Leaf Litter
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Thoughts On Gulf Coast Ecosystems

Together, Hurricane Katrina and the Deepwater Horizon oil spill cast a rather intense spotlight on the Gulf of Mexico. But many would argue that this level of attention to the Gulf is long overdue.

Bordered by five U.S. states to the north, five Mexican states to the west, and the island of Cuba to the southeast, the Gulf of Mexico is the 9th largest body of water in the world. Spanning over 600,000 square miles, and including more than 100 estuaries along the U.S. coastline alone, the Gulf region offers a wide array of habitats including coastal marshes, mangroves, dunes, coral and hardbottom communities, and submerged aquatic vegetation, to name a few. In fact, the Gulf Coast's mix of currents, climates, and habitats make it on of the most biologically rich regions on the planet. Not surprisingly, it has become an economic engine supporting commercial and recreational fishing, energy exploration, and tourism.

The Gulf's bounty of natural resources fuels and feeds much of our nation, yet the actions of humans have put its ecological health at risk. Can the Gulf handle the physical and chemical alterations we have made to its contributing waters? Can it withstand the rate at which we extract its resources? Just how resilient is the Gulf? Are people even aware of what is at risk?

We'll begin to examine these questions as we chat with noted Louisiana wetlands ecologist, Dr. Robert Twilley. Referring to the Gulf as "genetic soup," Dr. Tilley tells us why he thinks the Gulf Coast is one of the most fascinating biological systems in the world.

Landscape Architect Jennifer Dowdell reminds us that not all threats to the Gulf come from its immediate surroundings in her article Dead Zones In The Gulf: Reaping What Is Sown Upriver.

Senior Ecologist Terry Doss draws a parallel between the robust spirit of the people of New Orleans and hardiness of the region's wetlands in The Resilience of New Orleans.

We'll share some links and helpful resources on the Gulf and news about some exciting work we're doing in the Gulf region and beyond.

What do you think about all of this? Share your thoughts on our blog, Rhizome**,** or make a comment on the Biohabitats Facebook page. If you want to reference a specific article, be sure to include it in your post.

Leaf Litter Talks With

Dr. Robert Twilley
Vice President for Research
University of Louisiana at Lafayette

Until recently, Dr. Robert Twilley served as director and professor at Louisiana State University's Wetland Biogeochemistry Institute in the Department of Oceanography and Coastal Sciences. He was also a Distinguished Professor in LSU's department of Louisiana Environmental Studies and a fellow in the Northern Gulf Institute. This summer, Dr. Twilley assumed the role of Vice President for Research to the University of Louisiana at Lafayette, an institution at which he taught for 18 years and founded the Center for Ecology and Environmental Technology.

A respected scholar and scientist with over 100 peer reviewed publications and expertise in wetland ecology and rehabilitation, Dr. Twilley has focused much of his research on systems ecology and biogeochemistry of coastal wetlands in the Gulf of Mexico and Latin America. He has also studied climate change extensively and its effect on states along the Gulf of Mexico. Dr. Twilley heads up the America's Wetland Foundation's 'coastal sustainability studio' which was established to provide professional training in designing resiliency in natural and built communities along coastal Louisiana. He presently serves on the National Research Council Committee on Independent Scientific Review of the Everglades Restoration Progress (CISRERP), which serves to report on the status of ecosystem restoration in that region.

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The Gulf of Mexico is almost like a huge lake. About 90% of the area around the Gulf is bordered by shore, with only one inlet and one outlet. The inlet is between the Yucatan Peninsula of Mexico and Cuba. This very strong current-the Yucatan Strait-flows up toward the Louisiana coast, and then bifurcates off the coast of Louisiana. Part of the current drifts west toward

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Texas, and the majority of the current flows east along the Florida coastline and then flows through the Florida Straits, between Cuba and the Florida Keys. That water gets entrained into the Gulf Stream and flows along the Atlantic Seaboard. It's through those two small openings that water exchanges in and out of the Gulf of Mexico.

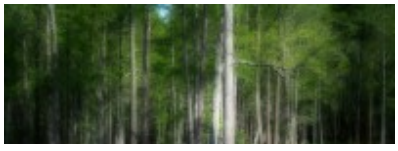
There are some very fascinating things about this 'lake,' or 'enclosed sea.' First, when you move from the southern to the northern part of the Gulf region you have a very strong climate gradient- from tropical/subtropical to warm temperate. With it, you find a migration of tropical species moving up into the United States along the Gulf coastlines. Take, for example, mangroves. Mangroves occur in south Florida and in Mexico. They grow to quite a large height in the Yucatan region. In Mexico's Terminos Lagoon, for example, the trees are 20 feet tall and one meter in diameter. Now, you actually find mangroves now in Louisiana, although they're only two meters tall. So you have this strong gradient that manages this mix of tropical and warm temperate mangrove communities.

Padre Island beach

Another fascinating thing about the Gulf region is that there is a west-east gradient in precipitation. To the west, in the Padre Island area of Texas, it's very dry. You have much higher evapotranspiration than rainfall, so you end up with cacti and drought resistant plants that you'd find in deserts. As you move into Louisiana, you have a very wet environment. We have 30-35 inches of rainfall, so we have a lot of wet land. Moving east into Florida, the moisture stays somewhat the same, but as you move down toward South Florida, it's not as wet as Louisiana, but not as dry as Texas.

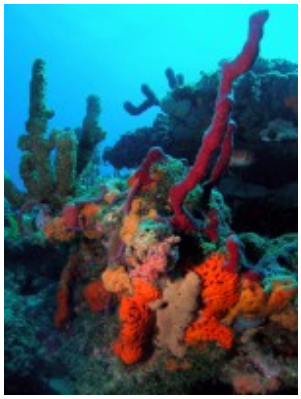
So west-east, you have a very strong moisture gradient and north-south, you have a very strong temperature gradient. That brings a lot of diversity in habitat. I tell my students, "if you want to see what climate change looks like in Louisiana, get in a van and drive west."

