twists.

Identifying, studying and educating on invasive species have long been part of the National Sea Grant Program mission. Now, the Program is working to turn the page on the impact of invasives with stepped-up regional prevention and control goals.

Sea Grant is administered through the National Oceanic and Atmospheric Administration (NOAA) and supports programs in 31 coastal states and Puerto Rico. In 2010-11, the Program will devote up to \$4 million for regionally based invasive-species initiatives. This funding is in addition to the projects outlined in individual state work plans.

Sea Grant equals water

Data from the U.S. Geological Survey indicates shipping is the No. 1 path of introduction for invasives into the U.S. Water certainly plays to Sea Grant's strength.

Plus, Sea Grant's vast and collaborative networks with coastal resource managers, commercial businesses, scientists, non-governmental agencies and the public means it has the connections to counter invasives.

"Sea Grant certainly has a history of identifying a problem with invasive species, and sometimes identifying a problem before it even exists, and then running it to ground," Sea Grant Research Director Dorn Carlson said. Along with that ability, he said, "Is one of the most compelling things about Sea Grant—its ability to mobilize for outreach work."

Dr. David Reid, NOAA Great Lakes Environmental Research Laboratory emeritus scientist, notes another attribute, "Sea Grant has a mission to support research within the academic community, the largest pool of scientific capability in the U.S. (and most countries). Government scientists are limited in numbers."

He continued, "Engagement (support) of the academic scientific community is essential for the scientific progress needed to understand and address the root causes of and solutions for the broader issue."



The broader issue is that without attention and action, invasives—either plant, animal or even viral—can continue a march, easily transferring from watershed to watershed. The costs are astronomical. Four years ago, Cornell University researchers pegged the annual price tag of environmental losses and damage due to all invasives at nearly \$120 billion. That figure has likely climbed given an accelerated rate of spread and increased amount of species that have made their way into the U.S.

Those same researchers further reported that 42 percent of the species on the threatened or endangered species lists are at risk primarily because of invasives. The indigenous species must compete with the newcomers or have become the prey of the interlopers.

Unhappy beginnings with happy endings

Here are some specific middle-narrative challenges, with Sea Grant contributing to happy endings:

- Some estuaries along the Pacific coast have become choked with a tall, quickly spreading plant called cordgrass that migrated from the Eastern U.S. when used as seafood packing material. Now, birds and small crustaceans can't get enough to eat because cordgrass is altering the habitat. Plus, cordgrass can disrupt water flow, leading to floods.

Sea Grant researchers introduced a plant-hopping insect that finds cordgrass seed to be a delicacy. In areas where the bugs established, scientists noted a 90-percent reduction in the seeds. This is a cost-effective and sustainable solution to the invasion.

- The Mid-Atlantic and New England intertidal areas have an unwelcome inch-long transplant that first rushed out of Japanese ships' ballast water more than 20 years ago. Now, Asian shore crabs are greedily consuming young oysters, mussels and clams that native shorebirds and fish generally eat or that shellfish farmers have been trying to bring to maturity.

In one Mid-Atlantic state, Sea Grant staff members worked closely with a research institution and the state's lead environmental agency to develop a blueprint for

management, research and outreach on aquatic invasive species, including the Asian shore crab. The plan lays out rapid-response containment and eradication protocols, and policy and legislative needs.

- The Illinois River, which in the past was a haven for water sports and recreational fishermen, is now teeming with Asian carp. These are the offspring of escaped fish originally brought to Southern aquaculture operations to keep ponds clean. When startled by boat motors, the invasive fish can leap up to 10 feet into the air and have been known to injure people. Asian carp have used the river as a highway toward the Great Lakes, threatening a \$7 billion fishing and \$16 billion recreational industry.

Sea Grant biologists have devoted countless hours to monitoring the river and surrounding habitats. They also provide extensive education about the threat of Asian carp migration into the world's largest freshwater system. One Sea Grant biologist even served as the first manager of a project to erect an electric barrier in the Chicago Sanitary and Ship Canal to repel foreign fish. As the situation continues to unfold, Sea Grant will be integral to assessments and the search for a viable evidence-based mitigation plan.

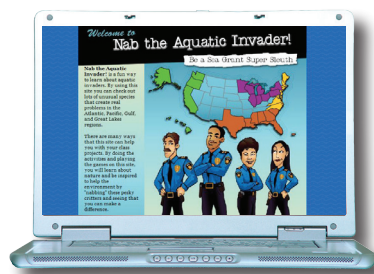
There is more to the story: Sea Grant educates and raises awareness

An informed and engaged public is an effective first line of defense against invasive species. Sea Grant has unleashed an army in this fight, an army of children who are meeting the enemy on their own virtual turf—online. It's through a game at www.sgnis.org/kids/ called "Nab the Aquatic Invader."

"This is a great way to deliver messages on how people can reduce invasive species. It's all science-based," said Sea Grant's Robin Goettel who spent several years developing content for the resource-laden site.

"Nab the Aquatic Invader" launched in 2005 with expansions in the two succeeding years to incorporate the top-ten invaders in all U.S. marine and Great Lakes environments. Now, it is truly a nationwide awareness-raising tool reaching an audience of children, and their teachers, which encompasses classroom- and service-learning. In 2009, the site logged nearly 90,400 visits and is on pace to attract even more would-be invasive fighters in 2010.

Getting out of classrooms, the site is also featured in a special kiosk setup at the Smithsonian National Museum of Natural History. Kiosks are also sprouting up at a growing



network of aquariums across the country. This network provides opportunities for 20 to 30 million people to learn more, and ultimately do more, about invasives.

Continuing on the theme of public education and outreach, Sea Grant staff members regularly conduct workshops. In one regional instance, the topic is an invasive pathogen that can sicken or even kill fish. The virus is a growing problem for Great Lakes states. Sea Grant staff target aquaculture businesspeople who raise baitfish with information about viral hemorrhagic septicemia.

Telling a research tale

It would be unfortunate to rid or reduce the effects of an invasive species in a given ecosystem and then find out that the method for doing so was itself harmful. That is just what Sea Grant researchers discovered when they collected data on a commonly used toxin used to minimize invasive sea lamprey larvae. Scientists learned the chemical harms other organisms.

This finding led to two outcomes—a more intense search for a new way to treat against sea lamprey and a regional educational campaign. That widespread campaign involved more than 400 radio stations, 5,300 Web site visits and the distribution of 3,500 publications.

Telling stories like these is important because, as the emeritus scientist Reid noted, "We've seen an exponential increase in the number of reported non-indigenous species in our coastal ecosystems. As globalization of commerce has taken place, many more potential sources of live organisms are being connected by these trade activities."

