Testimony for Energy and Environment House Subcommittee:

Thursday, 19 August 2010, 10:00 AM -- Room 2123 Rayburn House Office Building

The BP Oil Spill: Accounting for the Spilled Oil and Ensuring the Safety Seafood from the Gulf

My name is Ian MacDonald. Thank you for inviting me to testify for your committee. I am a professor of oceanography at Florida State University and a member of the steering committee for the Florida Oil Spill Academic Task Force. You have my CV. I have conferred extensively with colleagues on the matters before this committee; however, my testimony today is solely on my own opinions and findings. I will confine my remarks to questions of the extent and effects of the oil and oil/dispersant contamination from the BP spill on the environment including marine life. Could I also testify, before I embark on technical discussion, that I have spent 30 years of professional and private life travelling around, cruising on, and diving to the bottom of the Gulf of Mexico. I deeply, fiercely love this ocean and its people.

I would first offer a critique of the report titled "BP Deepwater Horizon Oil Budget: What happened to the oil?" that was authored by NOAA and the DOI.

I believe this report is misleading and raises more questions than it answers. It purports to explain what happened to the oil discharged from the broken well and what the effect of that oil could be on the Gulf of Mexico environment. The findings are summarized in a single pie-diagram, which lists several categories of oil, each as an exact percentage of the total oil released. This graphic is misleading because it mixes very different categories together and makes sweeping and largely unsupported arguments about the fate of each category in the Gulf of Mexico environment.

First of all, the chart includes as part of the total, oil pumped into tankers from the various caps and other tools, *oil which was never discharged into the ocean*. This inflates the total amount by 17% and gives the impression that the clean-up efforts were more effective than they actually were. The press has widely reported variations of Carol Browner's statement[1] that "more than three quarters of the oil is gone." This statement does not stand up to scrutiny. The report discusses oil "released from the well." The difference in meaning of the terms "released," meaning oil that came out of the well, and "discharged," meaning oil that escaped into the environment -- under the definitions of the Oil Pollution Act (OPA) of 1990, blurs the distinction between oil that can harm the environment going forward and oil that posed no such threat once it was pumped into waiting tankers. In all of my following statement, I recalculate percentages based on the discharged amount.

The total volume of discharged oil was slightly more than 4.1 million barrels. Of this, the NOAA report cites data from the Unified Command Response Effort indicating that 6% was burned and an additional 4 % was skimmed. Thus, only 10% of the oil in the ocean was actually removed from the ocean. The response effort has dispersant application records suggesting that chemical dispersion broke down an additional 10% of the oil, thereby allowing it to become diluted in the ocean. These data account for only 20% of the discharged oil. Fully 90% of the discharge was not removed from the marine

[1] Carol Browner, Wednesday, August 4th, 2010 in NBC's "Today Show."

environment by human agency; a fraction; perhaps 10%, will have evaporated into the air. The balance *remains in the marine and coastal ecosystem* even if it has changed form and become less visible.

Explanation for the fate of almost 90% of the discharge (3.3 million barrels) has been based solely on a theoretical model, which the report calls an "Oil Budget Calculator" composed of "scientific estimation" and "algorithms." There appear to be no samples or measurement to support these claims. My strong criticism is that neither the report nor its on-line references[2] provides *any* citations of scientific literature, formulas, or actual algorithms that would allow an independent reviewer to determine where these numbers actually come from. In short, it is impossible to check the calculations of this crucial report. So when the report claims that 26% of the released oil (31% of the discharge) is residual, i.e. still present in the ocean or its soils and still harmful to the environment, we really cannot check whether this number should actually be 36% or 19%. The committee should note that this residual estimate of 1.3 million barrels is 5 times the discharge from the MV EXXON VALDEZ, so a shift of percentage points would be significant.