Another fascinating element in the Gulf region is the migration of species down from the Appalachian Mountains. So in the Gulf, you have three major highways of biological migration. You have tropical species moving up along the coasts of Florida and Mexico, and temperate species moving down from the north. A great



example is Alabama. Among all U.S. states, Alabama ranks 25th in land area but 5th in biodiversity. It's one of the most fascinating regions – with this combination of

temperature and water –in the world, and it's a region hardly anyone knows about. If you interview E.O. Wilson, he'll tell you that his great childhood days were spent exploring the diverse landscape of Alabama.



Then there's a fourth dimension-the continental shelf. The continental shelf varies in its width and slope quite strikingly as you move along the shoreline. A broad, flat continental shelf off the coast of Florida extends over 100 miles. As you get to the Mississippi River, the continental shelf only stretches five miles and then goes into a very deep trench. Then it broadens out again along Texas down to the Yucatan Peninsula. Because of that continental shelf, you find ocean communities that live in shallow water and very interesting reef communities. Some of the highest biological diversity of any continental shelf environment in the world is located in our Gulf coast region–again because of the diverse temperature gradient, this mixture of species moving up from the tropics and down from the temperate zone, and the current, which is mixing this east-west exchange of biological organisms. It's a genetic soup.

There is a great book by Darryl Felder (Gulf of Mexico Origin, Waters, and Biota) that presents a new accounting of the biological systems in the Gulf of Mexico. The book cites more specifically the number of species and the wealth of biological systems in the Gulf. Published about a year ago, this book was a follow up to the Gulf of Mexico survey that had been done back in the 60s.

The Mississippi Delta. (c) 2009 Microsoft Corporation and its data suppliers, http://www.bing.com/maps.

One final comment to end this description of the Gulf: the Mississippi River. It's right in the heart of the Gulf of Mexico. It drains a large portion of the lower 48 states in the U.S., and even part of the Canadian provinces. So you can get a sediment particle passing New Orleans that may have come from Idaho. That sediment influences the mineral characteristics of our continental shelf. Those sediments also fill the wetland deltaic part of Louisiana, which is about 4.5 billion acres. It's the largest coastal wetland complex in the U.S. It's second to Alaska in total area of wetlands, but most of Alaska's wetlands are inland wetlands. It's the eighth largest delta by area in the world, and again, it's very diverse in plants and animals.

You referred to the Gulf of Mexico as "genetic soup." Can that soup be sampled anywhere else in the world? Ecologically speaking, does anything like the Gulf exist elsewhere?

There is no other environment of minerals, deltaic, muddy coast, and carbonate coral reef with a mixture of adaptive temperate and tropical

organisms. One of the conclusions of Darryl Felder's book is that the Gulf really is one of the most fascinating biological systems in the world. Again, that's because of the diversity in geology and climate, and this mixing by ocean currents of a major, muddy delta fed by water from the central part of the United States. In the Gulf, you've got a concentration of factors which I don't think you can find anywhere else.

How do all of the different ecosystems in the Gulf Coast function individually and together? What ecosystem services do they provide?

You start out with the muddy coast of Louisiana, a system that is driven by sediment moving down the Mississippi River. It's driven by the frequency of floods and the way the river has naturally switched east and west over the last 6,000 years and built this huge hunk of mud, on top of which is this huge wetland. Just to the east of Mississippi and into Alabama, you'll find some of the purest white sand beaches and barrier islands, which are driven by sand that moves east and west along the coast. It has totally different geology with a whole different ecological system, as its organisms deal with the dynamic sand. Inland of the barrier islands, you find beautiful salt marshes and inland lagoons-very shallow systems. Down into Florida and Mexico you find tropical systems that are driven by sediment formed internally by carbonate deposition. That carbonate is an entirely different type of geological formation, which is driven by the internal photosynthesis of organisms which enhances the deposition of carbonate. It's a whole different kind of sediment.

So you have muddy coast, sandy coast and the carbonate systems of the reef. Those are the three major platforms on top of which grow all of this ecology. They all function differently to provide ecosystem services because of the nature in which they have co-evolved.

When you look at all of these platforms together as one unit, what do you see as some of the key threats to the health of this unit?

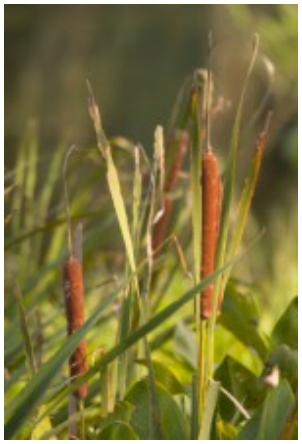
Flooded playground in Muscatine, Iowa during 2008 flood of the Mississippi River.

So much of what we have [along the Gulf Coast] is driven by processes of water–the way water moves. You start with the way water moves through a watershed, from the catchment down to the coast. That is a large part of a natural process that built this landscape. But we have created highly engineered landscapes. Public works projects have completely interfered with the way water flows from catchment to coast. All of the dams and levee systems constructed for flood control were built for public safety, but at the expense of all the processes that built our landscape.

The key benchmark in the Mississippi River was the 1927 flood, which

formalized the Flood Control Act of 1928**.** This act led to the national public works program which funded the entire levee and dam system of flood control structures which really disconnected the wetlands from the river. Then you go to the Everglades. A hurricane in the late 1920s resulted in another federal flood control effort, which completely re-engineered the flow of water. We all know the impact that has had on the Everglades.

So again, water and engineering and public works projects were implemented for the good intention of public safety, but at the expense some of the largest wetland landscapes. That's one of the most dominant human impacts on the entire Gulf Coast.



