OCEAN SCIENCE AND DATA LIMITS IN A TIME OF CRISIS: DO NOAA AND THE FISH AND WILDLIFE SERVICE (FWS) HAVE THE RESOURCES TO RESPOND? (PART 2 OF 3)

OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON INSULAR AFFAIRS, OCEANS AND WILDLIFE

OF THE

COMMITTEE ON NATURAL RESOURCES
U.S. HOUSE OF REPRESENTATIVES

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OVERSIGHT HEARING ON OCEAN SCIENCE AND DATA LIMITS IN A TIME OF CRISIS: DO NOAA AND THE FISH AND WILDLIFE SERVICE (FWS) HAVE THE RESOURCES TO RESPOND? (PART 2 OF 3)

Tuesday, June 15, 2010
U.S. House of Representatives
Subcommittee on Insular Affairs, Oceans and Wildlife
Committee on Natural Resources
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:02 a.m. in Room 1324, Longworth House Office Building, Hon. Madeleine Z. Bordallo presiding.

Present: Representatives Bordallo, Kildee, Sablan, Shea-Porter, Wittman, Fleming, and Cassidy.

Also present: Representative Bilirakis

STATEMENT OF THE HONORABLE MADELINE Z. BORDALLO, A DELEGATE IN CONGRESS FROM THE TERRITORY OF GUAM

Ms. BORDALLO. Good morning, everyone. The oversight hearing by the Subcommittee on Insular Affairs, Oceans, and Wildlife will now come to order.

Today, day 57 of the *Deepwater Horizon* oil spill, the Subcommittee continues its inquiry into the largest environmental disaster in United States history. Last week, we heard from distinguished panelists about the short- and the long-term impacts of the oil spill on trust resources, including fisheries, birds and other wildlife, marine mammals, tribal resources, protected fish and wildlife habitat, beaches, our coasts, and other natural areas. It was abundantly clear from that hearing that the communities that depend on these resources, from fishermen and hunters to the tourism industry, will be reeling from the impacts of this oil spill for decades.

Today's hearing will investigate both what we know and what we do not know about the environment to guide the oil spill response and recovery activities in the Gulf of Mexico. Clearly, there is so much that we do not know because of the unprecedented scale and complexity of this oil spill. But some of these unknowns can be eliminated through transparent access to data and information, and adequate deployment of assets to measure and monitor the spill.

We need to know how much oil has spilled and continues to spill into the Gulf. We need to know the fate of this oil and dispersant at the surface and in the water column. We need to collect and integrate baseline environmental data to properly assess natural resource damages.

This information is critical to our response and recovery activities because what gets measured gets managed. Sadly, there is so much that will not be managed because of the gaps and the limits in our understanding of the complex estuary, coastal, and marine environments in the Gulf. We have made such limited investments in coastal science programs and ocean observation systems that it has proven difficult to provide timely and accurate scientific information to target response activities and to assess damages to natural resources.

Whether we know enough to mitigate the impacts of this oil spill, to properly compensate the public for damages to natural resources and to prevent catastrophic oil spills in the future, remains to be seen. But we must strive to make the public whole and to take every protection to never let a disaster like this happen again.

I want to thank this morning all of the witnesses for being here during this very challenging and busy time, and I look forward to hearing your testimony. At this time, I would like to recognize Mr. Cassidy, the Acting Ranking Republican Member of this Subcommittee, for any statement that he may have.

[The prepared statement of Chairwoman Bordallo follows:]

Statement of The Honorable Madeleine Z. Bordallo, Chairwoman, Subcommittee on Insular Affairs, Oceans and Wildlife

Today, Day 57 of the Deepwater Horizon oil spill, the Subcommittee continues its inquiry into the largest environmental disaster in U.S. history. Last week we heard from distinguished panelists about the short and long-term impacts of the oil spill on trust resources, including fisheries, birds and other wildlife, marine mammals, tribal resources, protected fish and wildlife habitat, beaches, our coasts, and other natural areas. It was abundantly clear from that hearing that the communities that depend on these resources, from fishermen and hunters to the tourism industry, will be reeling from the impacts of this oil spill for decades.

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We need to know how much oil has spilled and continues to spill into the Gulf. We need to know the trajectory and fate of this oil and dispersant at the surface and in the water column. We need to collect and integrate baseline environmental data to properly assess natural resource damages. This information is critical to our response and recovery activities because what gets measured gets managed.

Sadly, there is so much that will not be managed because of the gaps and limits in our understanding of the complex estuarine, coastal, and marine environments in the Gulf. We have made such limited investments in coastal science programs and ocean observation systems that it has proven difficult to provide timely and accurate scientific information to target response activities and to assess damages to natural resources.

Whether we know enough to mitigate the impacts of this oil spill, to properly compensate the public for damages to natural resources, and to prevent catastrophic oil spills in the future remains to be seen, but we must strive to make the public whole and to take every precaution to never let a disaster like this happen again.

I thank all the witnesses for being here today during this very challenging and busy time, and look forward to hearing your testimony.

STATEMENT OF THE HONORABLE BILL CASSIDY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF LOUISIANA

Mr. CASSIDY. Thank you, Madame Chair. I appreciate your scheduling this hearing on the resources and knowledge available

to the Federal Government, especially NOAA and the Fish and Wildlife Service, in responding to the *Deepwater Horizon* spill.

It has been 57 days since the *Deepwater Horizon* exploded and sank some 42 miles off the coast of Louisiana. It is an ongoing disaster for the Gulf Coast region, its economy and environment, and the millions who live there, and it is a tragedy cut in stone for those who have lost loved ones. Particularly, it is an ongoing tragedy for those whose jobs are dependent upon the Gulf of Mexico, and a new tragedy is the President's moratorium on offshore drilling, which will effectively destroy the livelihoods of tens of thousands of Louisianians who rely upon well-paying jobs to support their family.

At previous hearings, I have referred to the National Academy of Sciences' report, "Oil in the Sea III." This report was released in 2003 and had many recommendations to Federal agencies regarding natural and man-made releases of oil and the research necessary to understand their effects. However, there are many recommendations in this report and other reports, such as the 2004 "Spill of National Significance" report, which have not been acted upon by these agencies.

At last week's Subcommittee hearing, concerns were raised about the use of dispersants. Well, there seems to be some understanding of the impact of dispersants' use on the water surface, but there are concerns about the short- and long-term impact of their use within the water column. We also do not have much information on how oil degrades in the ultra-deep and deep waters, as well as in sensitive marine areas.

Some of our witnesses today will discuss this and tell us where the science is limited. It is apparent that we do not have the knowledge necessary to address a spill this size. It is a disappointment that the Environmental Protection Agency, which was invited and has issued permits allowing the use of subsurface dispersants, apparently felt this hearing was not worth their time.

At today's hearing, we will examine what information was available to the Federal Government prior to this spill. Did each agency have adequate baseline data available for the Gulf of Mexico region to understand the impacts of the oil? In an area where oil and gas exploration occurs daily, it would seem essential to have this information, but a lot of Federal efforts following the spill, particularly the responses of NOAA and EPA, have been to create baseline data from scratch rather than acting upon an existing set of knowledge and preparations. And why haven't we learned from the previous spills? I have asked in this Committee on numerous occasions about the 1979 Ixtoc drilling accident in the Gulf of Mexico. How has it informed us? Why can't we do what the Norwegians did when they actually studied the effects of oil in the deepwater? Lake Barre was an oil spill in the Louisiana marshes. None of my witnesses, so far, have been able to tell us how clean-ups in that area could inform our clean-ups in this area. I look forward to these panels, and I am confident that you will be able to.

Why are outside researchers and even private citizens able to tell the Federal Government things long before the Federal Government is able to come to the same conclusion? For instance, why are researchers able to tell from watching BP's spill cam over the

Internet that more oil was being discharged than was being estimated? And then the Federal Government had to create a new committee before it could tell us that these researchers were right. And why have we not tested dispersant use in deepwater? What information is available in sensitive coastal areas?