As the book on research and education efforts fills volume one, Sea Grant is looking toward writing the sequel on successfully stamping out, controlling or simply preventing the introduction of invasive species. ❖

ECOSYSTEM-BASED MANAGEMENT: THE PROMISE OF PROCESS

By Erica Goldman, Maryland Sea Grant

Marine and coastal environments form complex interdependent webs of life. Big fish, little fish, plankton, crabs, algae, and reef-builders like coral or oysters all interact according to intricate rules of eat and be eaten. Humans play an integral node in this web, relying on marine and coastal systems for both livelihoods and recreation in a co-dependent relationship that requires the environment to remain healthy and vibrant.

How can we manage such complex, interdependent ecosystems in a way that integrates ecological, social, and economic goals? The answer may be ecosystem-based management, an approach that recognizes humans as key components of aquatic ecosystems, accounts for both ecological and political boundaries, and engages all stakeholders in the management process.

Ecosystem-based management is a natural fit for Sea Grant. Research support for sound science, sustained facilitation and coordination, communication and education—are all hallmarks of ecosystem-based management—and these are the strengths of Sea Grant.

From all over the United States, Sea Grant is making progress in ecosystem-based management. From the Great Lakes to New England to the coast of California, and from the Puget Sound to the Chesapeake Bay, Sea Grant-supported scientific research has expanded to meet the needs of interconnected social-natural ecosystems. Such research, integrated with policy, has helped pioneer institutional or interstate commitments which are working to forge a new way forward.

The Great Lakes

Sea Grant ecosystem-based management of the Great Lakes dates back more than 30 years. Lake Erie is an early case study for the success of Sea Grant ecosystem-based management activities. When the Cuyahoga River caught fire in 1969, pollution grabbed the national spotlight. Today, thanks to coordinated and sustained efforts to reduce pollutants, including phosphorus loading, Lake Erie boasts a robust walleye population, lucrative fishery, and thriving charter boat industry.

How did ecosystem-based management help turn the tide for Lake Erie? What role did Sea Grant play?

The context for an integrative ecosystem-based management framework dates back to the turn of the 20th century with the signing of the Boundary Waters Treaty in 1909 and the establishment of the International Joint Commission, which

was created to assist the U.S. and Canada in the protection of the trans-boundary environment. But despite the historic Great Lakes Water Quality Agreement of 1972 and much talk about the need for coordination in water quality and fisheries monitoring, the Great Lakes still lacked the necessary “integrative framework” for taking an ecosystem approach to research management. This was the finding of a special report of the International Joint Commission’s Research Advisory Board in 1978.



In the years to come, the Great Lakes Sea Grant programs would play a key role in building that “integrative framework.” They provided targeted research funding aimed at unraveling the food web architecture of Great Lake ecosystems. In Lake Erie, as phosphorus loads began to drop and the walleye population surged, Sea Grant worked closely with charter boat operators to ensure that fishery and boating industry both recovered in a sustainable manner.

In 1998, Ohio Sea Grant facilitated a meeting that brought together a group of scientists to discuss research needs, particularly with respect to phosphorus levels and invasive zebra mussels. This collaboration brought more than 50 scientists from four states, and became the Lake Erie Millennium Network, a group that includes representatives from both academia and federal agencies in the United States and Canada.

In following years, the network held 19 workshops and coordinated the development of dozens of research projects. In 2005, the International Joint Commission formally recognized the work of the Lake Erie Millennium Network and recommended the formation of similar groups for the other Great Lakes.

In response to the Joint Commission's recommendation, Sea Grant programs from all of the Great Lakes states came together in 2006 to develop a regional proposal to NOAA Sea Grant for the creation of the Great Lakes Regional Research Information Network with the goal to coordinate research and provide a single point of contact for each lake to reach all research scientists in the region.

Sea Grant directors for Michigan, Ohio, New York, Minnesota, and Wisconsin currently head up the network for each of the Great Lakes, with Jeff Reutter, Ohio Sea Grant Director, acting as one of the four overarching coordinators, along with an academic representative from Canada and two agency heads.

The Great Lakes Regional Research Information Network helps fund science crucial to ecosystem-based management. The network provides integrated support for interdisciplinary research, aligning scientists with the need for multilayered studies on complex questions. In 2009, Sea Grant coordination and facilitation helped 25 researchers from 14 different institutions come together to submit 7 individual proposals on complementary research projects. All seven projects also received funding from EPA, resulting in an innovative research program integrated across topic areas and institutions.

Filling a crucial niche

Ecosystem-based management tends to play out mostly on a large scale. It draws together agencies, managers, industries, and large-scale, applied research initiatives. With its interdisciplinary structure, Sea Grant can serve a key role, adding value to ecosystem-based management in strategic ways. Sea Grant programs have programmatic strengths and can leverage funding to catalyze targeted and well integrated research, outreach, and technical assistance.

In the Chesapeake Bay region, ecosystem-based management began with creation of the Chesapeake Bay Program in 1983. This watershed partnership brings together the states of Maryland, Virginia, and Pennsylvania, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission, a tri-state legislative body. These parties have pledged to work together, under the construct of Chesapeake Bay Agreement, to restore the Bay.

Over the years, Sea Grant programs in Maryland and Virginia have helped to fund critical research on hypoxia, nutrient cycling, food web relationships, and fisheries. Sea Grant engagement in the Bi-State Blue Crab Advisory Committee played a key role in setting terms for blue crab management in the Bay, along with developing a framework for ongoing management. Maryland Sea Grant is now deeply engaged in forging a process for ecosystem-based fisheries management in the Bay, one that involves creating a new operational structure. So far, more than 80 individuals from 12 different states are engaged in the ecosystem-based fisheries management effort on a volunteer

basis. They represent academic and research institutions, non-governmental organizations, state and federal management agencies, and independent contractors.

On the West Coast, ecosystem-based management is playing out in grand proportions in California—a state with a very strong conservation ethic. Since Governor Arnold Schwarzenegger put forth the Ocean Action Plan in 2004, tens of millions of dollars have been allocated for ocean protection, monitoring, and



the establishment of a network of marine reserves. Held as a national model, the California Marine Life Protection Act, passed in 1999 and now part of the California Fish and Game Code, requires California to reevaluate all existing marine protected areas potentially design new ones that together function as a statewide network.

In this environment of big players and big dollars, it becomes critical that Sea Grant contribute strategically, explains Christina Johnson, science writer for California Sea Grant. Partnerships become essential, explains Johnson, including working closely with state government.