The other is the way we've changed the chemistry of these waters. The use of fertilizers for farming in the Central Plains of the U.S. has resulted in a level of nitrate that is four times what we had 100 years ago. That nitrate flows down through the Gulf and causes large algal concentrations, which decompose, resulting in one of the largest hypoxic zones in the world. In South Florida, we have a parallel situation with sugar cane expansion around Lake Okeechobee. In this case, it's the application of phosphorous, which has led to the expansion of cattails out into the wetland landscape. This has completely transformed those wetlands through a different form of eutrophication.

There are also impacts which are more localized, such as the way we build canals [to facilitate navigation]. These are major modifications to the more local, coastal watershed, which have completely changed the way salt is distributed. A lot of people don't realize how much commerce we move in and out of this region. New Orleans and Tampa are major port facilities that require a lot of access.

I read that the Gulf Coast contains half of our nation's coastal wetlands (with Louisiana claiming 40%.) But I also read that Louisiana's coast is disappearing at the rate of a football field every 38 minutes. Is that true?

Yes, we're losing about 16 square miles each year. Basically, the wetlands are drowning. There are two factors that influence the elevation of our wetlands relative to water. One is that the land is sinking. This is a natural process. The compaction of silt causes the land to sink. So a wetland has to grow in elevation equivalent to the rate at which land is sinking underneath it in order to maintain a certain water level. If it doesn't, it drowns.

Part of the economy (input/output) of that elevation relative to water level is attributed to the sediment that gets delivered to wetlands, which adds to their elevation. With this sediment, wetlands are able to survive the change in elevation due to the land sinking beneath it. The second part of the formula is the fact that sea levels are rising. So as a wetland, I have two parts of the equation for which I need to compensate.

When sediment flows over the natural levees of the river and floods into the coastal wetland landscape that gives me part of that new elevation needed to compensate for rising sea level. There's another part of the elevation change in wetlands and that's what I [as a wetland] can produce myself when I grow roots, leaves and litter. That organic contribution that I make also increases elevation. If I'm a healthy wetland, I'll contribute my own organic productivity to an increase in elevation in addition to what I get from sediment. Over thousands of years, before humans started screwing up the process, this would give wetlands enough change in elevation to compensate for sea level rise and the subsiding land.

For 6,000 to 8,000 years, the wetlands in the Mississippi River *had* subsiding, and they *had* sea level rise, yet they were sustainable. But when you cut off the sediment and you cause plants to become less healthy and less productive, it's a double jeopardy. With less sediment and less organic matter, I [as a wetland] can't keep up with subsiding land and sea level rise, so I drown. The wetlands of Louisiana will deteriorate and form ponds in the interior. From airplanes, we see the pattern of the expansion of these ponds out to the perimeter of shoreline of wetlands.

Can you tell me about some of the major Gulf Coast wetlands restoration efforts with which you've been involved?

I've been very involved with the effort to try to get the Mississippi River reconnected to the wetlands. We call these ‘river diversions.' We've been looking at different analogs of where we have maintained the River respective to the wetlands. We've tried to document where those are sustainable and use those as analogs to develop calibration as to how much river it will take to sustain the Delta.

Instead of ‘flood control,' I'm trying to get us to move toward ‘controlled flood.' That's where I've spent a lot of my time and efforts.

Is this attempt to reconnect the Mississippi River to the wetlands what your work on the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) is all about (the collaborative effort among State, Federal, and LSU to provide scientific evaluation for restoration management)?

Yes. When I first started, my objective was to be able to say "If you do this, you will get that." I wanted to work with engineers to really define what that restoration program would look like. I also did it because I think you need to be honest with people when you talk about restoration. We give people the perception that we can bring a system back. We can't. We can't bring the Delta back to what it was in 1947 or

1927 or even 1985. What we have to do is give people a clear idea of what we *can* do, and so much of that is related to public safety.

At Biohabitats, we use the term 'regenerative,' which acknowledges that –like it or not-humans are a part of these systems.

You bet. Everybody thinks they're going to *get* something out of restoration, but really, everyone has to *give up* something or we all lose. This is the tradeoff we have to deal with now, given the human dominance of the land. People are going to have to give up something to allow that water back into these regions. That is so problematic when you use a term like 'restoration.'

I'd like to go back to CLEAR. Can you tell me a little more about your work on that program?

Around 2003, two years before Katrina, the State [of Louisiana] and the Corps of Engineers agreed to go into a joint program, with funding under the Water Resource Development Act, for a large, public works project to restore the Mississippi Delta. What you have to do in order to be eligible for these funds is develop a feasibility study. Under that feasibility study, I served on the oversight committee of the framework development team. On that team, I put a challenge to the project and its capability of predicting environmental benefits from different restoration measures. We were pretty much proclaiming benefits, as we do a lot in restoration, based on constructing different projects that have a certain cost. We all know that cost/benefit ratio is problematic. I wanted a stronger analysis of predicting and forecasting ecosystem response to different measure. That is how CLEAR evolved as a tool to patch together a variety of monitoring efforts across the state – starting with where we'd put the River and its sediment, how it would build land, what would be the plants and animals that would utilize that landscape, and what would be some of the other benefits, such as storm surge reduction. It was very spatially explicit and on a 50-year horizon.

We have several reports that you can see on our web site**,** along with all kinds of models and simulations. All of that went into the feasibility report that went to Congress. The Governor and the Corps of Engineers signed the feasibility study in January of 2005. Then Katrina hit in August.

How did Katrina impact the work you had done?

It did two things. Nearly all of the feasibility study focused on the ecosystem restoration relative to benefits. After Katrina, we obviously had to put a lot of emphasis on protection as a benefit. So Katrina raised the bar on highlighting protection as a benefit of restoration. A lot of re-evaluation went into how rebuilding land could reduce storm surge threat. That was a major effort.