Did the Administration react quickly enough to protect these areas? Do we know how these coastal wetlands will respond and how long it will take them to recover? How can we be more innovative in our approach in dealing with disasters like this, including reducing the Federal red tape that seems to hamstring our efforts at creating new approaches?

There are a great many outstanding scientists working at our universities, and especially in my state and other states affected by the spill, who should be consulted to understand these issues and find solutions. Instead, I have heard from academic professionals, in Louisiana and elsewhere, that they are not being offered the opportunity to engage with the Federal Government and share their wide-ranging expertise, and that even after the spill they have had little opportunity to provide input. And I have also been told by some researchers that they are being intimidated by BP to not go into the marshes, to publish their scientific findings, and if they do, they will risk legal action.

The Federal Government should be actively seeking the input of the academic community and ensuring that the data collected is published so we can learn from this devastating event.

Madame Chair, I look forward to hearing from our distinguished witnesses, who will give us their unique perspective on the impacts of this oil spill disaster.

Ms. BORDALLO. I thank the gentleman from Louisiana for his opening statement. And I would now like to recognize our first panel of witnesses to testify. Before we do that, I would like to ask those that are standing in the back, you can take the chairs up here on the lower dais if you would like to be seated. This may be a lengthy hearing, and I don't know that you can be able to stand through it all. Please feel welcome to sit here.

Our witnesses this morning on panel one include Mr. David Kennedy, the Acting Assistant Administrator, National Ocean Service, National Oceanic and Atmospheric Administration; Dr. Marcia McNutt, Director, U.S. Geological Survey; Dr. Jonathan A. Coddington, Associate Director for Research and Collections, National Museum of Natural History, Smithsonian Institution; and Dr. Merv Fingas, Committee on Oil in the Sea, National Research Council.

I would like to thank all of you for being here today. And as we begin, I would note that the red timing light on the table will indicate when your five minutes have passed and your time has concluded. We would very much appreciate your cooperation in complying with these limits. But be assured, ladies and gentlemen, that your full written statement will be submitted for the hearing record.

And now, Mr. Kennedy, welcome back to our Subcommittee, and thank you for being here today. Please begin your testimony.

STATEMENT OF DAVID KENNEDY, ACTING ASSISTANT ADMINISTRATOR, NATIONAL OCEAN SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Mr. KENNEDY. Good morning. Thank you, Chairwoman Bordallo and members of the Subcommittee, for the opportunity to testify on the critical role of ocean observations and data in this time of crisis and areas for future emphasis. My name is David Kennedy, Acting Assistant Administrator, Ocean Service Coastal Zone Management, for NOAA. I have been deeply involved in this spill and many before.

But before I move on—I want to discuss NOAA's efforts. I would like first to express my condolences to the families of the 11 people who lost their lives in the explosion and sinking of the *Deepwater Horizon* platform.

The entire agency is deeply concerned about the immediate and long-term environmental, economic, and social impacts to the Gulf Coast and the Nation as a whole from this spill. NOAA is fully mobilized and working tirelessly to lessen impacts on the Gulf Coast, and will continue to do so until the spill is controlled, oil is cleaned up, natural resource injuries are assessed, and restoration is complete.

Today, I am going to focus my comments on the importance of ocean observations in the Gulf of Mexico and future areas for enhancing oil spill response. Unfortunately, this oil spill is a grave reminder that spills of national significance can occur, despite the safeguards and improvements that have been put into place since the passage of the Oil Pollution Act of 1990. If a spill does occur, responders must be equipped with the appropriate tools and information, and effective response based on solid science and smart decision-making resources, environmental and socioeconomic impacts, as well as clean-up costs.

I am going to talk just briefly about surface observations, and then I will go to subsurface. One of NOAA's roles during the oil spill is to provide scientific information to the Federal on-scene coordinator. One of the products NOAA provides are spill trajectories. Real-time data on currents, tides, and winds, as well as sustained observations and physical and chemical parameters of the whole water column are important in driving the models that inform our understanding of the likely path of the spilled oil. The usefulness of NOAA's trajectory model depends in part on the accuracy of the input data.

Observational data play a critical role in ensuring the most accurate trajectory forecast is provided. These forecasts ensure that local communities have advanced warning of potential impacts, and as a result that plans can be put in place to protect sensitive natural resources. For modeling the surface movement of oil, ocean observations such as high frequency radar play a critical role. High frequency radar is delivered near real-time surface current data 24/7, covering thousands of square miles simultaneously. Surface currents of the ocean are key inputs to the models that generate estimates of the extent and trajectory of an oil spill.

In the Gulf of Mexico, this information is provided from the Gulf of Mexico Coastal Ocean Observing System, GCOOS, and the Southeast Coastal Ocean Observing Regional Association,

SECOORA. These regional associations are part of the U.S. Integrated Ocean Observing System, or IOOS, a Federal, regional, and private sector partnership working to enhance our ability to collect, deliver, and use ocean information.

Because we cannot predict where a spill will occur, data delivery from high frequency radar is envisioned to be part of a seamless national system that will ensure information 24/7. As IOOS generates more data from technological advances like high frequency radar, the prediction of oil's location will be improved by pulling these observations into NOAA's trajectory models.

Subsurface observations. As the *Deepwater Horizon* oil spill is demonstrating, our nation's existing capacity to deliver an accurate depiction of subsurface movement is limited. Although there is some capacity across the Federal and non-Federal oceanography community, ocean currents, oil density, and behavior in oil droplet size are all significant contributors to whether oil rises to the ocean surface or remains below the surface.

The subsurface concentration of dissolved oil or oil droplets is of significant concern in understanding how fisheries, marine mammals, and other species in the water column will be affected. The broad oceanographic community has responded in remarkable fashion and made available the best of their expertise and technology to better inform our understanding of the subsurface movement of oil.

However, to detect the presence of subsurface oil and estimate its movements beneath the surface, one needs a suite of observing assets combined with three-dimensional ocean circulation models. While ship surveys have been the conventional method for observing three-dimensional fields of temperature, salinity, and other properties, such as chlorophyll and nutrients, this method is slow and costly. A combination of profiling floats, moored buoys with profiling sensors, and gliders have the capability to deliver the information with the temporal and spatial parameters needed.

In addition to enhancing observations in the Gulf of Mexico to produce more robust trajectory models of surface and subsurface oil, additional research, enhanced response capability, and improved tools and technological innovation by the public or private sector would greatly improve our ability to respond to the level expected by the nation.

To mitigate environmental effects of future spills, responders must be equipped with sufficient capacity and capabilities to address the challenge. If another large spill were to occur simultaneously in another location elsewhere in the United States, NOAA would have difficulty responding to its complete ability. Strong science is critical to effective decision-making to minimize the ecological and economic impacts from, and mitigate the effects of, oil spills on coastal and marine resources in the associated communities.

Existing research has resulted in the advance of some response technologies. More can be done, however, to strengthen our nation's response capability, and continued development of tools and strategies can only increase the effectiveness of oil spills.

In closing, I assure you that NOAA will not relent in our efforts to protect the livelihoods of affected Gulf Coast residents and miti-

gate the environmental impacts of this spill. Thank you for allowing me the time. Thanks.

[The prepared statement of Mr. Kennedy follows:]

Statement of David M. Kennedy, Acting Assistant Administrator, National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Thank you, Chairwoman Bordallo and Members of the Subcommittee, for the opportunity to testify on the Department of Commerce's National Oceanic and Atmospheric Administration's (NOAA) role in the response to the Deepwater Horizon oil spill.

My name is David Kennedy and I am the Acting Assistant Administrator for Ocean Services and Coastal Zone Management at NOAA. I appreciate the opportunity to discuss the critical roles NOAA serves during oil spills and the importance of our contributions to protect and restore the natural resources, communities, and economies affected by this tragic event. Before I move on to discuss NOAA's efforts, I would first like to express my condolences to the families of the eleven people who lost their lives in the explosion and sinking of the Deepwater Horizon platform.

