Testimony to the U.S. Senate
Senate Committee on Commerce Science, and Transportation
Subcommittee on Oceans, Atmosphere, Fisheries, and Coast Guard

Hearing:
"Looking to the Future: Lessons in Prevention, Response, and Restoration from the Gulf Oil Spill"

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Good afternoon, Presiding Senator Begich, Chairman Rockefeller, Committee Ranking Member Senator Snowe, and members of the subcommittee. Thank you for this opportunity to participate in this timely hearing concerning the lessons from the Gulf Oil Spill and how we might do things better. I will briefly address the following topics and remain for any questions/comments you might have time for.

- •The current understanding of the short-term environmental effects from the *Deepwater Horizon* oil spill,
- •The long-term degradation of the Gulf of Mexico,
- •The appropriate restoration activities that should be undertaken, particularly by the National Oceanic and Atmospheric Administration (NOAA), but other entities as well, including in the watershed
- •What is needed to improve oil spill response and restoration in the future.

Background

Oil sheens and the smell of volatile organics remain in coastal Louisiana 15 months after the 20 April, 2010 BP Macondo (aka, DWH; Deepwater Horizon) oil spill disaster began at Mississippi Canyon Block 252, located about 66 km offshore of the Mississippi River delta. This disaster resulted in 13 deaths and 17 people injured, and released an estimated 4.4 X 10^6 barrels of oil into the Gulf of Mexico (804,877 barrels were also collected at the seafloor (Crone and Tolstoy 2010). It was the largest spill event in US history, equal to 7 times the size of the Exxon Valdez oil spill, and was the fifth largest in the world.

Oil from this industrial accident was first found on the Louisiana beaches on 11 May; fresh sightings of the oily mousse and tar balls in the estuaries continued after the leak was stopped using relief wells on 15 July and officially declared closed on 19 September 2010.

The Louisiana coastal ecosystems were disproportionately exposed to the released oil (Table 1). It had the highest percentage of its lengthy shoreline oiled (45%) resulting in 60% of the oiled shoreline in the GOM. The majority of the recovered oiled birds, turtles and mammals were in the three central states, and 70% of the recovered oiled birds were from Louisiana.

Table 1. Indicators of oil spill exposure and impact in the GOM States. These metrics indicate that Louisiana had the greatest onshore exposure and impact by oil.

Indicators	**west coast FL**	**AL**	**MS**	**LA**	**TX**
Percent of the GOM Tidal shoreline in State	30%	4%	2%	45%	20%
Oiled Shoreline of State shoreline	3%	15%	44%	8%	0%
Turtles oiled (live and dead)	16%	40%	4%	40%	0%
Mammals oiled (live and dead)	17%	0%	67%	17%	0%
Birds oiled (live and dead)	11%	8%	11%	70%	0%
Percent of the oiled GOM shoreline found in this State	16%	9%	15%	60%	0%

Sources: http://www.nmfs.noaa.gov/pr/pdfs/oilspill/turtle_data.pdf; http://www.nmfs.noaa.gov/pr/pdfs/oilspill/cetacean_data.pdf; http://www.restorethegulf.gov/sites/default/files/documents/pdf/Consolidated%20Wildlife%20Table%20110210.pdf

Oil coated these plants in a Barataria Bay (LA) marsh on September 2010. Photo by RETurner.

Current Understanding

Natural systems

The ongoing research results that I am aware of document damages to fish, birds, marsh, coral, and bottom-dwelling organisms, and changes in food webs. Oil on the sea surface injured or killed seabirds, sea turtles and dolphins, put at risk many commercially valuable marine organisms, such as blue-fin tuna, blue crabs, penaeid shrimps, and many fish. Shorebirds, tourists, and fisher(wo)men were harmed. Seafood was contaminated, and oyster reefs destroyed. Deep-sea organisms on hard- and soft-sediment habitats died from apparent oil deposition within some as yet undetermined distance from the wellhead.

The results from studies examining other oil spills suggests that the oil making its way into coastal ecosystems will persist for decades (Reddy et al. 2002). Its ecological effects may be immediately toxic to a variety of organisms, and the long-term effects last several decades (Teal et al. 1992; Culbertson et al. 2007a, b). Any damage incurred is expected to be dependent on exposure length and frequency. Recovery is possible, but not guaranteed. This is because, in part, oil quality changes with temperature, volatilization, and decomposition, and moved between ocean, estuary and marsh as droplets, tar balls, a brownish mouse with colorful descriptive names, or "mousse". This oil might coat the emergent wetland plants up to the high water mark or weigh them down as far as 10 m into the marsh. Its effects might combine with other influences to have a synergistic and maladaptive outcome. A series of cascading effects on the plant-dependent food web are expected to follow from these impacts.