The other important part was that following Katrina, the state initiated a

master planning process. They wanted a master plan for protection and restoration in front of our state legislature in time for their 2007 legislative session. So we used our CLEAR program to do the simulation for that master plan, which was submitted in May of 2007 and passed by the legislature.

When I think back to that time period from when we began CLEAR in 2003 to May of 2007, it's like a blur in my life! We really did stretch the limits of what we could do. In both situations, the schedule was dictated by politics. In the case of the Chief Engineer's Report [for CLEAR], we had to have it to the U.S. Congress in time for it to be ready for Congressional authorization for a public works project. In the case of post-Katrina for the State legislature, there was a requirement that we have a report submitted by March of 2007. So there were two different legislative processes with very strict timelines.

No matter how sophisticated your tool is, the timeline is non-negotiable, so you end up cutting corners. On one hand, I was providing a service to try to improve the analytical understanding of system response. I'm trained as a systems ecologist, and I knew that was very important. But on the other hand, I knew we were cutting corners, so there was a lot of criticism of the techniques and tools that we used. No matter how much you argue, "Yes, but there were time limits involved," we in the science and engineering community don't grade people on time limits, we grade on quality. So I took a lot of hits. I'm not quite sure I'd advise anyone to [work under such stringent time constraints] because your reputation can suffer.

In addition to five U.S. states, the Gulf Coast includes Mexico and Cuba. Do these countries get involved in any major, joint restoration initiatives?

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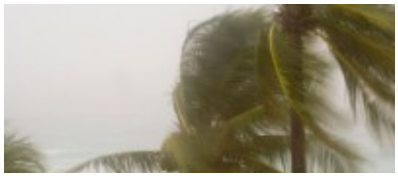
We've been very much involved in Mexico. In fact, the Usumacinta River Delta has similar experiences in wanting to implement stronger flood control by doing civil engineering at the expense of the processes that are needed to sustain the delta. You'll find this all over the world in deltaic environments. Nearly every catchment basin and river system which experiences flooding-which is so significant to the formation of deltas-there is the issue of wanting to initiate flood control for public safety at the expense of the natural landscape.

I'd argue that if you're smart, you can actually implement flood control that can also provide restoration opportunity. It's all about where you put these structures in the landscape.



The Gulf Coast must not only contend with human-induced threats, but also with curve balls from Mother Nature (hurricanes, storms). How resilient have Gulf Coast ecosystems been in

the past, and how has that resiliency been affected by human influences more recently? What do you think must be done to regenerate that resiliency?

The definition of vulnerability is the degree of physical change of a system relative to the capacity of that system to adapt.

We know that deltas, such as the Mississippi River, are dynamic. It's just the nature by which they operate. Floods, hurricanes, subsiding, and sea level rise have been part of the natural rhythms of deltas for centuries. They are very resilient. For over 6,000 years, [the Mississippi Delta] built four billion acres of wetlands–with hurricanes, with sea level rise, and with subsiding. But floods, a source of disturbance to our Delta, have also become a source of disturbance to society. By controlling nature and reducing our susceptibility to floods, we have basically shut off one of the major processes that provides resilience to the Delta. We now have a highly engineered landscape, the result of which is the reduction of critical processes necessary for adaptation. So what we've done is reduce the capacity to adapt. When you talk about resilience, the key is the capacity to adapt.

So reconnecting the Mississippi River to the Gulf wetlands would regenerate that capacity to adapt?

Yes.

How do we do that?

Atchafalaya Basin

Again, by controlled floods rather than flood control. Historically, part of our flood control strategy has been to develop outlets along a river so that when water reaches a flood stage, we can move it through an outlet to the Gulf. The Atchafalaya Floodway is such an outlet. It was constructed after the 1927 flood to be a major floodway, or relief valve. If the river flooded, you could put more water down the Atchafalaya and protect New Orleans and Baton Rouge. We formed another one called the Bonnet Carré Spillway, which opened as recently as 2008. It has opened to maintain a certain upper level of flow of the River going past New Orleans. Any flow above 1.2 million cfs is diverted through the Bonnet Carré Spillway.

I'd argue that when we have these flood stages in the River, we need to provide *multiple* outlets along the river that can serve as a flood control capacity, but at the same time provide restoration and adaptation capacity.

Is anyone doing that, and doing it well?

I think the old river control structure is a perfect example of the success we've had in using floodways that have turned out to be restoration systems. The only place along the Mississippi Delta where you have

active land and delta formation is at the mouth of the Atchafalaya River. So the mouth of that floodway is the only place where we are building land. It's been an experiment in progress since around 1935, and it has been extremely successful.

We have smaller diversion structures, such as Carnarvon and Davis Pond, but these were built to prevent salt water flow from moving further inland, not to move sediment. So they don't have much of a land-building capacity. They are also very small. Carnarvon is about 40 times smaller than flood control structures like Bonnet Carré. You can't build land in the Delta with a small trickle of water.

I'd like to talk about the oil spill and the topic of resource extraction. Have you been out on the water much since the oil spill? What are you seeing in terms of how and if it has affected the ecological health of Gulf Coast wetlands?

I haven't been out much. I've been on a couple of helicopter reconnaissance [flights], and I've been down to see some of the sites with my students. (One of my students lost her dissertation sites due to the oil.) My students have run some experiments on nutrient cycling in some of the oil areas, so we have been involved in looking at some of the impacts. Obviously some of the perimeter marshes and wetlands have been spoiled, and there's some concentration of that impact around Barataria Basin, Grand Isle, the mouth of the Mississippi River and the mouth of Breton Sound. There have been a lot of different estimates as to the exact total areas affected. All I can say is that it's much less than anticipated.