NOAA's mission is to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs. NOAA is also a natural resource trustee and is one of the federal agencies responsible for protecting, assessing, and restoring the public's coastal natural resources when they are impacted by oil spills, hazardous substance releases, and impacts from vessel groundings on corals and seagrass beds. As such, the entire agency is deeply concerned about the immediate and long-term environmental, economic, and social impacts to the Gulf Coast and the Nation as a whole from this spill. NOAA is fully mobilized and working tirelessly to lessen impacts on the Gulf Coast and will continue to do so until the spill is controlled, oil is cleaned up, natural resource injuries are assessed, and restoration is complete.

My testimony today will discuss NOAA's role in the Deepwater Horizon response and natural resource damage assessment process, observations related to the Gulf of Mexico, and future activities to improve response and resource assessment efforts.

NOAA'S RESPONSE AND DAMAGE ASSESSMENT EFFORTS

NOAA has three critical roles mandated by the Oil Pollution Act of 1990 and the National Contingency Plan:

1. During the emergency response, NOAA serves as a conduit for scientific information to the Federal On-Scene Coordinator. NOAA provides trajectory predictions for spilled oil, conducts overflight observations of oil on water, identifies highly valued or sensitive environmental areas, and conducts shoreline surveys to determine clean-up priorities.
2. As a natural resource trustee, NOAA conducts a joint Natural Resource Damage Assessment (NRDA) with co-trustees to assess and restore natural resources injured by the oil spill. NRDA also assesses the lost uses of those resources, such as recreational fishing, canoeing, and swimming, with the goal of implementing restoration projects to address these injuries.
3. Finally, NOAA represents the Department of Commerce in spill response decision-making activities through the National Response Team.

NOAA's experts have been assisting with the response to the Deepwater Horizon oil spill from the beginning, providing coordinated scientific services when and where they are needed most. Support from NOAA has not stopped since the first requests for information by the U.S. Coast Guard (USCG). Over the past eight weeks, NOAA has provided scientific support, both on-scene and through our headquarters and regional offices. NOAA's support includes daily trajectories of the spilled oil, weather data to support short- and long-range forecasts, and hourly localized 'spot' forecasts to determine the use of weather-dependent mitigation techniques such as oil burns and chemical dispersant applications. We develop custom navigation products and updated charts to help keep mariners out of oiled areas. NOAA uses satellite imagery and real-time observational data on the tides and currents to predict and verify oil spill location and movement. To ensure the safety of fishermen and consumer seafood safety, NOAA has closed oil-impacted areas to commercial fishing. NOAA scientists are in the spill area taking water and seafood samples to determine which areas are safe for commercial fishing. NOAA will reopen these areas only if it is assured that fish products within the closed area meet the Food and Drug Administration (FDA) standards for public health and wholesomeness. To that end, NOAA, in conjunction with FDA, is continuing to refine a reopen-

ing protocol based on both chemical and sensory analysis of seafood within the closed area. In addition, NOAA's marine animal health experts are providing expertise and assistance with stranded sea turtles and marine mammals.

To facilitate on-the-ground understanding of the spill's impacts, NOAA is awarding grants for rapid response projects to monitor the impacts of the oil spill on Louisiana's coastal marshes and fishery species through the Sea Grant Program. To support the local communities as they deal with the economic, social, and environmental impacts of the spill, the Gulf Coast Sea Grant Programs are hosting a series of open forums across the Gulf where citizens have the opportunity to interact with industry, government, and university representatives. In addition, NOAA helped organized volunteer beach clean-ups to remove pre-spill debris from state beaches, which eliminates obstacles and improves access, thereby helping to facilitate the identification and cleanup of oil along the shoreline.

With multiple agencies supporting a diverse array of research projects in response to the Deepwater Horizon oil spill in the Gulf of Mexico, it is important to coordinate research activities to ensure the best use of limited resources. NOAA's Gulf Coast Sea Grant Programs are developing a website to serve as a central database listing ongoing research activities and identifying funding opportunities for oil-spill related research, whether conducted by government, academic, or privately-supported scientists. The database's intent is to provide a single, comprehensive view of research activities in the Gulf that are being undertaken in connection with the Deepwater Horizon oil spill and to foster coordination of these efforts.

At the onset of this oil spill, NOAA quickly mobilized staff from its Damage Assessment Remediation and Restoration Program to begin coordinating with federal and state co-trustees and the responsible parties to collect a variety of data that are critical to help inform the NRDA process. NOAA is coordinating the NRDA effort with the Department of the Interior (another federal co-trustee), as well as co-trustees in five states and representatives for at least one responsible party, BP.

While it is still too early in the process to know what the full scope of the damage assessment will be, NOAA and co-trustees continue to collect data in the Gulf and across the five states. These data will be used to determine what natural resources have been injured and what human uses have been lost due to the spill. Several technical working groups comprising NOAA, federal and state co-trustees, and representatives from one responsible party (BP) are gathering existing scientific information and developing and implementing baseline (pre-spill impact) and post-impact field studies for multiple resource categories. Hundreds of miles of coastal shoreline were surveyed by air and samples were taken to determine baseline conditions prior to the oil hitting land, to identify where the oil has made landfall to support clean-up activities. Resources being assessed include fish and shellfish, bottom-dwelling plant and animal life, birds, marine mammals, turtles, and sensitive habitats such as wetlands, submerged aquatic vegetation or seagrasses, beaches, mudflats, bottom sediments, deep and shallow corals, chemosynthetic organisms, and the water column. Some of these resources may be included within National Estuarine Research Reserves and National Marine Sanctuaries. In addition, NOAA and co-trustee field teams are determining how human uses, including cultural uses, and natural resource services are being impacted.

Needless to say, for both the response and the NRDA, offices throughout NOAA are mobilized and hundreds of NOAA personnel are dedicating themselves to assist with this unprecedented effort.

ACTIVITIES TO IMPROVE FUTURE RESPONSE AND RESOURCE ASSESSMENT EFFORTS

The Deepwater Horizon oil spill is a grave reminder that spills of national significance can occur despite the safeguards and improvements that have been put into place since the passage of Oil Pollution Act of 1990. Although the best option is to prevent oil spills, the risk of oil spills remains a concern given the offshore and onshore oil infrastructure, pipes, and vessels that move huge volumes of oil through our waterways. If a spill does occur, responders must be equipped with the appropriate tools and information. An effective response, based on solid science and smart decision making reduces environmental and socioeconomic impacts, as well as clean-up costs. Research and development and technological innovation by the public or private sector in the following areas would greatly enhance the tools and technologies available in the event of a spill.

Surface Observations

Real-time data on currents, tides, and winds, as well as sustained observations of physical and chemical parameters of the whole water column, are important in driving the models that inform our understanding of the likely trajectory of the

spilled oil. The usefulness of NOAA's trajectory model depends in part on the accuracy of its input data. Observational data play a critical role in ensuring the most accurate trajectory forecast is provided. These forecasts ensure that local communities have advance warning of potential impacts and, as a result, that plans can be put in place to protect sensitive natural resources. Government, academic, and commercial entities are working together to provide the data needed to support these forecasting efforts. For example, several ocean current models are contributing to the trajectory analysis for the Deepwater Horizon oil spill, including those from NOAA, the Navy, the Department of the Interior's Minerals Management Service, the State of Texas, and academic partners. These models use satellite analysis, real-time and near real-time ocean observations, and long-term data.

For modeling the surface movement of oil, ocean observations such as the high-frequency radar play a critical role. High-frequency radars deliver near real-time surface current data 24/7, covering thousands of square miles simultaneously. Surface currents of the ocean are key inputs to the models that generate estimates of the extent and trajectory of an oil spill. This information is provided from the Gulf of Mexico Coastal Ocean Observing System (GCOOS) and the Southeast Coastal Ocean Observing Regional Association (SECOORA). These regional associations are part of the U.S. Integrated Ocean Observing System (IOOS®), a federal, regional, and private-sector partnership working to enhance our ability to collect, deliver, and use ocean information. GCOOS and SECOORA each have three high-frequency radars that are contributing valuable information to the spill response. These radars are part of a national network high-frequency radar data delivery system funded and managed by the NOAA IOOS Program. Because we cannot predict where a spill will occur, data delivery from high-frequency radars is envisioned to be part of a seamless national system that will ensure information 24/7. As the Integrated Ocean Observing System generates more data from technological advances like high frequency radar, the prediction of oil location can be improved by pulling these observations into trajectory models in real time.