Finally, for the oil still in the ocean, the report makes the claim that the oil in all its forms in the ocean "is biodegrading quickly." It is my testimony to this committee that science simply does not know how quickly or slowly oil will degrade either in surface waters or in the deep waters of the Gulf. Preliminary evidence suggests that oxygen depletion has been minimal compared with the quantities of oil and gas discharged, which would indicate a slow rate of degradation. The residual oil that has resisted dispersion and evaporation will be very persistent. Judging from past spills in the Gulf, this material will remain potentially harmful for decades. I expect the hydrocarbon imprint of the BP discharge will be detectable in the marine environment for the rest of my life. The oil is not gone and is not going away anytime soon.

I would like to comment briefly on an aspect of the discharge that has received scant attention from the Unified Command, namely the magnitude of the gas discharged by the BP spill.

The Macondo Field product contained a high proportion of hydrocarbon gas, i.e. methane, ethane, propane, butane, pentane, etc. Indeed the enormous pressure of this gas in the reservoir and certainly its explosive properties contributed greatly to the tragedy of the DEEPWATER HORIZON. However, all the reports of the pollutant load discharged from the well have been issued in barrels--a unit of liquid volume--and have ignored the gas. In fact, if calculated in equivalent units of weight (mass) or energy (barrel of oil equivalents), the magnitude of the oil plus the gas is equal to 1.5 X the oil alone. In other words, it is my testimony that if 4.1 million barrels of oil were discharged, the total discharge in barrel of oil equivalents (oil plus gas) was actually over 6 million barrels.

The Unified Command has made no mention of this gas, but it should not be ignored. Because the discharge occurred at 5000 ft depth, all the material rising toward the surface or drifting in subsurface plumes is *in the ocean* for hours, days, or months and can have a significant chemical and biological effect. So the hydrocarbon gas meets the OPA definition of "discharged." The hydrocarbon gas is highly

[2] http://www.noaanews.noaa.gov/stories2010/PDFs/DeepwaterHorizonOilBudget20100801.pdf

soluble in the deep, cold waters of the Gulf. Based on previous measurements,[3] much of the gas released at depth will dissolve before it reaches the surface. Microbes degrading this material will compete for nutrients (like oxygen) with those attacking oil and will significantly affect the overall degradation process held to be so important by NOAA and DOI. Fish exposed to concentrated methane have exhibited mortality and neurological damage. The hydrocarbon gas was a major component of the total pollution load discharged from the BP well.

My next comment concerns the so-called "resilience" of the Gulf of Mexico.

As a fair reading of the Oil Budget Report affirms, the northeastern Gulf of Mexico received a massive dose of hydrocarbon. Hundreds of miles of shoreline in four states were oiled, shoreline that includes numerous distinct habitats, each with its individual value and vulnerability. The seabed, crucial for oyster, shrimp, and crab fisheries, as well as for its indispensible roles in nutrient recycling and marine food webs, has been sprinkled with tar-balls over thousands of square miles. Buried oil impacts seafloor life and is readily exhumed by storms and potentially by upwelling to cause more damage to the coast. The oceanic surface, the zone of plankton production that drives the food web of the entire system, has endured months of volatile organic toxins from the floating oil. Some species could swim below the worst effects. Other species, including whales, sea turtles, flying fish, sargassum communities, and the larvae of many recently spawned species to name a few, were trapped in the zone of greatest exposure.

This total insult was not delivered to a vibrant and healthy ocean, rather to marine and coastal ecosystems already greatly stressed by serious existing problems. Let us not overlook the hypoxic dead zone, the fishing closures for shrimp and fin fish due to declining stocks, and the accumulated effects of coastal development and runoff. The Gulf can and will rebound, but how much and how fast it does so will take years to determine. In many cases, we do not know how the impact will occur because the experiments have not been carried out. For many species, the impact could be occurring at every life stage. Consider reef fish that have complex life cycles. Eggs and larvae could be hit at the surface by oil; those that survive to reach coastal estuarine nursery habitats could be hit again because oil entered coastal marshes and seagrass beds; and the adults in their benthic existence could have oil components magnified through trophic webs as they eat species that have taken in oil in the diet. This could have indirect effects on their fecundity (number of eggs they produce) and on their general condition and ability to survive.