It still is very strange watching the behavior of the oil as it comes ashore. It's quite striking how the dispersants seemed to minimize the on-shore impact. But the trade off, obviously, is that it doesn't mean the oil is gone. It means that it has been distributed to different types of environments in which impacts are much harder to document. In your bottom, benthic environment it is so well distributed and diluted, a lot of that signal is gone.

All I can say is this: the visual signs of the oil impacts are much less than we ever anticipated. The chemical, or eco-toxicological effects, however, are still unknown. I think it's going to take some more time to understand the complexity of that oil out in deep water environment.

Are you doing any research related to that?

We're not. We're staying in shore. You know, it's very interesting. You have these two disciplines–the near shore coastal estuarine group and the deeper water oceanographic group-that really don't interact that much. We now understand that these two groups have really got to work together. We have to understand that these are two very different environments but they communicate with one another, either by the movement of water or by the movement of organisms.

One of my colleagues had this question related to resource extraction: Currently, it seems that the resource is undervalued and mismanaged in the scramble for facilitating short-term, unsustainable resource extraction. Do you see more emphasis being placed on longer-term resource protection/ management moving forward or do you think the current balance between energy production and resource conservation/protection is as good as it gets?

We are nowhere close to properly mitigating for our continental shelf activity and its impact on the Delta. Before the oil spill, I would've told you that the number one impact [of oil extraction] is the amount of on-shore (transportation and processing) infrastructure you have to build in order to move 25% of your domestic energy supply. In addition to that, most foreign oil moves through our shoreline. We have a lot of highway transportation facilities, and a lot of infrastructure we have to build in our coastal zone, and it has a huge impact. The federal government has never properly mitigated for that industry activity.

Now, we have the addition of knowing our vulnerability to oil pollution from off-shore extraction. I think the industry is willing to deal with this. I know some in the industry very well, and I think they understand their responsibility. They argue right now, "We give the federal government $5 billion per year from the state of Louisiana. Why isn't the federal government spending more of that money to help mitigate the industry activities?" I would agree. We don't properly manage the money that these industries generate in order to mitigate for the activity. Until we start doing that, it is a one-sided operation, and the environment is not being properly treated in that operation.

I read that in 2006, the five Gulf states, together, had a Gross Domestic Product of $2.2 trillion (which would've made them the 7th largest economy in the world if they were a nation). Most of that economy is dependent on the Gulf–energy, seafood, tourism. Clearly, people in the region are deeply connected to the Gulf. To what degree do you think Gulf Coast citizens understand the flip side of this relationship?

That's a great question. I think their ancestors understood it much more than we do today. I think that is true of generations in general. We've lost contact with land.

Culturally, though, I do think there is a huge appreciation for the environment, but a lot of the industry that causes problems is the major economic bread and butter for these families. It really comes down to a culture that, economically, relies on these industries, and we have no other option. Unless there is stewardship that is properly managed,

there's no way we can remove that economic dependency that we have on these industries.

So there is a strong cultural tie, but there is also extremely significant economic dependence.

How strong is that tie as you move up the Mississippi? Are people to the north aware of how their actions impact the Gulf?

No. In most situations, as you well know, as soon as something moves - downstream, you lose any responsibility. If you ask anyone- farmer or economist- upstream, they'll say, "There is no way your fishery comes close to the economic value of our agriculture." The problem there is they don't factor in all of the economic values that this part of the nation down here in the Delta supports. When you just look at agriculture vs. fisheries, that argument works, but when you look at the multi-dimensions of economics, I think it's a more balanced equation.

Should people even be on the Gulf Coast? If I told you I had a job offer in, say, Gulf shores, Alabama. What would you say? Should I go?

I certainly am concerned about public safety, under our present conditions and in the future. If we're not going to change the way we manage our natural resources, I think we have to have an obvious discussion of retreat. In fact, I'll be one of the first to quit selling the goods on restoration when I don't think there is enough commitment to build the adaptation that we need.

The Resilience of New Orleans

By Terry Doss, Senior Ecologist, Biohabitats, Inc.

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Way down in New Orleans
In the land of dreamy scenes
There's a garden of Eden
You know what I mean
- Louis Armstrong

From our roots we gain strength for the future, and nowhere is this better exemplified than in New Orleans - in both its people and its surrounding wetlands.

The world watched as Hurricane Katrina and the failed levee system drowned New Orleans. Thousands were killed, tens of thousands fled, and conditions became increasingly squalid. But the most valuable

part of New Orleans—it's "who dat" spirit—could not be held down long.

This spirit of New Orleans grows from the grassroots of the community - its culture and traditions that celebrate life and connect it with the bayou landscape. It resonates in the music, food, and architecture of New Orleans and is what persistently draws and haunts tourists.

These grassroots are evident in organizations like Common Ground Relief, which is based in the Lower 9th Ward and builds new homes, provides a free legal clinic, develops community gardens, and restores wetlands. In pure New Orleans fashion, the nonprofit Environment America started a campaign called "Gumbo for the Gulf." The Louisiana-based Abita Brewing Co. is donating a portion of sales of its new "Save Our Shores" pilsner to Gulf relief. The community-based organizations that have developed to support New Orleans have grown from the soil of people's hard necessities, which generally makes their roots deeper and stronger.

Like its people, New Orleans' wetlands have taken some hard hits over time. If given enough soil to sink their roots into, however, they can continue to thrive.

These wetlands were built up over time by the sediments brought down by the Mississippi River, with twice-a-day tides acting as the lifeblood of these marshes, continually supplying new sediment and nutrients. But decades of building canals, levees and dams to control flooding, ease navigation and facilitate oil and gas exploration have choked off this flow of Mississippi sediments and nutrients, causing erosion, subsidence and overall loss of acreage. Most recently, the BP Gulf oil spill added insult to injury, with oil starting to cover the wetlands and its inhabitants. The most severe impacts to the local ecology from the dispersants used by BP to hide the floating oil are yet unknown, and may never be fully known.

