Gulf of Mystery

Without a basic understanding of the Gulf of Mexico ecosystem, scientists will never be able to evaluate the impact of environmental disasters

The Gulf of Mexico's waters are among the richest fishing grounds on Earth. Its wetlands protect the coasts from storms and serve as a nursery for hundreds of species of animals. Its beaches draw millions of tourists annually.

Yet, for all we take from the Gulf of Mexico, we know surprisingly little about its ecosystem. So, when environmental disasters like last year's Deepwater Horizon oil spill occur, it's almost impossible for scientists to accurately assess their impact.

"Many natural and human disturbances, in addition to oil spills, potentially impact the Gulf, including rising sea levels, more frequent and more powerful hurricanes, oxygen depletion, invasive species and overfishing," says Tom Frazer, associate director of UF's School of Forest Resources and Conservation. "But without a long-term commitment to coordinated ecological research, it is extremely difficult to attribute cause to any particular disturbance. This is a key lesson from the Deepwater Horizon."

Scientists like Frazer and dozens of other University of Florida researchers, many members of UF's multidisciplinary Water Institute, are hoping that businesses and policy makers embrace that lesson and use funding from BP and other sources to better document the Gulf's ecosystem.

SPECIES SURPRISE

Paulay's team is still cataloging the thousands of samples they brought back from the Gulf, but he says it is clear the nearshore ecosystem is even more diverse than scientists thought.

Gustav Paulay (right) led a team of researchers on two week-long expeditions to catalog marine invertebrates on the Gulf floor off Florida's west coast.

Despite a career spent assessing marine ecosystems, Gustav Paulay returned from eight days diving off Florida's west coast last March with a new appreciation for the diversity of life in the Gulf.

"It's remarkably rich in life," says Paulay, curator of malacology (mollusks) at the Florida Museum of Natural History. "We identified about 500 different species, including probably a couple of dozen that have never been documented in west Florida before."

And if some of those species are killed off by oil or other natural or man-made causes, we might never even know they were there or how their absence affects the rest of the ecosystem.

"Take sponges, for example," says Paulay. "Some can live as long as the giant redwoods, but if they die they'll just disappear. They're not like coral, so we won't know a certain species was even there if we don't do the baseline research."

With $195,000 in support from BP's "rapid response" fund, Paulay led two week-long cruises off Florida's west coast on the Florida Institute of Oceanography's research vessel, Weatherbird II.

The expedition was the most comprehensive biodiversity study ever of the hard bottom along the west Florida shelf. Researchers plan to repeat the survey next year to observe short-term changes in biodiversity. The data will be useful for science as well as the fishing industry.

The Weatherbird II traveled south from St. Petersburg to the Florida Keys March 4-9, then north from St. Petersburg to the Panhandle March 10-14. Divers ventured 30 to 100 feet underwater to reach the hard-bottom communities, which in Florida are typically fossilized limestone reefs and beds, with a thin sand veneer in places. These support large, attached animals like sponges, corals, sea fans, sea squirts and sea weeds giving structural complexity to the bottom.

The team also collected samples by dredging and trawling the waters as the ship traveled.

Funding for the project was part of a $10 million grant from BP to the Florida Institute of Oceanography, and Paulay's proposal was one of 27 selected from 233 submissions.

Paulay's team is still cataloging the thousands of samples they brought back from the Gulf, but he says it is clear the nearshore ecosystem is even more diverse than scientists thought.

Now that the researchers have a better idea of the sea-floor structure off Florida's west coast, the team is currently identifying three representative sites, each of which will have three stations for detailed monitoring. Monitoring will track not only sponges, corals and fish but also the myriads of smaller organisms so important in marine food webs. These will be tracked in Autonomous Reef Monitoring Structures (ARMS), made of stacked PVC plates that marine creatures will inhabit over time. ARMS soak for a year, then are harvested and taken apart to evaluate the biota.

Paulay's most recent research is an extension of the kind of baseline studies scientists like he and Frazer have been conducting for years, but as the scope of the Deepwater Horizon spill became apparent, many UF scientists ramped up their field work on everything from seagrasses to sea turtles in an effort to record as much about the pre-spill Gulf as possible before oil changed it irrevocably.

SAVING SEAGRASS

Eric Zamora

"Seagrasses are relatively light-hungry organisms. When excess nutrients cause excessive algal growth, less light reaches the seagrass, and it suffers and declines."

— Tom Frazer

Florida's Big Bend is home to the second-largest contiguous seagrass habitat in North America, making it a vital resource not only for the state, but also for the nation and the world. These seagrass beds support Florida's multibillion-dollar recreational and commercial fishing industries by providing habitat for everything from bay scallops to grouper.