Efforts led by NOAA since 2007 to increase the coordination and interaction of various ocean observing centers of expertise into a cohesive community under the framework of the U.S. IOOS has built strong collaborative relationships across the community. As a result, the community has been able to quickly exchange information, identify assets and establish means of working together to meet the challenge the Nation faces with the Deepwater Horizon oil spill.

In addition to in-situ sensors, data collected by space-based synthetic aperture radar can be used to produce high-resolution images of the Earth's lands and oceans and can also be used in all types of weather, as it can "see through" clouds and darkness. Current use of NOAA-generated experimental products suggests that data from space-based synthetic aperture radar can assist in detecting and refining the areal extent of oil, which would provide valuable information to help determine where response efforts and resources should be deployed.

Subsurface Observations

As the Deepwater Horizon oil spill is demonstrating, our Nation's existing capacity to deliver an accurate depiction of subsurface movement is limited; although, there is some capacity across the federal and non-federal oceanography community. Ocean currents, oil density and behavior, and oil droplet size are all significant contributors to whether oil rises to the ocean surface or remains below the surface. The subsurface concentration of dissolved oil or oil droplets is of significant concern to understanding how fisheries, marine mammals, and other species in the water column will be affected. To address these concerns, the federal response team established a formal Subsurface Monitoring Branch. In addition, the broad oceanographic community has responded in remarkable fashion and made available the best of their expertise and technology. In addition, federal agencies such as NOAA, U.S. Naval Oceanographic Office, and Environmental Protection Agency are all contributing capabilities to better inform our understanding of the subsurface movement of oil.

The emerging advancement in modeling three-dimensionally can greatly enhance response operations and mitigation efficacy. This year, NOAA started an effort to begin to enhance three-dimensional models, which will improve our ability to predict the movement of oil at depth and allow us to direct precious resources to validate the models' trajectory.

To detect the presence of subsurface oil and estimate its movement beneath the surface, one needs a suite of observing assets combined with three-dimensional ocean circulation models. In addition to the high-frequency radars to monitor the surface currents, one needs high-resolution circulation models informed by three-dimensional fields of temperature and salinity. While ship surveys have been the con-

ventional method for observing three-dimensional fields of temperature, salinity, and other properties, such as chlorophyll and nutrients, this method is slow and costly. Three-dimensional circulation models require synoptic measurements at sufficient time intervals to adequately capture the changing conditions in the water column. A combination of profiling floats, moored buoys with profiling sensors, and gliders have the capability to deliver the information at the temporal and spatial parameters needed.

NOAA is currently involved in several sampling cruises to better characterize what is in the water column. A number of gliders, autonomous underwater vehicles (AUV), and other existing technologies are being applied in new ways, such as through the use of multi-beam echo sounders and fisheries echo sounders to help map the potential locations of oil that might be present in the water column.

Current hydrographic surveys carry out sustained observations of the whole water column in the Gulf of Mexico, Florida Bay, and the Florida Keys, and will be extended if the oil or dispersant spreads through the Strait of Florida and into the Gulf Stream. These surveys, along with satellite observations and numerical models, allow monitoring of currents and features responsible for the transport of oil and dispersants.

Whether provided by new technologies, or through re-examining the capabilities of current technologies, information on the locations of spilled oil is of significant benefit in spill response, such as the Deepwater Horizon oil spill. Timely understanding of the location of the spilled oil allows responders to position their activities and better utilize limited resources to maximize our contributions to protect and restore the resources, communities, and economies affected by this tragic event.

Activities to Improve Future Response and Resource Assessment Efforts

- ***Response capacity and capabilities***

  To mitigate environmental effects of future spills, responders must be equipped with sufficient capacity and capabilities to address the challenge. NOAA's Office of Response and Restoration is fully engaged in responding to the Deepwater Horizon oil spill. Although unlikely, if another large spill were to occur simultaneously in another location elsewhere in the United States, NOAA would have difficulty responding to its complete ability.

  - **Expertise—** A diverse team of experts in analytical chemistry, environmental chemistry, biology, oceanography, natural resource damage assessment, administrative functions, and information management helps NOAA plan and prepare activities between spills, including training, development of area plans and response protocols, drafting and reviewing response job aids, and coordinating with regional responders.
  - **Training—** Response training and exercises are essential to maintaining capabilities. Continuous training, improvement of our capabilities, maintenance of our capacity, and investments in high-priority, response-related research and development efforts help to ensure that the Nation's response to these events remains effective. Training and coordination with other federal, state, and local agencies with response and restoration responsibilities is critical to success in mitigating effects of future spills.

- ***Response tools and technologies***

  The continued development of tools and strategies can only increase the effectiveness of oil spill response. Specific activities that would increase response effectiveness include:

  - **Natural Resource Protection Tools –** Environmental Sensitivity Index (ESI) database and map products provide information that helps reduce the environmental, economic, and social impacts from oil and hazardous substance spills. ESI maps include critical information on biological resources (such as birds, shellfish beds, and endangered species), sensitive shorelines (such as marshes, tidal flats, and marine sanctuaries), and human-use resources (such as public beaches, parks, and drinking water intakes). Spill responders use NOAA's ESI maps—and maps prepared by other federal and state trustees, including the Department of the Interior (DOI)—as tools to identify priority areas to protect from the spreading oil, develop cleanup strategies to minimize impacts to the environment and coastal communities, and reduce overall cleanup costs. NOAA's goal is to update ESI maps approximately every ten years so that responders have the most accurate information; other agencies update their maps according to their needs and schedules.
  - **Data Management Tools for Decision Making** – The key to effective emergency response is efficiently integrating current science, information

technology, and real-time observational data into response decision making. NOAA has developed the Emergency Response Management Application (ERMA), a web-based information management application, to facilitate preparedness and response and restoration decision making for oil spills and for other coastal hazards. ERMA integrates real-time observations (e.g., NOAA National Buoy Data Center data, weather data, shoreline data, vessel traffic information, etc.) with archived data sources (e.g., NOAA's National Oceanographic Data Center's historical data) in an easy to use, Google-based format to aid in evaluating resources at risk, visualizing oil trajectories, and planning rapid tactical response operations, injury assessments, and habitat restoration. Having access to retrospective data is critical to bringing value to real-time observational data being collected. NOAA is working with DOI and state trustees to assure that data management tools can be integrated.

NOAA is currently using the Gulf of Mexico ERMA for the Deepwater Horizon oil spill response to help manage the common operational picture for all command posts. The Gulf of Mexico ERMA is updated daily to provide a dynamic and automated tool allowing for greater access, more layers of data, and high-resolution photography. ERMA allows users to navigate through different layers of information to reveal actual data and magnify areas of geographic interest – ultimately improving decision making. For example, ERMA could provide a picture of diverse shoreline development (e.g., industry, residential, protected habitats, tourist/recreational use), information on routine shipments of oil and chemicals through the Gulf, and the proximity of wildlife management areas and conservation easements. In addition to the Gulf of Mexico, ERMA is operational in the U.S. Caribbean and New England.

Recently NOAA has worked with the U.S. Fish and Wildlife Service to integrate their developing Information, Planning, and Conservation decision support system into ERMA. The result is the ability to transfer information allowing users to seamlessly move between the systems to obtain information about Fish and Wildlife Service trust resources and recommended best management practices. This system integration will result in users only having to visit one location to obtain information regarding both agencies' trust resources. The ability to obtain natural resource information in as few places as possible is vital to effective emergency response efforts

• *Research*

Strong science is critical to effective decision making to minimize the ecological and economic impacts from, and mitigate the effects of, oil spills on coastal and marine resources and associated communities. Existing research has resulted in the advancement of some response technologies. More can be done, however, to strengthen our Nation's response capabilities.