But the grasses that reside in these marshes are incredibly resilient, and new shoots of *Spartina* grass have already been observed in the coastal marshes. Oil may saturate grasses growing above ground, but as long as the oil doesn't get to the roots, the marsh will grow back.

As with the New Orleans community, what is most important is protecting the roots to ensure the marshes will survive and sustain well into the future. To

help protect the roots of New Orleans' marsh grasses, a unique approach was recently put forward to help build up the marsh soils. National Geographic reports that the Sewerage and Water Board of New Orleans, the St. Bernard Parish, and the U.S. Army Corps of Engineers, together with a number of other community non-profit organizations, have come up with a plan to restore Bayou Bienvenue, a 30,000-acre wetland, by pumping in partially treated sewage. The Sewerage and Water Board of New Orleans plans to use $10 million to direct semi-treated wastewater biosolids into Bienvenue to fertilize the areas and build up the soil.

Katrina managed to wash away the rickety supports that folks had managed to build up over time and has thrown a huge magnifying glass on the problems which still plague New Orleans—poverty, crime, corruption—but the City and its people have proved to be resilient, slowly rebuilding those supports, stronger and deeper than they were before.

New Orleans will also need its marshy fortresses to help secure and protect its vital communities, industries and way of life. As long as we protect its roots, they know how to do the rest.

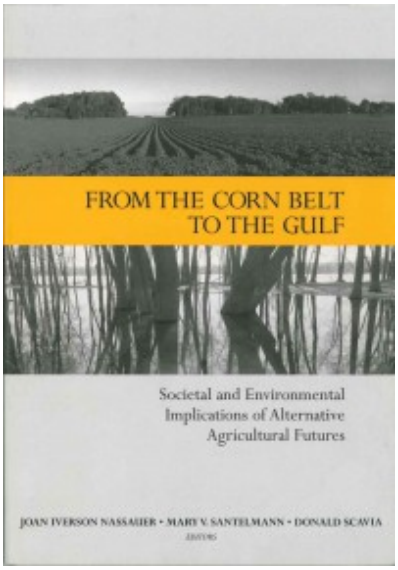
Dead Zones In The Gulf: Reaping What Is Sown Upriver

By Jennifer Dowdell, Landscape Architect, Biohabitats, Inc.

The impact of the Deepwater Horizon tragedy will be felt for years in the Gulf region. Ecological and economic impacts in the Gulf aren't limited to oil drilling, though. Decisions we make about development patterns and productive uses of land are also causing effects that resonate within the Gulf ecosystem. An oxygen-depleted "dead zone," at times measured to be about the size of Massachusetts, appears seasonally in the Gulf of Mexico and leads to serious fish kills. The dead zone, or hypoxic zone, results from a combination of excess nutrients and seasonal water stratification. Recent studies have shown that untreated agricultural runoff is one of the leading causes of the hypoxic zone in the Gulf.

But it's not just agriculture in and around the Gulf of Mexico. The Gulf is fed by the mighty Mississippi, whose watershed incorporates 41% of the land mass of the

lower 48 states, from Montana to Pennsylvania and Minnesota to Louisiana. Within this huge river basin are some of the highest concentrations of large-scale agriculture in the U.S. Excess nutrients flowing off of farmland are conveyed down to the Mississippi and end up in concentrated amounts in the Gulf, where algae feast on them. As the algae die and decompose, oxygen is depleted in the water and fish and other sea life cannot survive.



A series of studies in the mid-1990s and early 2000s linked the effects of hypoxia in the Gulf to the farming and agricultural practices in the Corn Belt. These studies also began to explore the potential for dramatic change through innovative, alternative landscape patterns in farming practices, which could provide many benefits and decrease downstream effects in the Gulf. *From the Corn Belt to the Gulf: Societal and Environmental Implications of Alternative Agricultural Scenarios*, edited by Joan Nassauer, Mary Santelmann, and Don Scavia, brings together these integrated assessments of land use in the Mississippi River Basin and the effects on the dead zone in the Gulf. The book also highlights alternative farming scenarios in two small agricultural watersheds in Iowa. Discussion focuses on the policy implications of alternative farming practices that emphasize ecological restoration and increased biodiversity, while providing new economic opportunity.

For the restoration community, one of the most important points to take from this huge body of work is the implication that there are many benefits that result from alternative landscape patterns that integrate productive use of land with restorative design and planning. With the inclusion of riparian buffers, the restoration of wetlands, the implementation of a more diverse selection of native crops, and the incorporation of natural areas into farming landscapes, we can see a myriad of benefits. These include improved human health, increased environmental health and habitat potential, and improved water quality, while lessening the potential for large flood events and providing new economic drivers. An old aesthetic can become new again, providing more holistically productive landscapes and seascapes, from the upper reaches of the Mississippi all the way to the Gulf.

For more information on the research done on the future Corn Belt agricultural scenarios and hypoxia in the Gulf of Mexico, see the following links:

Joan Nassauer's Landscape Ecology Perception and Design Lab at the University of Michigan: http://www-personal.umich.edu/~nassauer/rural_sheds.html

The Integrated Assessment by the Task Force on Hypoxia in the Gulf of Mexico: http://oceanservice.noaa.gov/products/hypox_final.pdf

2008 conference proceedings for *Hypoxia in the Gulf of Mexico and Implications and Strategies for Iowa*: http://www.card.iastate.edu/hypoxia/presentations.aspx

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Resources

Alabama Department of Environmental Management

America's Wetland Foundation

Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR)

Coastal Sustainability Studio

Coastal Wetlands Planning, Protection and Restoration Act

Dauphin Island Sea Lab

Everglades Foundation

Florida Department of Environmental Protection

From the Corn Belt to the Gulf: Societal and Environmental Implications of Alternative Agricultural Scenarios

GulfBase is a database of resources about the Gulf of Mexico.