The ecosystem consequences of exposures to and incorporation of toxicants at the base of the pelagic food chains and the massive organic carbon subsidy to the shallow and deep ocean remain uncertain, requiring new advances in oil spill oceanography to assess. The illumination of the indirect impacts and the dismissal of many presumed impacts will play out for decades in the scientific literature, in government reports, and in the courts.

A major coastal problem in Louisiana is to reduce wetland loss rates and to restore wetlands. Twenty-two percent of the wetlands existing in 1930 are now open water. These losses are primarily a consequence of dredge and fill operations, which were permitted by State and Federal agencies. It took 8,000 years to build these marshes, and so 22% of the wetland represents 1720 years of net land building. It is hard to see how to restore these wetlands faster than the natural system builds them, and so preventing more losses is extremely cost-effective. It is reasonable to ask if this oil spill accelerated these losses. I estimated how much this might be based on the penetration of oil into the oiled shoreline to address this question and estimate that there will be far more wetland loss (direct and indirect) from the annual dredge and fill permitting every year than from this one oil spill over the next ten years. The chronic demise of the marsh may be more significant than the losses due to a one-time dramatic oil spill.

<u>The Human Dimensions</u>

These impacts took place in an ecosystem and socio-political system that already had many significant 'stressors', including 1) intense hurricanes arising from global climate change exposes the Gulf coast to greater risks of catastrophic flooding, shoreline erosion, sea-level rise, 2) marsh channelization from petroleum-industry activities, 3) excessive nutrient (largely N) loading from agriculture and other anthropogenic sources extending into the Mississippi River watershed, 4) the exploitation of apex predators like sharks and blue-fin tuna, 5) bottom trawling and dredging, 6) industrial development, including petroleum production and refining, 7) failure to treat and control storm water and atmospheric emissions that have led to the introduction of mercury and other heavy metals and organic pollutants like dioxin, DDT, and PCBs into the Gulf. In addition, development of low-lying lands and coastal barriers has degraded and destroyed shoreline habitats and led to engineering of structural responses and dredge-and-fill projects to protect housing and infrastructure at risk, but such responses interfere with natural roll-over and transgression of barrier islands and resilience of natural shoreline habitats.

This set of conditions poses extreme socio-economic challenges: how can resilience of human communities, culture, and ecosystems be sustained or created when maintaining coastal residency increasingly risks property and life, yet retreating inland by entire communities challenges the fabric and glue of social cohesion and place-based history?

Synergisms

There were synergisms between the existing stressors and the oil spill. The State, for example, opened river diversions and this killed oyster beds; businesses closed that had been around for 100 years. It was the cumulative effect of the ill-informed State government, the threat of oil impacts, that finally forced them out of business for the first time in 100 years. The diversion volume would not have been as high and for the length of time, in my opinion, if the oil spill was not occurring. The State neglected the oyster fishermen, ignored scientists, and over-reacted because of some perceived need to open the diversions as much as possible.

There was (is) shoreline erosion before the oil spill, but I don't know that the combination of shoreline erosion and overzealous oil clean up caused more wetland loss than each operating separately. I suspect that is the case, but don't know it to be true. They would not have done some of the inappropriate things they did if it were not an oil spill.

Restoration in Context

Principles

Addressing the impacts of the DWH oil spill should be integrated into a holistic understanding of how all stressors may potentially combine to destabilize the ecosystem by passing through a critical threshold and into an undesirable state of the system. Restoration should be holistic, not piecemeal, and should be durable and sustainable under the conditions of dynamic change expected in the Gulf for over a century and longer. Traditional tests of restoration appropriateness of "in-place" and "in-kind" are likely to fail the criteria for sustainability under a changing climate, rising sea level, and more intensely stormy regime.

Below are a few simple operating principles that may help avoid potentially fatal flaws of logic, administration lapses, and financial waste (adapted from Turner 2009).

(1) Assume that key pieces of information are missing and may not be revealed (ever);
(2) Because of the collective and respected ignorance, be flexible in how to develop, evaluate and apply new information and perspectives; learn how to create the context for that new situation;
(3) Include many small steps that are addressed in multiple ways;
(4) Let data trump concepts, not the reverse. If "the bigger, the better" is the operating model, then the model is likely to be superficially abstract (this is not to dispute the need for hierarchy or a division of labor);
(5) Assume that surprises will occur;
(6) Develop exit strategies, including how to reverse interventions;
(7) Do no harm; do not implement plans that will be irreversible if they go awry; If irreversible outcomes are anticipated, then start with the smallest plans, not the largest ones.