My immediate concern is for a decline in the productivity and diversity in broad sectors of the ecosystem. As a percent of the total--say 10%--this effect might be difficult to demonstrate scientifically, and perhaps even harder to prove in court. The sustained impact over years, particularly if added to already stressed systems, could be severe. My greatest concern is that portions of the ecosystem may experience "tipping point" effects that overwhelm resiliency. This has been the

[3] Leifer, I. and I. R. MacDonald (2003). "Dynamics of the gas flux from shallow gas hydrate deposits: interaction between oily hydrate bubbles and the oceanic environment." Earth and Planetary Science Letters **21**(3-4): 411-421.
Solomon, E. A., M. Kastner, et al. (2009). "Considerable methane fluxes to the atmosphere from hydrocarbon seeps in the Gulf of Mexico." Nature Geoscience **2**(8): 561-565.

scientific result in Prince William Sound[4] after EXXON VALDEZ. And it is consistent with observations after the Gulf Ixtoc blow out. We can hope that mitigating factors --depth, distance from shore, dilution, a light oil product, etc. will mitigate the impact. It is not enough to hope however; we have to watch with utmost scrutiny and respond quickly wherever there is the chance of mitigation.

I suggest that we monitor a set of key indicator species and habitats of special concern. By focusing on individual species, we have the chance of verifying damage, or hopefully sustained recovery. In consultation with colleagues from the Florida Oil Spill Academic Task Force, the National Wildlife Federation, and elsewhere, I have compiled a preliminary list of watch species and habitats--appended to my testimony. I will not read it here, I would ask this be entered into the record, and I ask my learned colleagues at NOAA, NMFS, FWS, and other agencies to please consider this approach.

My final comment concerns the debt we owe to our Gulf of Mexico.

Consider the three points I just made: that the majority of the oil persists in the environment, that the gaseous fraction of discharge has not been adequately addressed, and that the ecological impact will take years to assess and mitigate. It is clear that the sincere and strenuous efforts of our responders barely have made a dent in cleaning up the ecological impacts created by BP's exploded well. The Gulf of Mexico system has been required to dispose of some 3.7 million barrels of oil and an additional 1.8 million barrel-of-oil-equivalents of gas. The circumstances of discharge--deep in the ocean, far from land--spreads the impact over an unprecedented geographic extent of the ocean basin. As noted, this cannot happen without lasting damage. We are making Mother Nature clean up our big mess and she is suffering for it.

Over the past three months, the people of the region, and of the entire country, have undergone a traumatizing sympathetic reaction to the Gulf's suffering. Now that the acute phase appears to have passed, what have we learned? Even though it is unthinkable to imagine a Gulf of Mexico without her oystermen, shrimpers, beach-goers, boaters, and recreational fishermen, this culture and way of life will not continue unless the Gulf is restored to health and placed on a path toward rejuvenation.

How should this be done? Much as I sympathize with the economic hardship caused by the BP discharge and desire that restitution be paid, a big part--the biggest part--of our response must put the Gulf herself first in line for repayment. A massive and unfaltering effort must be launched to restore, understand, and sustain the coastal and marine ecosystem of the Gulf of Mexico in perpetuity. What I mean are the coastal wetland restoration plans already formulated in Louisiana, but stalled for lack of funds. I mean the creation of extensive marine protected areas to preserve marine biodiversity, which will require public education and enforcement. I mean mitigation of farming practices in the Mid West that burden the Mississippi River with excessive nutrients. I mean regulation and subsidies to treat residential sewage in coastal development. The list is very long and the costs are high and recurring.

[4] Peterson, C. H., S. D. Rice, et al. (2003). "Long-Term Ecosystem Response to the Exxon Valdez Oil Spill." Science **302**(5653): 2082-2086.

Fortunately, we do have visionary leadership in this regard in the U.S. Congress. I am speaking of the bipartisan legislation[5] proposed by Senators Snowe and Whitehouse and supported by Florida's Senator Nelson that would create a permanent *Ocean Endowment* to protect, conserve, restore, and understand the Nation's oceans, coasts, and Great Lakes. This endowment would be funded by criminal fines and fees on the offshore industry. The need and the way forward could not be more clear. Certainly the House and Senate and hopefully the two parties can work together for this worthy legislation. You will be joined by massive support from the people of the Gulf of Mexico region.