Gulf and South Atlantic Regional Panel on Aquatic Invasive Species

Gulf Coast Research Laboratory

Gulf of Mexico Alliance

Gulf of Mexico Foundation

Gulf of Mexico Origin, Waters, and Biota

Gulf of Mexico Regional Habitat Restoration Web Portal

Gulf Restoration Network

Harte Research Institute for the Gulf of Mexico Studies Series

Louisiana Department of Natural Resources

Louisiana Seagrant Fisheries

Mississippi Department of Environmental Quality

National Estuarine Research Reserve System

The Nature Conservancy in the Gulf of Mexico

NOAA Coastal Services Center (Gulf Coast)

NOAA Office of Ocean and Coastal Resource Management

Northern Gulf Institute at LSU

U.S. EPA's Gulf of Mexico Program

U.S.G.S.: Atchafalaya and Mississippi River Deltas Study

U.S.G.S. Galveston Bay Project

U.S.G.S. Tampa Bay Study

White House Council on Environmental Quality's Gulf Coast Ecosystem Restoration Program

Joan Nassauer's Landscape Ecology Perception and Design Lab at the University of Michigan

The Integrated Assessment by the Task Force on Hypoxia in the Gulf of Mexico

2008 conference proceedings for *Hypoxia in the Gulf of Mexico and Implications and Strategies for Iowa*

Biohabitats' Projects, Places and People

Projects

It Ain't Easy Being a Barrier Island in the Gulf

Hurricanes often have dramatic effects on barrier islands, and the impact of 2008's Hurricane Ike on Galveston Island, Texas was no exception. Yet the hurricane left in its wake a keen awareness of the need to address the consequences of such storms and their dramatic effects on the island. It also catalyzed a master planning effort to guide the redevelopment, management, protection and restoration of Galveston Island State Park, a treasured natural and recreational resource that is bordered by the Gulf of Mexico to the south and West Bay of Galveston Bay to the north. Despite being surrounded by developed land, this 2,000-acre park is home to a

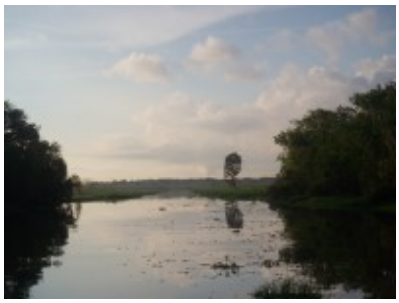
variety of natural habitats, including beach and dunes, coastal strand prairie, tidal marsh and seagrass beds.

Biohabitats is a key member of the planning team, which is being led by MESA of Dallas, TX. The plan, which is being produced for Texas Parks and Wildlife Department, looks out on a 50-year horizon, addressing not only hurricanes, land use, and infrastructure needs, but also projected sea level rise and changes. After conducting an inventory and assessment of the park's natural resources, we performed predictive modeling to project the impacts of sea level rise on the landscape, and how habitats may shift accordingly. Next steps include using this information to develop a plan to guide the restoration and management of park habitats. We applaud the Texas Parks and Wildlife Department for striving to be a leader in implementing effective natural resources conservation while providing valued outdoor recreation.

Rare Opportunity to Witness Instant Gratification in Gulf Coast Marsh Restoration

In the last issue of *Leaf Litter*, we reported that we had begun work to restore ecological health to a landscape ravaged by decades-old canals in Louisiana's Jean Lafitte National Historic Park and Preserve. Built to facilitate resource exploration and extraction, these canals dramatically altered the hydrology and ecology of a once-healthy marsh system. Not only did the canals diminish the marsh's ability to rebuild and sustain itself, but spoil mounds created by their excavation offered the ideal elevation and conditions for the invasive Chinese tallow tree (*Sapium sebiferum*). Our goal was to restore historic hydrology and reduce infestation of Chinese tallow along miles of canals. Our work began in May and was completed by mid-July, before hurricane season. We're delighted to report that wetland vegetation has already colonized much of this landscape. It is not often in ecosystem restoration that we get to witness such a dramatic and rapid transformation. If you question the resilience of Gulf coast wetlands, just take a look at these pictures.

Before restoration



Making progress!

Floating Wetlands Turning Heads

Urban waterfronts along Baltimore's Harbor and Philadelphia's Central Delaware River are looking a bit greener these days. This past spring, as part of our work on the Waterfront Partnership of Baltimore's Healthy Harbor Initiative, we worked with students from Baltimore City Schools to construct floating wetlands to place in the City's Inner Harbor. With plastic bottles removed from the Harbor providing their flotation, the wetlands serve to improve water quality, provide habitat, and present a unique tool with which to educate people throughout the watershed how their actions impact the Harbor and Chesapeake Bay. This summer, a volunteer kayak flotilla transported the wetlands to their new, highly visible home near Baltimore's popular Harborplace, where they have garnered quite a bit of media coverage and stimulated a great deal of curiosity from passersby. But humans are not the only species drawn to these unique floating patches of green. Crabs, fish and waterfowl have already begun to call them home.

As part of our efforts to help the Delaware River Waterfront Corporation (DRWC) and the Philadelphia Horticultural Society create an urban park that restores ecology and public access to a neglected riverfront, we developed floating wetlands for the City's Pier 53. The wetlands, which we assembled with community volunteers, use trash (plastic bottles) as a floatation device and include a palette of native wetland plants. These plants are clearly happy in their floating home. On a recent visit, we spied freshwater cordgrass that is seeding, cardinal flower in bloom, and marsh mallow reaching over four feet tall!