In New England, Rhode Island offers another example of a place where Sea Grant's contributions to ecosystem-based management are deeply entrenched. For 30 years, Rhode Island Sea Grant has worked with the RI Coastal Resources Management Council to develop and implement Special Area Management Plans (SAMPs), affectionately called "tools with teeth". SAMPs are science-based ecosystems-based management plans that comprehensively review ecosystems, regulatory environments and social structures, then propose guidance on regulations to be adopted by the state. Such guidance is closely tailored to the unique ecological and social conditions of each place. To date, Rhode Island has six SAMPs in place for its rural, suburban and urban coasts, and island ecosystems, plus has developed the first interstate SAMP for ecosystems it shares with Connecticut. Now in the works, Rhode Island's 7th SAMP will be the largest ever, covering 1,500 square miles of ocean, with a focus on the state's push to develop renewable offshore energy from wind. Rhode Island Sea Grant's Coastal Extension Leader Jennifer McCann has led the \$10 million process with co-PIs from many university, state and federal organizations. "In Rhode Island," she says, "we know how to SAMP." ❖

SEA GRANT PROGRAMS STRIKE A BALANCE BETWEEN PROTECTING SPECIES AND PROTECTING ECONOMIES

By Dan Williams

Population growth, coastal development and greater demand for seafood generate increasing interaction between people and protected marine species. Is it possible to protect imperiled species without inhibiting economic activity? The Sea Grant Program has some answers.

In commercial fishing, many fish end up as bycatch, caught unintentionally by vessels targeting other fish. Marine mammals and birds can become bycatch, too. Bycatch is accidental and indiscriminate. Species caught and killed in this manner can include those that are endangered, protected or threatened. If bycatch of a certain species within a particular fishery gets too high, the fishery could be curtailed or even shut down, causing economic hardship for commercial fleets and coastal communities—and higher prices for consumers.

Through research, education and outreach, Sea Grant is addressing bycatch from the Gulf of Maine to the Gulf of Mexico to the Gulf of Alaska. And from California to the Caribbean, Sea Grant programs are helping recreational fishermen and beachgoers learn how to conserve, manage and interact with marine species that are of special importance to their areas.

The highest rates of bycatch are associated with shrimp trawling. Shrimp trawl fisheries account for 2 percent of the world's total catch of all fish, by weight, but more than 33 percent of the world's bycatch.

In New Hampshire, Sea Grant is working on a project to modify shrimp trawl design to reduce the catch of fish and smaller shrimp. In sea trials in the Gulf of Maine, the new gear not only resulted in larger caught shrimp but also reduced bycatch of herring, a fish that's important to both the economy and the marine food web, by 90 percent.

In the Gulf of Mexico, Texas Sea Grant is working directly with shrimpers on trawl gear demonstration projects. New gear that proved effective at reducing bycatch was also reducing shrimp take by 10 percent—a significant economic hit for a fishery recovering from hurricane damage and competing with imported farmed shrimp. More recent gear developments are

now allowing a better shrimp catch but are more complex and challenging to use. Texas Sea Grant has conducted workshops and training in 27 ports and distributed 600 new trawl devices to shrimp vessels, helping reduce bycatch and boost a beleaguered industry.

Meanwhile, back on the East Coast, the Rhode Island and New Hampshire Sea Grant programs have contributed to a major success story in the cod and haddock fisheries. Research sponsored by the two programs led to the development of the Eliminator Trawl—new gear that is extremely effective at reducing bycatch of cod, an endangered fishery, while allowing the capture of haddock, a recovered fishery.

Use of the nets has become widespread, boosting Northeast fishery economics by opening previously closed haddock areas and allowing further recovery of the cod fishery. In tests, the nets reduced cod catch by 61 percent, with only a 16 percent loss of haddock, and eliminated almost all other species from capture, including flounder, lobster, skates and dogfish.

In Alaska's longline fisheries, it was seabird, not fish, bycatch that was creating problems. Many birds commonly drawn to fishing operations would become hooked and drown as they attacked sinking baited hooks. Sometimes, the victims were short-tailed albatrosses, an endangered species. Regulations stipulated that a take of six short-tailed albatrosses within a two-year period could interrupt or close Alaska's \$300 million longline fisheries.

Building on earlier collaborative work to reduce seabird bycatch in salmon drift nets, Washington Sea Grant launched a suite of research and outreach programs in collaboration with industry, NOAA Fisheries and the U.S. Fish and Wildlife Service to

reduce seabird bycatch in Alaska's longline fisheries. A two-year research program led to development of parallel streamer lines played out behind the vessel to a point beyond where the baited hooks sink. This solution proved almost 100 percent successful at eliminating the catch of albatrosses and resulted in an overall eight-fold decrease in seabird mortality.

Washington Sea Grant is now applying its model for research and



New Hampshire Sea Grant

industry collaboration to the West Coast groundfish fishery and, internationally, to several fisheries in the Southern Hemisphere.

In Virginia's striped bass gillnet fishery, the issue was not bycatch but mortality of smaller striped bass that were caught and then discarded because they were considered too small for market. Virginia Sea Grant provided data that the state used to develop new regulations governing net mesh sizes. Previously, the fisher could choose the mesh size. The result is a better-managed fishery and reduced mortality among smaller striped bass.

Interaction between people and marine life is not limited to commercial fishing operations. In the Caribbean, coastal development and a growing tourism industry are threatening sea turtles habitat. Puerto Rico Sea Grant organized a cadre of beach volunteers that monitored three marine turtle species, generated important data about threats to the species and raised funds for educational signage about sea turtle habitat, regulations and conservation. The data



helped develop conservation strategies and a regional Protocol for Sea Turtle Management.

Sport fishing is an important economic contributor to coastal areas. But when species are threatened and seasons shortened, fishing and tourism businesses suffer. Four Sea Grant programs are helping to improve the survival of released sport fish and keep sport fisheries sustainable. The California, Oregon and Southern California Sea Grant programs are all engaged in educating sport fishermen about barotrauma in rockfish. Barotrauma occurs from the change in pressure when fish are reeled in, causing their swim bladders to swell, and mortality is high among fish that are not properly handled.

California Sea Grant research led the California Department of Fish and Game to discourage use of venting—puncturing the swim bladder with a hollow needle. California and Oregon Sea Grant collaborated on an educational program to explain different methods for returning rockfish to depth. In Oregon, the Department of Fish and Wildlife estimates that 78 percent of catch-and-release fishermen use the methods taught by the program, resulting in a 50 percent reduction in rockfish mortality.