Seagrasses also represent an important food resource for endangered green sea turtles and manatees, and they generate oxygen, dampen wave energy, stabilize sediments to reduce shoreline erosion, sequester carbon and enhance water clarity. In sum, seagrasses are essential to the integrity, health and value of the state's estuarine and nearshore coastal ecosystems.

Unfortunately, seagrasses are also among the most threatened ecosystems on the planet. Around the globe, seagrass beds have disappeared at the alarming rate of about 100 square kilometers per year since the 1980s.

Tyler Jones

Ecologist Tom Frazer collects seagrass near Crystal River on Florida's Gulf coast.

Frazer has led UF seagrass research on the Big Bend and Florida's Gulf Coast for the last 15 years. A vital base for this work is Project COAST (Coastal Assessment Team), with its network of fixed sampling stations and monitoring of water quality factors, especially nutrients and planktonic algae.

From 2010 through 2012, Project COAST will be augmented with a study more specifically characterizing the species composition of seagrass communities and assessing their ecological performance.

"Seagrasses are relatively light-hungry organisms," Frazer says. "When excess nutrients cause excessive algal growth, less light reaches the seagrass, and it suffers and declines."

Because of his long-term research on seagrasses, Frazer was well-positioned to expand ongoing studies — with additional funding from Florida Sea Grant's Rapid Response Program — and begin documenting changes following the spill. All of this work is important, Frazer says, because once damaged, seagrass beds don't recover readily.

"If you lose seagrasses, they can take decades to recover," he said. "If we can predict or garner an early warning of a decline in (seagrass) performance before there's a collapse, we'll be in a better position to do something about it.

HALF-SHELL HABITAT

Like seagrasses, oyster reefs are one of the world's most important marine habitats — and one of the most endangered, having declined by more than 90 percent from historical levels. The Gulf of Mexico supports more than 60 percent of the healthy oyster reefs in the world. Along the Big Bend area of Florida's Gulf coast, oysters provide habitat for fish and wildlife and support commercial fisheries and related jobs.

UF researchers Peter Frederick and Bill Pine have been studying risks to Big Bend oysters from numerous threats, including climate change and rising sea levels. Oysters are beneficial to coastal ecosystems and human communities, shielding homes from storm surge, mitigating erosion, filtering seawater and creating essential marine habitats. Despite their importance, we know little about what makes oyster reefs healthy.

"Many aspects of the ecology of the Gulf of Mexico are not well studied, and if you don't know how a system works, it's very hard to restore it once it's damaged," Frederick says.

Frederick and Pine were interested in reports of changes in oyster distribution along the undeveloped Big Bend coastline in the last 50 years and earlier research suggesting that reduced Suwannee River freshwater flow could threaten oysters.

Using Florida Sea Grant funds, the wildlife ecology and conservation researchers began in February 2009 to map Big Bend oyster bed distribution using high-resolution aerial imagery. By linking the new imagery to mapping efforts in recent decades, the pair began to understand the timing, location and extent of reef changes. They recruited postdoctoral fellow Jennifer Seavey to help assemble the photographic evidence and began to zero in on a possible reason for the reef changes: rising sea levels.

Tyler Jones

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— Peter Frederick

The team's plans changed abruptly when the Deepwater Horizon oil platform exploded and it became clear that their data would be invaluable in assessing the impacts if oil reached the Big Bend. On the other hand, if the area were spared, the data would provide reference sites for comparison to impacted areas.

With funding from IFAS, Florida Sea Grant and the U.S. Fish and Wildlife Service, the team worked with local fishermen to complete on-the-ground surveys of oyster health, growth, abundance and distribution during the critical period before the spill was capped and the oil's immediate impact on the Gulf of Mexico was known.

The scientists say UF's involvement left the university in an excellent position to assist with future oyster reef threats nationwide.

Tyler Jones

Bill Pine (top) uses a one-square-meter gauge to calculate how many oysters, living and dead, are on the reef near Cedar Key, Florida. Peter Frederick uses a laser level to establish elevation profiles on an oyster reef.

MARSH MESS

Students Jessica Diller and Kamala Earl (above) and post-doctoral researcher Gabriel Kasozi (below) prepare enclosed treatment plots in oiled marshes of Barataria Bay, La.

Andrew Zimmerman has been studying organic matter adsorption and charred carbon for much of his career, so as images of oil-slick marshes in Louisiana blanketed the media last year, he immediately thought of ways his research could contribute.

"We had all kinds of people talking about all sorts of unnatural sorbents," says Zimmerman, an assistant professor of geological sciences. "We immediately began to think of a way to use natural sorbents."

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With a $200,000 grant through the Florida Institute of Oceanography from the BP spill fund, Zimmerman and biology Assistant Professor Brian Silliman have spent the last year documenting oil contamination and associated ecological damage to the marshlands around Louisiana's Barataria Bay.