Tackling A Bear In Northeast Ohio

When the Cuyahoga County Board of Health (CCBH) wanted to restore approximately 1,600 linear feet of Bear Creek in the City of Warrensville Heights, Ohio, they turned to Biohabitats. The channelized creek is severely incised and completely disconnected from its floodplain. The folks in our Great Lakes bioregion office are hard at work developing restoration concepts that will not only maximize ecological benefit and minimize disturbance, but also inspire ongoing stewardship and education within the Warrensville Heights City School District. To help the CCBH improve Bear Creek's water quality and habitat, dissipate stream energy, minimize erosion, protect infrastructure and provide innovative stormwater management, we are taking a two-pronged approach. On the Upper Reach, we are focusing on increasing channel stability and capacity and improving the riparian buffer.

PLACES

Later this week, you'll find Biohabitats president Keith Bowers, along with Ivette Bolender and Jennifer Zielinski from our Great Lakes Bioregion office at the Healing Our Waters®-Great Lakes Coalition's 6th Annual Great Lakes Restoration Conference**,** in Buffalo, NY. As the sponsor the conference's Poster Showcase Happy Hour on Sept. 23, we can't wait to swap Great Lakes restoration success stories and give away a $150 gift certificate to a native plant nursery to the first attendee who collects all three of our ecological restoration trading cards!

Also this week, from Sept. 21-24, Mike Lighthiser from our Southern Rocky Mountain Bioregion office will be in Snowmass Village, CO attending the Colorado Association of Stormwater and Floodplain Managers Annual Conference.

Catch a sneak peek at Freshkills Park in NYC on October 3. Senior Ecologist Terry Doss will give a tour of the North Park Wetland Restoration we designed and hope to soon construct.

On October 5-7, Senior Ecologist Laura Backus, from our Southern Rocky Mountain Bioregion office, will address attendees of the 2010 Sustaining Colorado Watersheds conference on the topic of leveraging agency restoration projects through the use of volunteers. Her joint presentation with John Giordanengo of Wildlands Restoration Volunteers is entitled, "How to Involve the community in riparian Restoration Work."

Biohabitats will have a strong showing-and lots to share-at the 2010 AWRA Annual Water Resources Conference, November 1-4 in Philadelphia. Landscape architect Jennifer Dowdell will present "Sustainability and Campus Planning." Fluvial geomorphologist Ellen McClure will present "Stream Restoration Feasibility and Design at Cobbs Creek in Philadelphia," and senior ecologist Ed Morgereth will share "Revitalization of the Central Delaware River Waterfront: A Focus on Ecology, Access & Stewardship at Pier 53."

We're psyched that Baltimore is host to this year's Urban Waterfronts 2010 Conference, The conference, centered around a theme of "The City Resurgent," will take place November 4-6.

Biohabitats is proud to be a sponsor of this year's Restore America's Estuaries Conference, which will take place November 11-13 in Galveston Island, TX. The theme of the conference is *Preparing for Climate Change,* and Biohabitats senior environmental scientist, Dr. Peter May, and senior ecologists Terry Doss and Ed Morgereth will be on hand to present, discuss and share highly relevant case studies and information.

Hey y'all, don't miss the biennial Stream Restoration in the Southeast Conference in Raleigh, NC from November 15-18. This event is a terrific opportunity to share ideas and lessons learned in stream restoration planning, design, construction, and evaluation. For example, Biohabitats environmental scientist Suzanne Hoehne will co-present a case study

about the restoration of Terry's Branch in Kentucky.

PEOPLE

Landscape architect Michael Spina has a keen eye for the useful details in life that are often discounted by others. In fact, his home in New York is furnished almost entirely with items others have discarded. This resourcefulness, along with his strong environmental ethic, makes Michael a very welcome, new member of the Biohabitats team. Michael recently completed his MLA at the City College of New York, where he focused on landscape restoration and urban ecology. He has worked in both private and public sectors, most recently as an intern in New York City's Department of City Planning and Partnership for Parks. We can't wait to see Michael put his education and experience to work in our Hudson River Bioregion office.

Glossary

Bloom: a sudden increase in the abundance of algae or phytoplankton resulting in a contiguous mass of highly concentrated phytoplankton algae in the water column – NOAA

Dead Zone:a more common term for hypoxia, which refers to a reduced level of oxygen in the water -NOAA

Eutrophication: The term "eutrophic" means well-nourished; thus, "eutrophication" refers to natural or artificial addition of nutrients to bodies of water and to the effects of the added nutrients….When the effects are undesirable, eutrophication may be considered a form of pollution. - National Academy of Sciences, 1969

Evapotranspiration: the combined process by which water is transferred from the earth's surface to the atmosphere. It includes evaporation of liquid or solid water from soil and plant surfaces plus transpiration of liquid water through plant tissues expressed as the latent heat transfer per unit area or its equivalent depth of water per unit area. – University of Maryland Cooperative Extension

Hypoxia: he condition in which dissolved oxygen is below the level necessary to sustain most animal life- generally defined by dissolved oxygen levels below 2mg/l [miligrams/liter] (or ppm [parts per million])." - Committee on Environment and Natural Resources, 2000

Storm surge: the onshore rush of sea or lake water caused by high wind and low pressure centers associated with a landfalling hurricane or other intense storm - NOAA

About Leaf Litter

Leaf Litter is a publication of Biohabitats, Inc. Coinciding with the earth's biorhythms, it is published at the Fall Equinox, Winter Solstice, Spring Equinox and Summer Solstice to probe issues relating to conservation planning, ecological restoration, and regenerative design. Biohabitats has attempted to ensure the accuracy and veracity of the information provided in *Leaf Litter*, however, information contained in *Leaf Litter* should not be construed as a recommendation or endorsement by Biohabitats. Please click here to contact Leaf Litter editors with questions, comments or content ideas.

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