Reduced fish mortality is also the result of North Carolina Sea Grant's efforts to educate sport fishermen about the use of circle hooks. North Carolina Sea Grant staff members have been attending fishing tournaments and conducting workshops about the hooks, which increase survivability in catch-and-release fisheries by an estimated 25 percent.

Sea Grant programs are making a difference in minimizing the accidental mortality of protected or sensitive marine species from bycatch and other human activities. It all adds up to stability and sustainability, both ecologically and economically. ❖

Sea Grant Reduces Bycatch Mortality and Fosters Positive Interactions between Humans and Protected Species

Population growth, coastal development and greater demand for seafood generate increasing interaction between people and protected marine species.

In commercial fishing, fish, marine mammals and birds can become "bycatch," caught unintentionally by vessels targeting different species. Bycatch can further deplete an already endangered fishery. Bycatch of too many threatened or endangered species can curtail or even shut down a fishery. In sport fisheries, some catch-and-release practices actually kill the fish that are released. In coastal tourism areas, development and human activity can devastate sensitive habitat. All of these actions have economic consequences. Sea Grant is addressing these issues by finding solutions to regional problems and effectively applying them to other regions through its national network.

Sea Grant programs in Rhode Island and New Hampshire have supported research on new shrimp trawls and haddock nets. New shrimp trawl gear has not only resulted in larger caught shrimp but also reduced bycatch of herring—a fish that's important to both the economy and the marine food web—by 90 percent. Texas Sea Grant has taken new gear technology to the shrimp industry in the Gulf of Mexico, conducting workshops and training in 27 ports and distributing 600 new bycatch-reducing trawl devices to the shrimp industry. In the Alaska longline fishing fleet, solutions developed by Washington Sea Grant reduced bycatch of endangered short-tailed albatrosses by nearly 100 percent, preventing closure of a fishery worth \$300 million annually. Sea Grant is now applying these solutions in the West Coast groundfish fishery and even internationally. New haddock nets developed in Rhode Island and New Hampshire have caught on in the North Atlantic, reducing cod catch by 61 percent, with only a 16 percent loss of haddock, and eliminating almost all other species from capture, including flounder, lobster, skates and dogfish.

In Pacific recreational fisheries, California and Oregon Sea Grant programs are improving the survivability of rockfish that are caught and released. California Sea Grant research led the California Department of Fish and Game to discourage popular practices that were proving fatal to rockfish. California and Oregon collaborated on an education program, and the Oregon Department of Fish and Wildlife estimates that 78 percent of catch-and-release fishers use the methods taught by the program, resulting in a 50 percent reduction in rockfish mortality in that state. North Carolina Sea Grant used the same type of approach to educate recreational fishers about circle hooks, which have increased catch-and-release survivability by an estimated 25 percent

SEA GRANT ENSURES SAFE SEAFOOD, PREVENTING ILLNESS AND SAVING CONSUMERS MILLIONS

By Peg Van Patten, Connecticut Sea Grant

The nation's \$27 billion seafood industry employs about 250,000 workers, and the U.S.A. is the third largest consumer of seafood. Concerns about food-borne illnesses caused the U.S. FDA to establish strict regulations for handling seafood in 1997, requiring all seafood processors to undergo training in the principles of Hazard Analysis and Critical Control Point (HACCP). Standardized HACCP training programs have been provided by Sea Grant programs around the nation, empowering businesses to comply with FDA requirements and stay in operation. Seafood processors, dealers, importers, and inspectors learn to identify and plan to control potential biological, chemical, and physical food safety hazards. Consumers are protected by ensuring that all domestic and imported seafood and fishery products are processed in the safest manner possible. In addition, many Sea Grant programs also offer sanitation programs and/or good management practice programs for food processing facilities. This training has also been used to design or renovate seafood

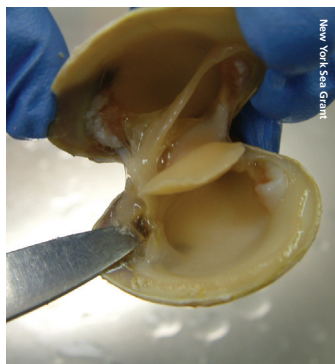
processing plants to optimize sanitation and efficiency. Agency employees who conduct seafood safety inspections, health professionals, some retailers, and students interested in vocational seafood careers have also benefitted from Sea Grant's food safety training. Improvements in seafood safety also means higher quality products for consumers. In Louisiana, two cease-and-desist orders were dropped after two seafood processors completed training and prepared their HACCP plans. Because HACCP-like principles are being adopted by other nations, processors in the Great Lakes region have been enabled to enter new markets overseas. Having seafood processed under HACCP gives consumers a sense of confidence in the product which aids marketing. In Alaska, two new salmon businesses were started. Over the past three years, Michigan Sea Grant Extension has facilitated the development of a whitefish marketing cooperative, and all the participating businesses are HACCP practitioners. In Virginia, HACCP training is offered in both the English and





Spanish languages. Eskimos and various native American tribes have participated. Aquaculture and baitfish industries have applied HACCP principles voluntarily to also prevent the introduction and spread of aquatic invasive species.

To date a total of approximately 26,000 people have been trained in HACCP, with 60-80 courses held per year (Association of Food and Drug Officials). The net result is competitive businesses with effective intervention strategies; safe, wholesome seafood; a workforce and regulators trained in safe seafood principles; decreased food-borne human illnesses, and greater consumer confidence. Surveys show that businesses with HACCP-trained employees remain competitive globally and seafood quality has improved. FDA has evaluated HACCP training and found it to be extremely effective. Estimates suggest that at least \$115,000,000 in economic losses from food-borne contamination have been prevented. ❖



Vibrio and other pathogens/ toxins (PSP, Ciguatera)

Cases of Paralytic Shellfish Poisoning (PSP) illness, which occur sporadically, have decreased due to decades of Sea Grant education and outreach efforts. For example, in Alaska in 2007 there was only one documented case in areas where subsistence shellfishing is important, and in Georgia the number of cases remained the same despite a 14% growth in population. A system of PSP monitoring, response, intervention and outreach for Aleut communities extended the known range of PSP occurrences from King Cove Alaska to the Commander Islands, Russia. New research has developed new methods for quickly and rapidly detecting *Vibrio vulnificus* and other pathogens in shellfish, thus sustaining the industry. In addition, inexpensive post-harvest depuration treatments for oysters with *V. vulnificus* have been developed to make crops safe for consumption. A collaborative web site, <http://www.safeoysters.org/medical/pubhealthimpact.html>, provides information about *Vibrio* and a profile of human demographic susceptibility to the disease. These efforts prevent human illness by better reporting of pathogens in the product and better educated consumers with lower risk of contracting PSP illness.