Pew Panel Recommendations

A workshop panel was recently completed under sponsorship of the Pew Foundation to make recommendations about the long-term sustainability of the Gulf of Mexico within the context of the DWH oil spill. I am one of 15 authors of this report. The report (Peterson et al. 2011) offers guidance on how funds from the Deepwater Horizon Blowout might be used for restoration. This report is due to be completed within 2 months and contains the following relevant recommendations about priority areas for restoration of the Gulf of Mexico following the DWH oil spill.

Restore water quality and damaged habitats
Restore habitats directly and indirectly damaged by the oil release;
Demonstrate transformative farming in Mississippi Basin to reduce nutrient loading;
Remove marine, estuarine, and riverine debris and inhibit future discards;
Restore water flows, water quality, riparian habitats, and ecosystem services of smaller rivers.

Rebuild fish stocks and wildlife populations by protecting habitat functions
Purchase and preserve functionally valuable habitat for fish and wildlife sanctuaries;
Protect habitat and implement recovery plan actions for injured species;
Sustain and enforce existing federal legislative habitat, fish, and wildlife protections;
Create networks of protected habitats to enhance fish stocks and valuable species;
Manage Gulf fisheries sustainably by recognizing ecosystem processes.

Make the Gulf coast resilient – A single integrated human and natural system
Investigate deep-sea oil fate and injury to allow restoration of ecosystem services;
Determine full impact of oil on, and restore, *Sargassum* and associated fish and wildlife;
Engage Gulf communities to adapt to increasing coastal inundation – while sustaining fish and wildlife;
Assess with rigor the potential fishery benefits of trawling protections of shelf bottom;
Endow capacity building of GoM in social-environmental monitoring and problem solving;
Communicate within communities to inspire informed environmental decisions.

A fish kill off Grande Isle, LA, 17 July 2011. Catfish, croakers and berried crab were trapped between the beach and the low oxygen zone in shallow water (hypoxic zone, aka 'Dead Zone'). Photo by Zach Rowalt.

<u>Example – Hypoxia (aka "Dead Zone")</u>
Hypoxia (dissolved oxygen < 2 mg l^{-1}) is a symptom of too many nutrients in the water. Hypoxia is a growing problem worldwide (Rabalais et al. 2010), and the extent and persistence of hypoxia on the continental shelf of the northern Gulf of Mexico makes the Gulf of Mexico 'Dead Zone' one of the most extensive manifestations of anthropogenic coastal nutrient over-enrichment (Figure 1). Systematic mapping and monitoring of the area of hypoxia in bottom waters began in 1985 (Rabalais 2002. An Integrated Assessment (CENR 2000) of the causes, consequences and actions needed to reduce hypoxia was completed and a 2008 Action Plan for Reducing, Mitigating, and Controlling

Hypoxia in the Northern Gulf of Mexico (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2001) was endorsed by federal agencies, states and tribal governments.

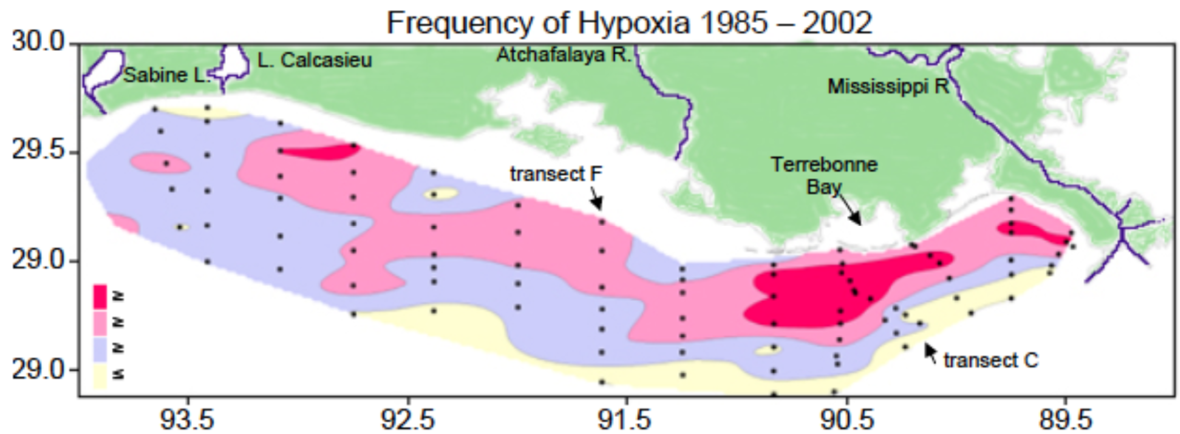

Figure 1. The distribution of the hypoxic zone from 1985-2002 in summer. The area (aka 'Deac Zone') is on the bottom of the water column and has few, if any, shrimp or fish in it. Its size has been increasing to the area of Massachusetts in recent years. Data collected by N. Rabalais and R.E.Turner, based primarily on support from NOAA.