They are also studying whether biochar, a form of charcoal, and calcium peroxide, an oxidant, could be used in future spills to lessen the damage from oil and other pollutants.

Zimmerman, Silliman and their team have made four trips to Barataria Bay since October. In addition to complete death of marsh grasses in areas of the coast that had seen heavy oil coverage, additional damage was done by washing of the marshes with detergent dispensed through high-pressure hoses.

"There was a lot of damage done by washing," he says. "The erosion was dramatic."

All sign of invertebrate life was absent from areas that had received heavy oil impact, but these areas were not as extensive as first feared, extending only about 40 feet in from the shoreline on portions of island facing the incoming tide waters.

But Zimmerman says he was encouraged by the small signs of recovery evident during a trip in April.

"On our last trip, the plants were starting to come back along the edges of the untouched areas, into the heavily oiled areas."

Zimmerman's earlier research focused on how biochar could be used as a type of fertilizer, improving the soil and sequestering carbon simultaneously. So when the oil spill occurred, it was a short leap to using it as a remediation material.

The researchers are also studying the feasibility of using calcium peroxide to increase oxygen levels in the soil.

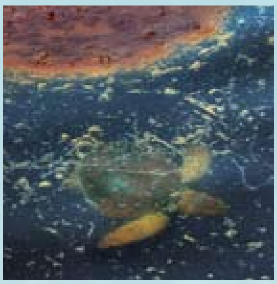
"Everyone is talking about using microbes and nutrients to break up the oil," Zimmerman says, "but all of these chemical reactions require oxygen, so we're looking at ways to increase the oxygen content in the soil."

The team has set up monitoring plots at four sites in Louisiana, two impacted by oil, the other two not impacted. Each includes a control site with no treatment, a biochar site, a calcium peroxide site and a site with both.

Because there are so many variables in this particular natural environment, Zimmerman says, the researchers will also be studying the impact of biochar on oil-saturated soil in the laboratory.

BASELINE BLAME

NOAA



Brian Stacy was one of numerous UF veterinarians and biologists who helped rescue live sea turtles and necropsy dead turtles.

Famed UF biologist Archie Carr's studies of sea turtles took him to every corner of the Gulf of Mexico, but the director of the center that bears his name says scientists' understanding of the Gulf and of how ecological disasters can impact it are limited.

Karen Bjorndal, a UF biology professor and director of the Archie Carr Center for Sea Turtle Research, says the challenges of the Deepwater Horizon spill are similar to the ones scientists faced after the Exxon Valdez oil spill in Alaska in 1989.

"We lack critical data to determine the ecological consequences of human-induced environmental disasters," Bjorndal says.

In an article in the journal *Science* last February, Bjorndal joined numerous other scientists to argue that the United States needs "strategic national research plans for key marine species and ecosystems." Bjorndal says little has changed since the Exxon Valdez oil spill as far as getting the data needed to assess and restore a marine ecosystem after an environmental disaster. She hopes the Deepwater Horizon spill will provide an impetus for action.

"We know how to create these research plans — what is needed now is the political will and leadership to do so," she writes.

Part of the challenge, says Mark T. Brown, director of UF's Center for Wetlands, is that traditional economic models have no way of accounting for "ecosystem services" such as the plankton, algae and seagrasses that support the shrimp and fish that are the primary diet for myriad marine animals, birds and even some land animals. The Gulf's other environmental services range from the buffering of temperature and climate to the absorption of carbon dioxide from the atmosphere to water cleansed of pollution by wetlands.

"This storied body of water is also the source of many cultural services," Brown says. "For example, the comfort, spiritual solace or intellectual inspiration that draw so many visitors to its shores."

Brown is a student of famed UF ecologist Howard T. Odum, who developed an environmental accounting method called Emergy Synthesis — that's "Emergy" with an "m" — that evaluates natural resources and ecosystems despite their lack of market, ultimately assigning them economic values.

"The various projected costs from the Deepwater Horizon leak have ignored environmental services because, in a purely economic sense, there is no market for them, so they have no economic value," Brown says.

"But we can make some educated guesses if we assume that the same proportion of costs can be attributed to environmental damages as in the Exxon Valdez spill, then they could total about 40 percent of the cleanup and economic damages, or close to $5 billion."

Ultimately, the UF researchers are no different from other Floridians who want to see their coastal environment protected.

"I have young children and my hope is that in 50 years they can still eat Cedar Key oysters," Pine says. "I think that by working now to understand what's going on in these ecosystems and protecting them, we'll be able to do that."

Joseph Kays, Mickie Anderson and Susan Gildersleeve contributed to this report.

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