BUILDING RESILIENT COASTS: EXPOSING HIDDEN HAZARDS RESULTS IN MORE RESILIENT INFRASTRUCTURE

By Nancy Hoene, Minnesota Sea Grant

Obvious hazards that threaten coastal communities are usually forces of nature—hurricanes, earthquakes, tsunamis, shoreline erosion, bluff failures, and the like. But a hazard that is commonly overlooked or underestimated is coastal infrastructure deterioration. One specific form of deterioration is corrosion, which also occurs naturally when a material (usually a metal) reacts to its environment. It can damage infrastructure in coastal areas—bridges, piers, docks, harbor buildings, power plants, off-shore platforms, pipelines and other structures—threatening public safety, disrupting operations, and requiring expensive repair or replacement. Corrosion impacts safety, the economy, and the environment, and part of coastal communities’ resiliency is mitigating or eradicating its effects.

The Federal Highway Administration reported in 2007 that the annual cost of corrosion was \$430 billion nationally, or about three percent of Gross Domestic Product. That’s significant, if not all coastal.

Corrosion takes many forms and each coastal region presents different causal agents. Often, other government entities turn to Sea Grant for assistance, and Sea Grant partners with non-governmental organizations or the private sector in providing non-advocacy, science-based understanding and solutions.

For example, the Federal Emergency Management Agency (FEMA) turned to North Carolina Sea Grant’s coastal engineering specialists for help when they realized the metal connectors they recommended to hold buildings together during hurricanes were subject to serious corrosion.

North Carolina Sea Grant used historical records from a local firm, La Que Corrosion Services, to identify the serious consequences of corrosion for buildings near the ocean. Sea Grant funded ten years of full scale exposure testing and subsequently wrote FEMA’s Technical Bulletin, *Corrosion Protection for Sheet-Metal Connectors (TB8-96* or www.fema.gov/MIT/techbul) which is distributed to builders, designers, and coastal communities nationwide.

In keeping with its strategic aims, Sea Grant has taken the lead in convening groups to address corrosion problems, funding research to identify the extent of the problem, isolating causes, and offering solutions. As you read further, you will see how Sea Grant efforts have led to innovative processes, resilient products, new legislation, as well as outreach workshops and seminars.

For years, corrosion research focused on saltwater marine environments, leaving a gap in research. Then in 2004, when underwater sheet piling supporting many of the freshwater docks in the Duluth Superior Harbor in Lake Superior were found to be corroding at an accelerated rate, Minnesota and Wisconsin Sea Grants organized a team of experts to

investigate the unusual freshwater and coldwater corrosion in Lake Superior. If the structural integrity of the docks and loading facilities were to continue corroding rapidly, the failing steel would have to be replaced at a cost of \$1,500 or more per linear foot, or about \$120 million.

“We immediately focused on two very different study directions. One direction was determining the cause of highly unusual freshwater accelerated corrosion, while the other was studying ways to rehabilitate or repair those structures already in peril,” said Gene Clark, Coastal Engineering Specialist, Wisconsin Sea Grant.

In collaboration with the Duluth Seaway Port Authority and the U.S. Army Corps of Engineers, Minnesota and Wisconsin Sea Grant convened experts, consultants, engineers, and scientists to examine potential causes, recommend mitigation measures, and identify next research steps for the 13 miles of steel sheet piling corroding throughout the harbor. In subsequent tests—micro-biologically influenced corrosion (MIC) lab investigations (see *Types of Corrosion*)—bacterial communities on the corroded steel in the most affected part of the harbor were found to be different from bacterial communities in less affected areas just outside the harbor. Bacteria that oxidizes iron (from Fe²⁺ to Fe³⁺) was isolated from the corroding structures. Preliminary research indicated a unique combination of bacteria, water chemistry, and ice scouring were responsible.



Concurrently, testing continued on a collection of coupons (steel plates) from trays placed throughout the harbor to investigate the rate of corrosion and possible coatings that could protect the steel. Both uncoated and coated coupons are removed, inspected, and replaced. Ice abrasion and impact test samples, installed in 2008, are also being pulled, inspected and then returned for another year. Additional linear polarization testing will be conducted in 14 locations. These and other tests are helping determine the causes of corrosion and most importantly, methods for saving the steel structure that’s left on existing docks. The Great Lakes Network of Sea Grant programs were ready and able to assist in providing science-

Types of Corrosion

Generalized Corrosion: a well-distributed, low level attack on the entire metal surface with little or no localized penetration... the least damaging type of corrosion.

Pitting Corrosion: localized deep penetration of a metal surface with little general corrosion around it. It is caused by surface deposits, electrical imbalance, or some other initiating mechanism. Pitting corrosion may include: crevice corrosion, waterline attack, under deposit attack, concentration cell or erosion corrosion.

Galvanic Corrosion: an aggressive, localized form of corrosion due to electrochemical reaction often found between two dissimilar metals in an electrically conductive environment. It occurs because the electronegative material (the anode) is attacked by the electropositive material (the cathode).

MIC Corrosion: microbiologically influenced corrosion is deterioration caused by microorganisms on the surface and under specific environmental conditions. MIC corrosion usually signals a severe threat to the entire system. It produces large deep pits due to the microorganism using iron as an energy source, then producing corrosive metabolic by-products.

Erosion Corrosion: the gradual and selective deterioration of a metal surface due to mechanical wear and abrasion.

CUI Corrosion: corrosion under insulation is a threat to holding tanks or systems operating at lower temperatures in humid environments. Outdoors, moisture, rain, snow or ice can penetrate the insulation and cause physical damage. CUI usually remains hidden until severe damage has occurred.

Concentration Cell Corrosion: when the surface is exposed to an electrolytic environment where the concentration of the corrosive fluid or the dissolved oxygen varies.

Crevice Corrosion: occurs at places with gaskets, bolts and lap joints where crevice exists. Crevice corrosion creates pits similar to pitting corrosion.

See corrosion photo gallery at:

<http://www.cornview.com/gallery1.htm>

based experience and non-advocacy testing of applicable demonstration projects. Project reports, fact sheets, and photos can be found at: <http://seagrant.wisc.edu/CoastalHazards/Default.aspx?tabid=1539>

As a major player in corrosion research—along with the U.S. Navy, the National Academies and NACE International (an association of corrosion engineers in the private sector), Sea Grant is behind a number of innovative processes that fight the problem.