Several models have summarized various relationships between the river loading of nitrogen and the severity of the hypoxic zone (Rabalais et al. 2007). These models link the area of hypoxia and nutrient loading, and support the key component of the management action, which is to reduce nutrient loading to the Gulf of Mexico so that the average hypoxic area in summer is 5,000 km^2 or less by 2015.

Reducing nutrient loading to the GOM can happen with 'win-win' outcomes if the agricultural communities are constructively involved in more flexible ways than presently allowed. We propose the creation of a network of research and demonstration projects that will establish and evaluate new bio-economic enterprises based on multi-functional production systems. This program will help develop and refine federal farm-bill policy by using existing subsidies, but applied in regional-specific ways. The Deepwater Horizon Oil Spill Restoration funds would be the catalyst for this change.

Administrative bodies that integrate across political, economic, and social boundaries (Roux et al., 2008) will be required to successfully apply management practices in ecological units stretching from small upland watersheds to coastal waters. To address problems of this magnitude requires working in watersheds at sufficiently large temporal and spatial scales to match the needs of the farming communities. These 'demonstration' watersheds would be used to improve outcomes arising from the relationships between farm policies, on-the-ground outcomes, and environmental benefits or consequences that are suggested as benefits by others (e.g., Jordan et al., 2007; Batie, 2009). In particular, the Farm Bill should provide the agricultural R&D infrastructure with incentives to evaluate multi-functional production as a basis for a sustainable agricultural bio-economy. We judge that this can be done with very modest public investments (ca. $ 10 million annually X 5 sites X 25 years). A variety of strong political constituencies now expects a very different set of outputs from agriculture, and the US farm landscapes. The cooperation of NOAA, EPA, USDA and others is important for this to succeed in the existing mosaic of balkanized jurisdictional mandates.

A key positive outcome of this proposed effort involves how river diversions are used to restore Louisiana's wetlands. The diversions are causing *more* wetland loss, not less (Kearney et al. 2011) in the organic soils lining the flanks of the lower Mississippi River. We suggest that their vulnerability to storms reflects the introduction of nutrients in the diversions (that add insignificant amounts of additional sediments), which promotes poor rhizome and root growth in marshes and oxidizes the existing soils. Improving water quality through implementation of sustainable farming practices will keep working farms working (and with better profits), decrease the size of the Dead Zone, and improve prospects for wetland restoration.

<u>Example - Conflicting Agendas</u>
A number of daunting restoration issues existed even before the BP oil disaster. Louisiana's legal integration of coastal restoration and hurricane protection in 2005 still left the issue of how to prioritize between these two necessities unresolved. *The Comprehensive Master Plan for a Sustainable Coast* (2007) is primarily a summary of major options and alternatives for restoration and protection.[i] Neither the *Master Plan* nor the LaCPR Report (2010) provides the final decisions on which specific alternatives to choose.[ii]

One problematic decision involves the large new levee systems being planned for the Louisiana coast. These systems would consist of continuous levees, with a number of hydraulic gates to allow or block tidal flow, which would be closed to keep out storm surge. The construction of these levees would, essentially, wall off the coast, and cause more wetland loss. People are being polite about it, but make no mistake, wetland restoration will be compromised if these levees are built. These are not abstract issues, because some coastal parishes, with state approval and funding, have constructed sections of the Morganza to the Gulf levee system.[iii] Louisiana cannot afford to complete the entire project itself, it is expected that state and local officials plan to ask the federal government to perform this function at some point in the future.[iv] Fungible BP oil spill funds could well be sought to pay for these projects.

In addition, both the existing sea-level rise and the acceleration of sea level rise from climate change puts major Gulf cities like New Orleans and Houston at risk of flooding. When hurricanes are added to this mix, then the long-term human occupation of the Mississippi delta and coastal shorelines of all Gulf states becomes problematic. There have also been attempts to decouple the climate and coastal issues that should not escape national scrutiny. While Louisiana is not the only state to oppose the EPA's Endangerment Finding of greenhouse gases, it is the only one asking for an estimated $60-$100 billion in federal funds to restore and protect its coast.

Resolution of these issues is critically important to create sustainable systems. Federal resources, leadership and participation are (still) essential to optimizing fruitful outcomes.