- **Long-Term Effects on Species and Habitats**—Spilled oil can remain on the shoreline and in wetlands and other environments for years. More than twenty years later, there is still oil in the sediments of Prince William Sound from the Exxon Valdez spill. Continued research is needed to improve our understanding of the long-term effects of oil on sensitive and economically important species and habitats. Research is also needed to determine the effects of oil and dispersants that are suspended in the water column on mid-water and pelagic species, as well as on deep-water corals, chemosynthetic communities (animal communities living in the deep sea on dissolved gases), and benthic habitats. Such studies can provide valuable information on the sensitivity and/or resilience of these deepwater communities and can inform response actions and assessment work.
- **Research to Improve Tools for Assessment and Restoration**—As our understanding of complex ecosystems evolves, it is important that we continually update and refine our techniques to assess and restore injured natural resources. For example, research and tools to better assess and quantify natural resource services—such as water filtration and capture, flood protection, carbon sequestration, recreation, and education—across a range of habitat types, can help ensure that the public is fully compensated and that the environment is fully restored.
- **Research on behavior of surface and subsurface plumes**—The transport of chemical and biological substances, and dilution and transformation thereof is key to determining the concentrations that living marine resources will encounter. This, in turn, determines whether envi-

ronmental impact will be significant or not. Research and development on observing systems and predictive models capable of characterizing plumes will provide much needed capability.

- **Air Quality Impacts**—In addition to its marine responsibilities, NOAA is also responsible for predicting the air-quality impacts from oil and hazardous substance spills in cooperation with the Environmental Protection Agency. The characteristics of pollution released from large areas of burning oil and the widespread evaporation of oil are significantly different from routine atmospheric-dispersion scenarios. Research and development of improved tools to estimate the characteristics of compounds entering the atmosphere, and integration of those tools with NOAA's existing atmospheric modeling capabilities, would significantly improve NOAA's ability to predict smoke and chemical concentrations in the atmosphere resulting from such incidents.
- **Oil in Arctic Environments**—Continued acceleration of sea-ice decline in the Arctic Ocean as a consequence of global warming may lead to increased Arctic maritime transportation and energy exploration that in turn may increase the potential for oil spills occurring in the Arctic. Recent studies, such as the Arctic Monitoring and Assessment Programme's Oil and Gas Assessment, place emphasis on improving our understanding of how oil will behave in icy environments or when it sinks below the surface. Acquiring a basic understanding of the current environmental conditions is important for conducting injury assessments and developing restoration strategies. Research is needed to better understand the challenges of spill response in Arctic waters and the most effective tools and techniques to utilize in such environments. There is also a need to identify site-specific protocols for assessing injuries to the unique, high-value habitats found in the Arctic
- **Human Dimensions**—Research is needed on how to incorporate impacted communities into the preparedness and response processes to help address the human dimensions of spills. Such research would consider social issues, community effects, risk communication methods, and valuation of natural resources. Transparency and communications can be improved to share information with impacted communities on how and why decisions are made and the breadth of response and NRDA activities that have been and will be undertaken for the Deepwater Horizon oil spill.

CONCLUSION

I would like to assure you that NOAA will not relent in our efforts to protect the livelihoods of affected Gulf Coast residents and mitigate the environmental impacts of this spill. In the wake of such an event, we are reminded of the fragility of our coastal ecosystems and the dependence of coastal economies on the health and prosperity of our seas. Thank you for allowing me to testify on NOAA's response, damage assessment efforts, collaboration with other trustees, and areas for future research. I am happy to answer any questions you may have.

Response to questions submitted for the record by David Kennedy, Acting Assistant Administrator, National Ocean Service, National Oceanic and Atmospheric Administration (NOAA)

Questions from Chairwoman Madeline Z. Bordallo (D–GU)

1. What is the status of efforts to map the underwater plumes?

NOAA, federal partners, academics, and others in the research community have mobilized to research and quantify the location and concentration of subsurface oil from the spill. Since the beginning of May, NOAA has been conducting and coordinating sampling of the sub-surface region around the Deepwater Horizon well-head and beyond to characterize the presence of subsurface oil. The sub-surface research involves the use of sonar, UV instruments called fluorometers, which can detect the presence of oil and other biological compounds, and collection of water samples from discrete depths using a series of bottles that can be closed around a discrete water sample.

NOAA ships *Gordon Gunter* and *Thomas Jefferson* have both conducted missions to collect water samples from areas near the wellhead, as well as further from the wellhead and in the coastal zone. Water samples from many of these missions are still being analyzed and additional missions are in progress or being planned to continue the comprehensive effort to define the presence of oil below the surface and understand its impacts.

Water samples taken by researchers on the *R/V Weatherbird II* have also been analyzed for the presence of subsurface oil. The samples from the *R/V Weatherbird II* confirmed low concentrations of surface oil from the Deepwater Horizon oil spill 40 nautical miles northeast of the wellhead. Additionally, hydrocarbons were found in samples 45 nautical miles northeast of the wellhead—at the surface, at 50 meters, and at 400 meters—however, the concentrations were too low to confirm the source.

In accordance with the National Incident Command (NIC) and Environmental Protection Agency (EPA) requirements for the use of subsurface dispersants, BP contracted ships, *R/V Brooks McCall* and the *Ocean Veritas,* have been collecting water samples in the area close to the wellhead. NOAA, EPA, and the White House Office of Science and Technology Policy (OSTP) released a summary report about the subsea monitoring in the vicinity of the Deepwater Horizon wellhead conducted from the *R/V Brooks McCall* from May 8 – 25, 2010. The report confirmed the existence of a previously discovered cloud of diffuse oil at depths of 3,300 to 4,600 feet near the wellhead. Preliminary findings indicate that total petroleum hydrocarbon concentrations at these depths are in concentrations of about 1–2 parts per million. Analysis shows this cloud is most concentrated near the source of the leak and decreases with distance from the wellhead. Beyond six miles from the wellhead, concentrations of this cloud drop to levels that are not detectable. Decreased droplet size is consistent with chemically dispersed oil. Dissolved oxygen levels in the water column are largely what are expected compared with historical data.

The Unified Command has established an inter-agency Joint Analysis Group to aggregate and analyze all the relevant data from the many subsurface oil missions in order to develop a comprehensive picture of the situation. This group is made up of federal scientists from NOAA, EPA, and OSTP.

2. What can NOAA do better to ensure a coordinated, effective, and transparent data collection and research process to better understand and respond to the spill? Are NOAA and other Federal agencies utilizing the data coordination and management framework which was developed as required under the National Integrated Coastal and Ocean Observation System Act?

We believe transparency is important and NOAA is working to share data with the public and scientists. We recognize the public's interest in the federal government's response to this crisis, and we are committed to providing answers with clarity and transparency. NOAA has launched a federal website meant to provide data and information — http://www.geoplatform.gov/gulfresponse/ — a central online location for detailed near real-time information about the response as well as data collection associated with the Natural Resource Damage Assessment. While access to and transparency of data to inform decision making is critical, it is also important that data be provided with appropriate quality assurance and context.

NOAA is providing up-to-date information on its numerous ongoing science missions related to this historic spill at the following website: http://www.noaa.gov/sciencemissions/bpoilspill.html. In addition, NOAA—as a participating member in the Joint Analysis Group (JAG), an interagency panel created to coordinate information about subsurface sampling related to the Deepwater Horizon oil spill—has posted on its website a recently released JAG review of the R/V *Brooks McCall* mission to examine subsurface dispersant use concentrations and distribution of oil (http://www.noaa.gov/sciencemissions/PDFs/JAG__Report__1__BrooksMcCall__Final__June20.pdf).