With a grant from NOAA Sea Grant and Maritime Administration (MARAD), the University of Maryland's Chesapeake Biological Laboratory tested the ability of the Venturi Oxygen Stripping™ to kill or deactivate harmful microscopic aquatic organisms. Lab-scale testing proved effective, as well as treatment at high flow rates. Results showed that the system is able to meet the International Maritime Organization (IMO) standards.

Ohio Sea Grant funding is making it possible for the University of Akron to develop effective, non-toxic, environment-friendly antifoulants, by understanding a natural product, zosteric acid (ZA). ZA deters attachment of many microorganisms, algae, barnacles and tubeworms and interacts with cells. Traditional heavy metal-based anti-fouling paints release toxins that create environmental concerns. The use of non-toxic or less toxic marine products as antifoulants represents a promising new approach.

In California, Florian Mansfeld at University of Southern California (USC) Viterbi School of Engineering (whose early work in corrosion was funded by USC Sea Grant) was among the first to show that if the problem with MIC corrosion is biofouling, then the solution may be the opposite: bacteria that can protect metals. *Shewanella oneidensis*, a bacterium that metabolizes metals and changes their chemical structures by giving them electrons, proved to be the best of these and the process is called "microbiologically influenced corrosion inhibition," or MICI.

In order to make a difference, research results must be applied by decision-makers, local officials and the public. Sea Grant is instrumental in delivering corrosion education and outreach. For instance, Washington Sea Grant, Jefferson Education Center and Washington State University (WSU) offer workshops for marine professionals on galvanic corrosion, crevice corrosion, types of anodes, corrosion damage from stray current, and more.

Sea Grant's corrosion research also informs public policy. Congressman Michael Conaway (R-TX) and Congresswoman Betty Sutton (D-OH) introduced H.R. 1682, *Bridge Life Extension Act of 2009* which could have far-reaching impact on the integrity of the nation's bridges. It is estimated that more than 45,000 bridges are in danger of serious structural issues related to corrosion. Sea Grant-funded research is bound to impact the discussion.

As coastal communities in the United States move forward, applying science and technology to the reduction of coastal hazards and preparing coastal communities to be resilient in the face of disasters, NOAA Sea Grant (and its partners) are solving the underlying challenges that coastal infrastructure corrosion presents. ❖

SEA GRANT FACILITATES HURRICANE RECOVERY

By Paula Ouder, Louisiana Sea Grant

Sea Grant contributes to the understanding of long-term coastal and environmental trends through research, education and engagement with stakeholders. The program's unique combination of strategies and its credibility with coastal communities make us uniquely able to assist constituents who find their lives and livelihoods suddenly upended by natural disasters. Local programs in the Gulf of Mexico have proven to be vital partners in community recovery from the devastation of recent hurricanes.

Boats and fisheries

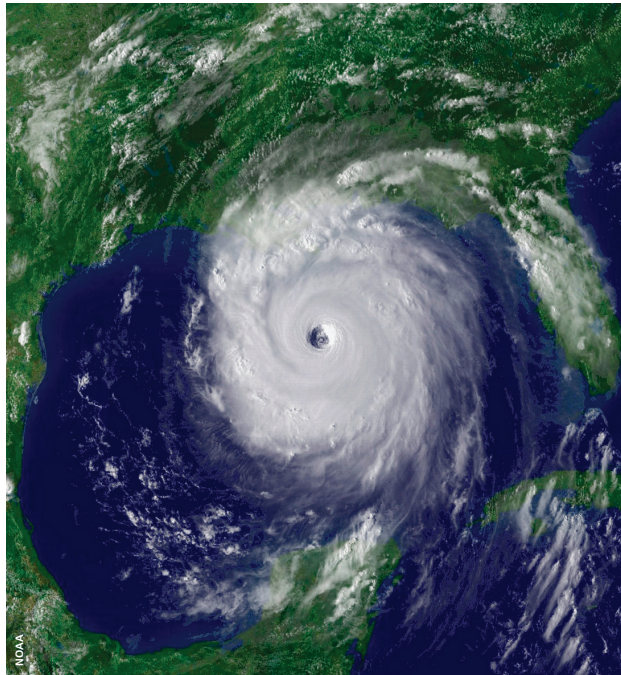
The devastation wrought by these powerful hurricanes could not have come at a worse time for Gulf of Mexico shrimpers, who were already struggling under the double yoke of high fuel costs and low prices for their catch. Countless commercial and recreational boats sank or were broken apart by violent storm surge. Others remained seaworthy but were grounded in area marshes or flung inshore, sometimes by miles.

For the captains whose craft survived, returning to work was among their top priorities. Washington, Alaska and Louisiana Sea Grant programs worked with a host of agencies and organizations to secure the donation of a surplus Marine Travelift from Valdez, Alaska, to the Plaquemines Parish government in Louisiana. The mobile boat hoist moves vessels in and out of the water and replaced the boatyard's launching equipment that was lost in Katrina and Rita. New devices of this type cost upward of \$250,000.

Two Texas Sea Grant county agents made it their mission to reunite hundreds of recreational watercraft with their owners. The agents recorded GPS coordinates and took photographs of roughly 80 derelict vessels scattered during Hurricane Ike. By cross-referencing state registration numbers with Texas Parks and Wildlife Department records, boat owners were identified and received postcards detailing the exact

location of their vessels. This assistance sped the insurance reimbursement process.

One Louisiana Sea Grant agent laid the groundwork for future collaboration and disaster planning to serve Louisiana's fishing industry. He teamed up with community relations personnel from the Federal Emergency Management Agency (FEMA) to provide reliable information to the fishing community, assistance with housing and utilities for displaced residents, and help restoring government and business services. The agent also spoke at public meetings about industry needs and possible solutions.



Recovery

Submerged debris threatens economically viable fishing grounds and public safety, and storm surge from Hurricanes Katrina and Rita generated an unprecedented number of these underwater hazards. The National Oceanic and Atmospheric Administration (NOAA) turned to Sea Grant to meet its communication goals when NOAA established the Gulf of Mexico Marine Debris Project in 2006. For three years, NOAA contractors used sonar to scan the near-shore waters in Louisiana, Mississippi and Alabama to locate sunken items. Data and maps detailing the location and size of

each target were posted online. Louisiana Sea Grant and the Mississippi-Alabama Sea Grant Consortium worked together to design and execute a multi-media outreach campaign to make the boating public aware of this potentially lifesaving information. The fruits of this partnership drew more than 60,000 visitors to the project's website and helped safeguard recreational, charter and commercial boaters and their vessels and fishing gear.