Improving Future Oil Spill Response and Restoration
The status quo is not enough, and never will be in a changing world. The existing resources for

adaptation might be supplemented by the fines and legal settlement from this spill, that are projected to be as large as $20 billion, which is equivalent to $320 per capita for the GOM states. These are significant funds that can be spent to prevent or reduce the unknown consequences of past, present and future actions. They can be invested in the natural system capital supporting sustainable systems, or used inefficiently as fungible funds spent for projects with short-term goals in mind. They can be used to create the knowledge and experience to deal effectively with the unknown. Here are three areas that need attention to improve the status quo.

1) Increase rapid funding: There was an undeniable lack of quick-response funding to determine baseline conditions before the oil spread out from the wellhead, and just after it polluted an area. The National Science Foundation is the only agency that spent quick-reaction funds in a merit-reviewed way to figure out what was happening. It was a hectic process and could have been faster if funded adequately, but these NSF funds allowed people with expertise, local knowledge, and limited appearances of conflicted interests to get into the field quickly. We were left to our own devices to get around the administrative obstacles offered by State and Federal agencies, and from the industry consultants seemingly in charge for too long. But we could not have been nimble without these quick-reaction funds. These options need to be encouraged for the next spill, the next unexpected set of circumstances, and the next unexpected event.

2) Expand the long-term observations of natural systems: Measuring impacts and creating a baseline against which to measure restoration requires long-term measurements, and not just in one location, but many. These science-based observations need to be encouraged through funding and accomplished by independent scientists that can append additional inquiries onto them. I recommend that any funds from the polluting party that funds science studies by academics, are not to be used by academics (or non-profits) if they are involved in the NRDA or BP assessments. The USGS has this policy and it is a good one that maintains a high standard viz a viz the appearance of conflicting allegiances.

3) Improve the NRDA capabilities for field-based assessments: For the most part, the current NRDA process does not have the necessary tools and experience to evaluate ocean ecosystem impacts and lacks the capacity for rigorous testing of dispersant effectiveness or toxicity in natural systems. The clumsy laboratory tests used in this process may meet the needs of the legal system, but they are fairly useless in telling about the in situ impacts. An NRC panel assessment is recommended.

4) Expand infrastructure support: Several federal programs, including NOAA programs, support infrastructure for education, policy development, public support and research in coastal affairs. Some of these are listed in Table 2. Some states have taken advantage of these program, while others have not. They are usually incredibly inexpensive programs and demonstrably effective, like pre-emptive educational initiatives almost always are. Most of these offer shared governance with the local, regional and State governing bodies. All have been operational for > 20 years. Expansion of these programs will enhance the quality and quantity of the response to the next oil spill, the sustainability of coastal systems, and raise the quality of life and livelihood of coastal residents.

Thank you for the opportunity to testify and for your time.

Table 2. Indices of educational and research coastal infrastructure in the GOM: marine laboratories, coastal reserves, conservation zones, and State/Federal partnerships. Data are normalized per shoreline length to facilitate comparisons. SAML is the professional organization of non-federal marine laboratories. The others (NEP, NERR, NPS, NMS) are Federally-supported programs, some of which are co-managed with State entities. These metrics indicate that the strongest infrastructure is in Texas and Florida, and the weakest in Louisiana.

Program	west coast FL	AL	MS	LA	TX
1. Southern Association of Marine Laboratories (SAML)					
a) # Members	20	1	2	1	11
b) Km shoreline per member	410	977	289	12,431	492
2. National Estuarine Program (EPA/State)					
a) # Estuaries	3	1	0	2	5
b) Km^2 Area	19,969	115,467	0	15,769	129,293
c) Km^2 per Km shoreline	2.4	118	0.0	1.3	24
3. National Estuarine Research Reserves (NOAA)					
a) # Reserves	2	1	1	0	1
b) Km^2 area	1,158	19	75	0	752
c) Km^2 per 1000 Km shoreline	141	20	129	0	139
4. National Parks on coastline (Interior)	5	1	1	1	0
5. National Marine Sanctuaries (NOAA)	1	0	0	0	1

Notes: 1. http://www.naml.org;
2. http://www.epa.gov/owow_keep/estuaries/programs/gom.html;
3. http://www.nerrs.noaa.gov/; 4. Park Boundaries overlap the State boundaries;
5. http://sanctuaries.noaa.gov

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[ii] LaCPR Final Technical Report, 2009, U.S. Army Corps of Engineers, http://lacpr.usace.army.mil/default.aspx?p=LACPR_Final_Technical_Report.
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