The data management and communications system envisioned in the Integrated Coastal and Ocean Observation System (ICOOS) Act of 2009 has not been fully implemented. NOAA continues to work to build and sustain this system and NOAA has made incremental progress on this front by engaging the data management community to develop web services that assist with data access and distribution, and continuing to apply this data architecture to meet user needs. Through initial efforts aimed at demonstrating the value of interoperable data, NOAA has built a solid foundation from which to further advance national availability and efficient access to ocean and coastal data.

3. NOAA and the Fish and Wildlife Service are preparing Natural Resource Damage Assessments required under the Oil Pollution Act, in coordination with the States and BP. Neither agency has provided much information on its processes or the information it has gathered to this point. Why does NOAA appear to not be conducting its NRDA process in a transparent manner that incorporates public input and continuously updates the public as new information is gathered? Are the agencies limited under law from revealing information?

NOAA and co-trustees (Department of the Interior and states of TX, LA, MS, AL, and FL) are collecting data across the Gulf of Mexico that will be useful to determine what natural resources have been injured and what human uses have been lost due to the oil spill. Several technical working groups composed of state and federal natural resource trustees and representatives from BP are gathering historical information and developing and implementing baseline (pre-spill) and post-impact field studies for multiple resource categories. Resources being assessed include fish and shellfish, bottom dwelling biota, birds, marine mammals, turtles, and sensitive habitats such as wetlands, submerged aquatic vegetation, beaches, mudflats, deep and shallow corals, and the water column, including bottom sediments. NOAA and the co-trustees are also collecting and reviewing relevant water column, shoreline, wildlife and other data being collected as part of the response and by other entities.

We recognize the public's interest in the federal government's response to this crisis, and we are committed to providing answers with clarity and transparency. NOAA has launched a federal website meant to provide data and information with clarity and transparency —http://www.geoplatform.gov/gulfresponse/— a central online location for detailed near real-time information about the response as well as data collection associated with the Natural Resource Damage Assessment.

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JAG__Report__1__BrooksMcCall__Final__June20.pdf).

4. Under the Coastal Zone Management Act of 1972, coastal States are required to have included in their Federally-approved coastal management plans, a planning process for energy facilities in the coastal zone, including a process for anticipating the management of the impacts resulting from such facilities.

a. Have these planning efforts been adequate to respond to an oil spill of this scale and complexity? How can they be improved?

The Coastal Zone Management Act (CZMA) energy planning process requirement was met by states many years ago and these plans are likely not adequate to respond to oil spills. Some states have amended their CZMA programs over the years to update energy-related enforceable policies, but these too are likely not adequate to respond to major oil spills. State agencies do participate in the development of Area Contingency Plans (ACP) under the Oil Pollution Act of 1990. State CZMA energy plans could be improved by re-evaluating what the plans should include and how the plans should apply to and be coordinated with the ACP process and other federal and state oil spill response activities.

In addition, CZMA § 315(e)(3)(c) makes an allowance for state National Estuarine Research Reserve System (NERRS) agencies to receive Natural Resource Damage Assessment (NRDA) funding without match but there is no analogous requirement for the development of response plans for either the state coastal management energy planning process or for NERRS. Therefore, another improvement would be greater integration of NERRS NRDA activities into state coastal management response planning.

b. Should the Federal government provide additional technical or financial resources to assist coastal States for oil spill planning, logistics, response, and recovery?

Response planning and coordination is accomplished at the federal level through the U.S. National Response Team (NRT), an interagency group responsible for three major activities related to managing responses: (1) information distribution; (2) emergency planning; and (3) emergency training. The NRT also supports the Regional Response Teams. There are thirteen Regional Response Teams (RRTs) in the

U.S., each representing a particular geographic region (including the Caribbean and the Pacific Basin). RRTs are composed of representatives from field offices of the federal agencies that make up the National Response Team, including NOAA, U.S. Coast Guard, and the Environmental Protection Agency, as well as state representatives. The Deepwater Horizon oil spill has highlighted the longstanding need for more comprehensive preparedness strategies, training programs, and oil spill research and development. A strong state and federal partnership under the RRTs would help to ensure that federal and state agencies are exchanging information to plan for emergencies and conducting the proper training to prepare for future events.

It is also important to note that a coastal community's ability to prepare for and withstand impacts of an event like the Deepwater Horizon oil spill can be critical to the efficacy of long-term ecological and socio-economic recovery efforts. NOAA stands ready to work directly with the States and fishing communities if and when there are Congressional appropriations to address the disasters as determined by the Secretary in April.

Questions from Ranking Republican Member Henry Brown, Jr. (R–SC)

1. Can you provide the Committee with a breakout on how NOAA used appropriated $6.6 million funds for the line item NOAA ocean observation systems?

The FY 2010 appropriation includes $21 million total for IOOS activities. This includes $14.5 million to develop the regional component of IOOS (IOOS – Regional Observations) through competitively awarded grants and cooperative agreements. The $6.5 million was appropriated to guide development of the national network (NOAA IOOS, also referred to as U.S. IOOS). U.S. IOOS is a national integrated system of ocean, coastal, and Great Lakes observing systems to address regional and national needs for ocean information, gather specific data on key coastal, ocean, and Great Lakes variables, and to ensure timely and sustained dissemination and availability of these data. As a collaboration of existing national and regional entities working together, IOOS will improve coordination of observation strategies and systems, identify gaps in the Nation's ocean observing capacity, and facilitate the exchange of information to help decision makers address pressing policy issues. As the lead federal agency for implementing IOOS, NOAA is developing the national partnership of 17 federal partners, 11 Regional Associations and Regional Coastal Ocean Observing Systems, and a validation and verification testing capability with a shared responsibility for the design, operation, and improvement of both the national and regional network of observations linking marine data in a compatible and easy-to use manner by the wide variety of U.S. IOOS customers.

Budget Summary (Dollars in Thousands):

Line Item Name	FY08 Enacted	FY09 Enacted	FY10 Base	FY10 Program Change	FY10 Request
IOOS Regional Observations	$0	$20,000	$14,555	$0	$14,555
NOAA IOOS	$0	$6,500	$6,555	$0	$6,555
Integrated Ocean Observing System	$26,360	$0	$0	$0	$0
Alliance for Coastal Technologies	$940	$1,000	$0	$0	$0
TOTAL	$27,300	$27,500	$21,110	$0	$21,110

In FY 2010, Congress appropriated funding to be used for:

- $2.85 million for U.S. IOOS Data Management and Communications
- $2.54 million for IOOS Program Operations and Management
- $0.73 million for Regional and External Affairs
- $0.44 million for IOOS Technical Support Contracts

2. You mentioned at the hearing that there was a budget anomaly with regard to the ocean observation line item. Specifically, that the budget was stable even though the budget document showed a decline. Can you provide further information to clarify your comments?

To clarify, from a funding perspective, regional observing capacities were developed primarily with congressionally directed funding until FY 2007. With the omnibus appropriation in FY 2007, NOAA initiated a competitive funding process and funded each of the 11 Regional Integrated Ocean Observing System (IOOS) partners. Beginning with the FY 2008 President's Request, funding was requested for Regional Observations and for national capacities, like data management, that benefit the entire system. The FY 2008 President's Request included $11.5 million for

Regional Observations and $2.5 million for data management and national capacities. The FY 2009 President's Request for these two elements included $14.5 million and $6.5 million, respectively, and has remained stable at about these amounts, with small increases for adjustments to base. The FY 2011 President's Request increases support across NOAA's programs for ocean observations with an additional $10 million to develop ocean sensor technology, $3 million for Arctic Watch, $4.8 million for the Global Ocean Observing System, and $20 million in the form of grants to support regional ocean partnerships and coastal and marine spatial plans. Advancing the collection and integration of coastal data is central to developing well-informed and comprehensive coastal and marine spatial plans.