Restoration

Coastal land is another casualty of recent storms. The success of a three-acre beach restoration pilot project funded

by the Mississippi-Alabama Sea Grant Consortium led to a \$100,000 grant from the U.S. Army Corps of Engineers. This funding will restore 26 linear miles of Mississippi beach. Community volunteers have donated more than 700 hours to the project, securing the upper-beach areas with more than 10,000 new plants.

Economic impact

Obtaining timely, accurate estimates of the economic impact of a natural disaster is crucial for allocating resources and obtaining federal recovery funds. Research developed by Louisiana Sea Grant-sponsored economists resulted in a new technique for gauging the impacts of hurricanes on coastal fishing infrastructure. Their method utilizes field surveying, revenue and market data, and data on storm surge height to provide a more rapid and spatially precise estimate of damages. A process that required two years to develop and complete after Hurricanes Katrina and Rita took only two weeks to complete after Hurricanes Gustav and Ike.

The small fishing community of Delcambre, La., was inundated during Hurricane Rita, and fewer than two dozen of its nearly 1,000 homes and businesses escaped flooding. With assistance from Sea Grant professionals and architecture and design students from area universities, town leaders prepared a comprehensive business plan and a grant application that was ready as soon as recovery funds were released. Consequently, the town was awarded \$2.2 million from the Louisiana Recovery Authority for redevelopment. Parish government will provide an additional \$600,000. The funding will transform the industrial waterfront into a mixed-use residential and business zone. In addition to improving safety, aesthetics and functionality, the project is expected to increase local tourism.

Building resiliency

As extraordinarily destructive as the 2005 and 2008 hurricane seasons were, more are likely coming. Preparing for future threats will save lives and property, diminish economic losses and expedite recovery. Education is one key to helping coastal residents understand their vulnerability and helping them safeguard against it.

The Louisiana Sea Grant Law & Policy Program published the 250-page *Louisiana Hazard Mitigation Guidebook* to explain issues from zoning and structure siting to construction methods and legislation that can be employed to build more hazard-resistant communities. Based on a similar guidebook developed by Hawai'i Sea Grant, the Louisiana guidebook outlines strategies to reduce the risks from coastal natural hazards such as storm surge, other flooding, subsidence and sea level rise, and demonstrates how communities can adopt a flexible approach to hazard planning. The guidebook is now being used as a text at

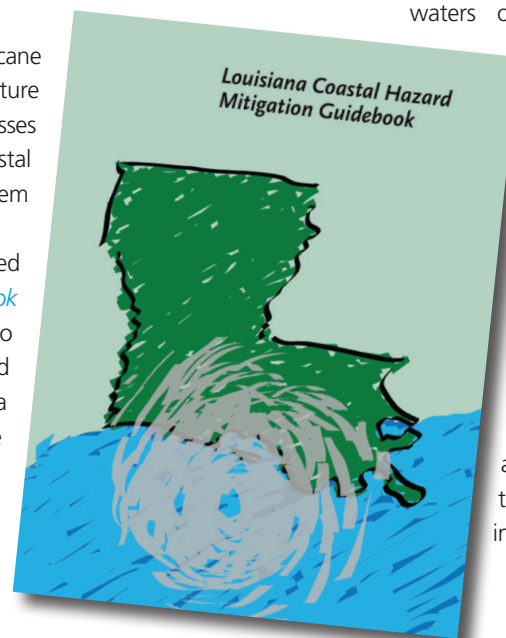


the Louisiana State University law school. Approximately 650 to 700 books have been distributed to date. Sea Grant also offered workshops for Louisiana citizens and government officials to help them understand and implement the strategies outlined in the guidebook. Videos of the workshops and copies of the guidebook are archived online and available free of charge.

"The Next Storm Surge" outreach series graphically demonstrated how vulnerable communities and individuals are to hurricane flooding. Louisiana Sea Grant Extension agents and disaster and GIS specialists assessed the vulnerability of eight of the state's 24 coastal parishes. Using computer modeling and local data collected on the ground after hurricanes, they prepared maps showing the extent of potential flooding under various storm scenarios. They superimposed images of flood

waters on photographs of

local businesses and landmarks to help residents visualize predicted impacts. More than 2,000 people attended the program at local libraries. Maps and printed materials remained on display for library patrons after each program to extend the project's impact. ❖



SWEET OR SALTY, QUALITY COUNTS: SEA GRANT PRIORITIZES CLEAN WATER

By Sharon Moen, Minnesota Sea Grant

Beluga whales living in the St. Lawrence Estuary can be so contaminated that they qualify as hazardous waste. The endangered population also exhibits the highest known rate of cancer in any wild mammal species, one that's comparable to the rate among human adults in the United States.

Sea Grant-funded researchers at the Woods Hole Oceanographic Institution (WHOI) have studied genes that affect the susceptibility of belugas to toxins to understand whether the population's condition reflects the chemical soup in which they dwell. Pollutants from industry, agriculture, and urban development in the entire Great Lakes Basin funnel through the St. Lawrence, along with pollutants from far off places that fall from the sky (a circumstance known as atmospheric deposition). The researchers found that belugas have a high-sensitivity version of a specific gene that responds to polychlorinated biphenyls (PCBs), suggesting that these chemicals may be particularly troublesome in cetaceans like whales.

"Certain contaminants appear to be causing noticeable biochemical effects in many organs of belugas and other marine animals," said Mark Hahn, a senior scientist at WHOI with research interests in toxicology. "Our work has revealed that some marine animals, including belugas, may be especially sensitive to these chemicals, whereas others, such as certain seabirds, may be more resistant. My hope is that as we

clarify how exposure to compounds like PCBs and endocrine disrupting chemicals affect organs and individuals, we can begin to ask questions about the risk that contaminants pose at the population level. That's the ultimate goal."

The quality of the water in the Great Lakes—sometimes dubbed "North America's Sweetwater Seas" or the "Fourth Coast of the United States"—concerns the National Oceanic and Atmospheric Administration, particularly through its regional network of university-based Sea Grant programs. The federal and state partnerships that fuel Sea Grant programs in coastal states around the nation were designed to support research, outreach, and education that improve the economic and environmental prosperity of the nation's coastal regions. By state, by region, and as a national network, 32 Sea Grant programs work toward sustaining the nation's water quality and supply.

Superior waters

"Lake Superior sets the bar for water quality in fresh surface waters," said Jeff Gunderson, the director of the University of Minnesota Sea Grant Program, which operates less than five miles from the westernmost edge of the Great Lakes. "Sea Grant helps to ensure that Lake Superior's reputation is not only warranted, but sustained. To do this we stay vigilant and proactive about educating community leaders and emerging



California Sea Grant



scientists, funding aquatic research, working with industries, and exchanging ideas with residents.”