[5] S.3641 National Endowment for the Oceans Act

Appendix: Draft list of species and habitats that could serve as indicators of marine and coastal ecosystem health.

Oceanic species--

- Tuna-- Three important species are blue fin, yellow fin, black fin. The adults will have been able to avoid concentrations of oil, but the larvae will be vulnerable. Our baseline knowledge of population levels are poor. Yellowfins are a hugely important recreational species and changes in landings may give a clue--next year! Blue fin tuna are already severely stressed by fishing pressure.
- Sea turtles--Three species of sea turtles are critically endangered, two are endangered, and one is vulnerable and there have been a number of reported moralities.
- Sperm whales--also a vulnerable species. One confirmed mortality--the area of the major concentration of the spill corresponds to the normal summer feeding grounds of a resident sperm whale population in the Gulf of approximately 200. It will be crucial to evaluate this population post spill.
- Other cetaceans--pilot whales (status unknown), spinner dolphin (status unknown), even orcas (status unknown).
- Sargassum communities--this comprises the diverse assemblage of fish and invertebrates associated with floating masses of sargassum plants.

Forage Species

- Flying fish--a particularly vulnerable species because they live in the upper most layer of the water where the floating oil was concentrated and where they feed on plankton. They are an important forage species for larger sport fish, including mackerel, tuna, swordfish, marlin, dolphins, porpoises.
- Menhaden – filter feeders, critical forage species for many economically important fishes. Also the third largest fishery in the country with catch going into industry and livestock feed.

Coastal species

- Brown pelicans--a previously threatened species with rookeries badly hit.
- Bird species including gannets (which live offshore and "monitor" those conditions) and oyster catchers Saltmarshes--I'm very worried about the channel edges that got oiled. If there is a die back of the oiled edge, the result would be that the channels are dilated--even a 5-10% dilation would potentially have a huge impact on wetland hydrography.
- Coquina (Donax)--bivalves living in oiled beach sands. Important burrowers.
- Fiddler crabs, mole crabs, ghost crabs--vital for aerating the soils. All burrowers are very important for keeping the sand aerated. Burrowing will be inhibited by buried oil. And lack of aeration will tend to preserve buried oil. A vicious circle.
- Marsh periwinkle (*Littoraria irrorata*) are very abundant grazers who might be impacted by buried oil.
- All three species of commercial shrimp (*Penaeus)* occur in coastal waters and may be impacted by oil on the seabed.

Plankton

The oceanic and coastal plankton need to be closely monitored using satellite methods and direct sampling. This is the base of the food chain and it is also potentially the source of harmful algal blooms that can affect human health.

Microbial community

The bacterial assemblage that breaks down oil could be a sensitive indicator of residual oil in the environment--even if the oil is not directly detectable. The disappearance of oil degrading microbes might then indicate complete disappearance of oil.

Shelf-edge and Slope species

- Any of the offshore habitat engineers in these habitats could be important indicator species because they serve as the focus for community development and biological diversity and because they actively manipulate the sediment, contributing significantly to the three-dimensional architecture of the seabed. These would include things like red grouper on the shelf edge which creates holes roughly 15 ft across and 3-6 ft deep (density in gulf of mexico ~250/km2) ; tilefish on the slope because of the pueblo-like burrows they create (density in gulf of mexico 600-1600/km2)
- Sharks, which are top-level predators and comprise many threatened species

Deep Sea Corals

Cold-water corals are widely distributed throughout the Gulf of Mexico (http://fl.biology.usgs.gov/documents/20100504Gulf_corals_v1.pdf). While there is tremendous need to know more about the distribution and composition of these deep-water communities (the structure), it is also essential that we gain greater understanding of their function in terms of ecosystem services and their response to the presence of dispersants/oil combinations and oil alone.

Across Depth Strata

Sponges and soft corals provide a suite of ecosystem services, including filtering water, nutrient cycling, providing nursery habitat and shelter for a diverse group of fishes, shrimps, crabs, etc. We know little about their distribution, composition and function in most sites from inshore to the deep sea.