Budget Summary (Dollars in Thousands):

Line Item Name	FY08 Request	FY08 Enacted	FY09 Request	FY09 Enacted	FY10 Request *	FY10 Enacted
IOOS Regional Observations	$11,500		$14,555	**$20,000**	$14,555	**$20,000**
NOAA IOOS	$2,500		$6,555	**$6,500**	$6,555	**$6,555**
Integrated Ocean Observing System		**$26,360**				
Sensor Verification and Validation						**$3,000**
Super Regional Modeling Testbed						**$4,000**
Alliance for Coastal Technologies		**$940**		**$1,000**		**500**
Northeast Coastal Monitoring Collaborative						**550**
TOTAL	$14,000	**$27,300**	$21,110	**$27,500**	$21,110	**$34,605**

*Note: The FY 2011 President's Request includes $21.1 million for IOOS activities.

3. It seems as if a lot of NOAA's efforts early after the spill were to gather base-line data on water quality, seafood quality, and the status natural resources. Why was so much effort necessary to gather this data? Was there no base-line data available for the region?

NOAA and co-trustees have collected and continue to collect data in the Gulf and across the five states. These data will be used to determine what natural resources have been injured and what human uses have been lost due to the spill. Several technical working groups comprising NOAA, federal and state co-trustees, and representatives from one responsible party (BP) are gathering existing scientific information and developing and implementing baseline (pre-spill impact) and post-impact field studies for multiple resource categories. Hundreds of miles of coastal shoreline were surveyed by air and samples were taken to determine baseline conditions prior to the oil hitting land, and to identify where the oil has made landfall to support clean-up activities. Resources being assessed include fish and shellfish, bottom-dwelling plant and animal life, birds, marine mammals, turtles, and sensitive habitats such as wetlands, submerged aquatic vegetation or seagrasses, beaches, mudflats, bottom sediments, deep and shallow corals, chemosynthetic organisms, and the water column. Some of these resources may be included within National Estuarine Research Reserves and National Marine Sanctuaries. In addition, NOAA and co-trustee field teams are determining how human uses, including cultural uses, and natural resource services are being impacted.

NOAA has historical base-line data sets on water quality, fisheries, and other resources in the Gulf of Mexico such as fisheries assemblages, water quality data and sediment data from long-term monitoring sites, and satellite and hydrographic survey data. Another baseline data set is collaborative research between NOAA and the Department of the Interior (DOI), collected over the past several years and focused on locating and characterizing deep water communities along the West Florida Shelf and the northern Gulf of Mexico shelf break. This information is being used to understand how these habitats are being affected by the Deepwater Horizon spill. Given the spatial extent of this spill and the biological diversity of the Gulf of Mexico, NOAA is working closely with other federal agencies and academic partners to gather existing historical base-line information and pre- and post-spill data for the Natural Resource Damage Assessment.

4. Is there any base-line data available on the Gulf's deepwater ecology to understand the impact, if any, of the subsurface dispersants used for the Deepwater Horizon spill?

Prior to the spill, NOAA, in collaboration with the Department of the Interior (DOI), had an on-going study that began in 2008 at deep *Lophelia* coral sites (approximately 300–500m deep and 30 miles north of the spill site) in the Gulf. This study, entitled *Lophelia* II, produced invaluable baseline data, ranging from photos and videos of the coral ecosystem to sediment samples and water quality properties.

Elsewhere in the Gulf, studies from selected mesophotic coral ecosystems, low light environment around 100 meters deep, and deep chemosynthetic ecosystems, including tube worms and mussels that grow on methane seeps, have been conducted within the last decade. Overall, the geographic coverage of baseline studies is patchy.

With the available baseline data, NOAA and other agencies, including DOI, developed a natural resource damage assessment work plan to visit selected sites using a NOAA research vessel equipped with a remotely operated vehicle to determine the current coral conditions and compare with pre-spill data.

5. How many grants has NOAA awarded to monitor the impact of the oil spill on Louisiana's coastal marshes? What is the cost of those grants and who are the recipients of this Sea Grant money?

NOAA Sea Grant awarded a total of $100,000 to Louisiana Sea Grant to be invested in rapid response research projects. Louisiana Sea Grant set aside $50,000 from the 2010–2012 Omnibus Grant (Program Development funds), and that amount was supplemented with an additional $50,000 from an incident special rapid response grant made available by NOAA Sea Grant to each of the four Gulf Coast Sea Grant Programs (TX, LA, MS–AL, and FL).

The funds are supporting ten research projects in Louisiana, as follows:

	Principal Investigator	Institution	Project Description	Amount
1	Caroline Taylor	Tulane	Deepwater Horizon Oil Spill Effects on Blue Crab Recruitment	$10,000
2	Laurie Anderson	LSU	Changes in coastal food webs caused by the Deepwater Horizon crude oil spill: responses by and effects on oysters and other primary consumers	$9,000
3	Ralph Portier	LSU	Microbial species & community structure as indicators of oil spill recovery & restoration: Initial Investigations	$8,800
4	Martin O'Connell	UNO	Assessing oil spill impacts on juvenile fishes, crabs, and shrimp at the Chandeleur Islands: a comparison to baseline data	$10,000
5	Kim de Mutsert	LSU	Effects of the Deepwater Horizon oil spill on growth and mortality of *Farfantepenaeus aztecus* (Ives, 1891) and *Callinectes sapidus* (Rathbun, 1896) in an affected Louisiana estuary.	$10,000
6	Kenneth Brown	LSU	Rapid assessment of the impact of the Deepwater Horizon oil spill on Louisiana oyster reefs	$10,000
7	Qianxin Lin	LSU	Evaluation of Potential Impacts of Oil Spill from the Accident of the BP Deepwater Horizon Rig on the Vegetation of Louisiana Coastal Wetlands	$9,825
8	Sophie Warny	LSU	Quantifying the effects of crude oil on the base of the food web by analyzing the evolution of phytoplankton population pre and post Deepwater Horizon oil spill event.	$10,000
9	Donald Baltz	LSU	Short-term Oil Spill Effects on Marsh-edge Fishes and Decapod Crustaceans: Deepwater Horizon Event	$9,838
10	William Stickle	LSU	The impact of PAH's from the Deepwater Horizon Crude Oil Spill on the Eastern Oyster *Crassostrea virginica*	$10,000

6. What type of outside help has the agency asked for to respond to the oil spill? Has the agency released any funding for scientists to get involved with answering questions regarding the impact of the oil on the Gulf of Mexico environment?

The lives of Gulf of Mexico coastal residents have been disrupted and many have lost jobs and income. Additional adverse effects are likely to include the threat of widespread damage to the ecosystem and the fisheries. The Gulf Coast Sea Grant Programs, with the full support of the remaining 28 members of the Sea Grant Network, are working to serve their communities and constituents. Given NOAA Sea Grant's place-based infrastructure and long-term relationships with coastal stakeholders, NOAA is working with a broad array of stakeholders including fishermen and the seafood industry. All four Gulf programs are currently working with affected residents to help them deal with loss of jobs, income, and the uncertainty about what lies ahead.

NOAA Sea Grant has released an additional $200,000 to the four Gulf Coast Sea Grant programs to support time-sensitive, state-specific or regional research, extension and communications projects. Louisiana Sea Grant used its $50,000 for rapid response scientific research (see reply to Question 5 above), while Florida Sea Grant immediately invested $34,000 of its $50,000 to conduct similar pre-impact studies. The $16,000 Florida balance will be used to fund additional research and/or extension and communication efforts related to the Deepwater Horizon oil spill. The Texas and Mississippi-Alabama Sea Grant programs have used $50,000 each for outreach and education projects ranging from public community forums to seafood sensory training programs.

NOAA, federal partners, academics, and others in the research community have mobilized to research and quantify the location and concentration of subsurface oil from the spill. NOAA ships *Gordon Gunter, Thomas Jefferson, Nancy Foster, Delaware II, and Pisces* have conducted and continue to conduct missions to collect water samples from areas near the wellhead, as well as further from the wellhead and in the coastal zone. Water samples from many of these missions are still being analyzed and additional missions are in progress or being planned to continue the comprehensive effort to define the presence of oil below the surface and understand its impacts.