Aside from contributing to the way coastal communities manage stormwater runoff, development, and water quality, Minnesota Sea Grant has conducted seminal research on bacteria that triggers beach closures, chemicals that disrupt the normal production of hormones, and toxins such as PCBs and toxaphene. In fact, Time Magazine (2006) recognized that the work of Minnesota Sea Grant researcher Michael Sadowsky would redefine how *E. coli*, a bacteria used for indicating fecal contamination, is used in water quality monitoring. They wrote:

Sadowsky and his fellow researchers have found a way to tease out stretches of marker DNA that indicate whether the bacteria came from human or nonhuman sources. With cities and states across the country spending billions on new water-quality systems, the impact of Sadowsky's work could be huge.

Other Sea Grant offices conduct a similar suite of research, outreach and educational activities to ensure sustainable water supplies and high water quality. For instance, Sea Grant extension professionals have cooperated with the Miller Brewing Company to improve the waters near Milwaukee beaches and have helped city officials plan how Chicago's 8.7 million people will continue to have a safe drinking water supply. Whether in South Carolina or Southern California, Sea Grant has improved peoples' understanding of groundwater and surface water relationships in such a profound way that some are taking considerable pains to install new septic systems, raingardens, and water retention ponds. To sustain their water quality and supplies, residents, businesses, and communities are willing to commit the time, money, and sweat required for such water management projects.

Back from the dead

Even though it is still bedeviled by episodes of waterfowl botulism and “dead zone” areas where oxygen is scarce, Lake Erie can be touted as one of the world's most powerful environmental success stories. Jeff Reutter, the director of the Ohio Sea Grant Program and Stone Laboratory, tells it this way:

Lake Erie was in rough shape 40 years ago. One of its tributaries, the Cuyahoga River caught on fire (1969). Erie itself was called a “dead lake” due to high

contaminant levels and its excessive phosphorous loads. As well as an embarrassment, Lake Erie became a national joke. “I heard Lake Erie is the place fish go to die,” quipped Johnny Carson on late night television (1976).

In response to Lake Erie and the generally deteriorating water quality of the country, the United States government created the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency, and passed the Federal Water Pollution Control Amendments of 1972 (commonly known as the Clean Water Act). Lake Erie responded dramatically to the ensuing limits put on phosphorous inputs. Through the efforts of many entities, including Sea Grant, the lake went from “dead” to “the walleye capital of the world” with more pounds of fish being harvested from Lake Erie than the other four lakes combined.

In addition to funding investigations regarding Lake Erie, Sea Grant helps to coordinate research in the United States and Canada that will solve a troubling increase in phosphorus levels and harmful algal blooms, among other challenges. The Binational Executive Committee recently tapped Sea Grant's outreach capabilities to aid agencies in communicating information about Lake Erie's current situation to managers, decision makers, and the public.

Creating cleaner waters

If the people, communities, and industries around Lake Erie can cooperate to improve water quality, Sea Grant knows it is possible to inspire the same synergy within the Chesapeake Bay and the Gulf of Mexico. They, too, are on the receiving end of stormwater runoff laced with pollutants from multiple and vast agriculture and urban centers. The influx of excess nutrients leads to excess algal production and low levels of oxygen in the water. Fisheries, boating, and tourism—not to mention waterfront real estate—are multi-million-dollar activities jeopardized by deteriorating water quality. Sea Grant staff and researchers put considerable effort into complex water quality challenges that lead to dead zones and harmful algae blooms using the national program's trademark approach:

- Improve scientific understanding.
- Support integrated management decisions that reflect science.
- Create an informed citizenry.

The approach was fully implemented in response to Section 303d of the Clean Water Act. This act requires states to develop

Total Maximum Daily Loads (TMDLs) for waters impaired by pollutants. The objectivity and finesse required to calculate TMDLs—the amount of a pollutant that a waterbody can receive and still meet water quality standards—inspired the EPA, state agencies, and watershed districts to recruit Sea Grant staff to facilitate dialogues and conduct surveys, reviews, and public education. The TMDL process and Sea Grant's non-advocacy, non-partisan, science-based reputation helped to generate plans that substantially reduce suspended solids, nutrient enrichment, and bacteria inputs to waterbodies. The EPA lauded projects to which Sea Grant contributed as outstanding examples of TMDL planning, processes, and public outreach.

Also, Sea Grant trains citizen scientists of all ages to conserve the quality of their water. People have reported making sustained behavioral changes to improve water quality after their children studied Sea Grant's watershed curriculum, and after participating in Sea Grant's watershed programs and projects. By providing city governments with science-based regional scenarios regarding climatic change and tools to evaluate the tight association between land use and water quality, Sea Grant staff adds rigor to decision-making and furthers the goals of community economic and ecologic sustainability.

Sea Grant-funded researchers are creating new technologies for removing harmful algae toxins from drinking water as well as studying the causes for dead zones. They're working to understand how water seeps into the ocean through submarine groundwater discharge and how this affects water quality around coasts, corals, and shellfish beds. Communities have become better at enhancing, conserving, and managing their water quality and supplies because of Sea Grant-funded water flow modeling and septic system research.

We all live downstream

Beyond clarifying the correlation between septic systems and seawater quality, Sea Grant has reduced chemical pollutants in waterways by organizing pharmaceutical collection events and a first-ever buy-back program for human drugs that may cause



Photo: Rio Sea Grant

problems when discharged into aquatic environments. To rid the nation's coasts of non-biodegradable plastics, Sea Grant organizes the retrieval of derelict fishing gear and monofilament fishing line from beaches, and arranges for the recycling of shrink-wrap from boating facilities. Millions of pounds of beach litter have been properly disposed or recycled through Sea Grant's efforts.

As safe and sustainable water supplies become scarcer and therefore more precious, as is predicted in the next century, NOAA Sea Grant's devoted pursuit of excellent water quality is not only heartening, but also economically essential. The St. Lawrence River belugas, those cancer-ridden sea canaries at the mouth of the Great Lakes Seaway, may be oblivious to the causes of their undoing, but they and other coastal creatures (including humans) don't need to be undone. Each year, Sea Grant's dedicated researchers produce new insights into ways to improve, manage, and protect water supplies. Echoing these science-based insights, Sea Grant's

passionate extension professionals work to make sure research results are accessible to those people who most need and want them. Sweet or salty, water is essential to your life and keeping that water clean is essential to NOAA Sea Grant.

For more information on the ways that NOAA Sea Grant ensures safe and sustainable water supplies, go to the national network's Web site at: www.seagrants.noaa.gov. ❖