In addition, NOAA continues to work with the Department of the Interior to prepare for an expedition in the Gulf to locate, map, and investigate deep water habitats. NOAA also worked with partners from our Cooperative Institute for Ocean Exploration, Research, and Technology (which includes the Harbor Branch Oceanographic Institute, Florida Atlantic University, and the University of North Carolina Wilmington) to secure the services of the *R/V Seward Johnson* and Johnson Sea-Link submersible to conduct habitat investigations. NOAA has worked with the Cooperative Institute for Ocean Exploration, Research, and Technology and partners at the National Institute for Undersea Science and Technology to redirect previously funded projects to focus on spill-related issues.

7. Has NOAA used any of its contractors to collect air quality or hydrographic survey data? If not, why?

Yes. NOAA used some contractors to aid its work in collecting air quality survey data. Two examples are:

- Contract staff participated in NOAA's efforts in modeling local and regional air quality impacts from the spill to determine impacts of evaporative and pyrogenic emissions on regional air quality and to assess the spill's impact on regional levels of atmospheric mercury.
- In early June, NOAA diverted its WP–3D flying laboratory from California to the Gulf of Mexico. Several contract staff participated in this study. This research aircraft flew two missions over the Gulf in close proximity and downwind from the spill site on June 8 and 10 to characterize the air quality in the region. The data collected, and NOAA's interpretations, are being shared with the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) who have responsibility for assessing impacts from the oil spill on the workers in the Gulf and the public ashore.

NOAA is working with Professor Donald Blake from the University of California-Irvine to collect additional air samples on the surface near the spill site to help characterize the impacts on air quality. These samples are being collected on the NOAA ship *R/V Thomas Jefferson,* which is operating near the spill site. The samples will be analyzed, with National Science Foundation funding, for atmospheric hydrocarbon concentrations at Professor Blake's laboratory in California. NOAA will work with EPA and OSHA on the interpretation of these data as they are received.

NOAA has not conducted any hydrographic surveys as part of the Deepwater Horizon oil spill response efforts. The Navy did conduct a side scan sonar survey to ensure a new anchorage at the Mississippi River entrance was safe for maritime traffic. As part of the Navy survey, NOAA contracted with C&C Technologies to provide magnetometer equipment and operators for the survey.

8. You mention that regional Gulf of Mexico and Southeast Coastal ocean observing systems each have 3 high-frequency radars that are providing valuable information on the spill. What specific information are they providing?

High frequency (HF) radars provide surface current velocity data over hundreds of square kilometers on an hourly basis and with spatial resolutions that vary from about 1 to 6 km. These data are extremely valuable because oil at the surface is moved by the ocean surface currents and winds. HF radar is the only instrument that can provide these large-scale maps of currents with this level of temporal and spatial resolution. Some satellite-borne altimeters can provide ocean currents but those measurements only capture a portion of the ocean current (the geostrophic component), not the complete surface current and only at much coarser spatial (large gaps between overflights) and temporal resolutions (days apart). During the Deepwater Horizon oil spill, the HF radar data has been successfully used continuously by NOAA's Office of Response and Restoration in their models that predict the flow of the surface oil.

9. Are the regional ocean observation systems providing all of the necessary data to respond to the spill or has the agency determined that there is data not currently collected that should be included in the regional collection systems?

Within the region covered by the Gulf of Mexico regional ocean observing system, there are no high frequency (HF) radars located west of the Mississippi Delta. Hence, no surface current velocity data maps can be made available for oil spill trajectory forecasts for most of the coast of Louisiana and none of the Texas coast. Those regions have to rely on forecasts based on data from buoys. For several years in the past, HF radars had been successfully deployed and operated along the Texas coast by Texas A&M University as an oil spill research activity sponsored by the State of Texas General Land Office (TGLO), but were removed at Texas A&M's discretion when TGLO discontinued funding support for those activities. The Gulf of Mexico Coastal Ocean Observing System has been focusing its limited resources on data management services in order to provide access to existing data sources in the Gulf of Mexico and improving data integration and access capabilities consistent with national Integrated Ocean Observing System (IOOS) data management priorities.

In the Southeast regional ocean observing system, there are significant gaps in HF radar coverage as well, especially along the east coast of Florida and along most of the South Carolina and North Carolina coasts. Historically, funding for HF radar systems has been a leveraged capacity, where the initial acquisition and deployment was funded by states or academic research grants. With the Regional IOOS funds, most regions have prioritized maintenance of existing HF radar capacity rather than expanding the network beyond sustainable levels by acquiring new radars to fill gaps.

Underwater gliders using onboard instrumentation to assist with detecting the presence of oil below the sea surface have been deployed by several organizations during the Deepwater Horizon oil spill. These gliders cover large areas providing three-dimensional surveys of the ocean water column. While they are not a complete substitute for shipboard measurements, the gliders contribute valuable, low-cost datasets of temperature, salinity, and currents that are used to develop a more complete picture of the subsurface spill effects. Most of the gliders being used to assess the Deepwater Horizon oil spill are not owned by the regional observing systems in the spill region but, instead, were loaned by partners within other regional observing systems (Mid-Atlantic region, Northwest region, Southern California region) and the U.S. Navy. Only four of the ten gliders deployed are owned by Gulf of Mexico and Southeast regional partners.

The Unified Command has employed a variety of observing assets such as remotely sensed imagery, airborne imagery, existing buoy and gauges, ships, and autonomous vehicles. Many of these assets were brought in from outside the Gulf of Mexico and do not permanently exist within the region. Because we cannot predict where a spill will occur, data delivery from high frequency radars is envisioned to be part of a seamless national system that will ensure information 24/7. As the Integrated Ocean Observing System generates more data from technological advances

like HF radar, the prediction of oil location can be improved by pulling these observations into trajectory models in real time.

10. Has NOAA organized any volunteer beach clean-ups of tar balls? What type of protective clothing are you providing to volunteers?

Beach cleanups of tar balls are being coordinated by the Unified Command and by trained workers. NOAA is not coordinating cleanups of oiled coastline. However, the Weeks Bay National Estuarine Research Reserve in Alabama did organize several pre-oil impact beach cleanups to remove marine debris prior to fouling in an effort to ease cleanup post-impact.

11. On Page 3, you note that: "If a spill does occur, responders must be equipped with the appropriate tools and information". It is now Day 57 since the explosion of the Deepwater Horizon; can anyone legitimately say that responders were adequately prepared prior to the spill? Why were they so ill-prepared?

The data management and communications system envisioned in the Integrated Coastal and Ocean Observation System (ICOOS) Act of 2009 has not been fully implemented. NOAA continues to work to build and sustain this system and NOAA has made incremental progress on this front by engaging the data management community to develop web services that assist with data access and distribution, and continuing to apply this data architecture to meet user needs.

A spill of the scale of the Deepwater Horizon oil spill comes with high environmental and financial consequences. Continued use of science, through a robust research and development program, can improve the effectiveness of spill response efforts, habitat restoration, and mitigate of effects.

It is important to ensure that robust research and development efforts continue between spills so additional tools and greater understanding can be developed before the next spill. Applying the latest science and continuing research and development can improve our response decisions, thereby reducing the severity of oil spill injuries to our Nation's economy and environment.

12. What has been NOAA's position on Governor Bobby Jindal's proposal to build temporary berms to protect wetlands? Do you support or oppose efforts to increase the number of approved berms?

NOAA works closely with the state of Louisiana and the federal agencies responsible for reviewing and approving proposals to minimize the effects of oil on natural resources. As part of that process, the state and federal resource agencies provided suggestions and recommendations on the merits of the proposed measures. Unlike the barrier island berm projects approved for six segments in eastern and southern Louisiana, the proposal to build three berms in western Louisiana was determined to be very likely to create more problems than would be solved. Because of higher tidal energy, it is unlikely the berms proposed for construction in the Isles Dernieres would provide significant protection for wetlands from oiling; at the same time, adverse effects to the ecosystem would likely result from the moving and placement of sand on those three islands. Other unintended consequences of the project would likely have led to increased erosion of existing barrier islands and induced breaching of barrier islands in places where they are especially vulnerable to currents and over-wash. NOAA has long been supportive of the restoration of Louisiana's coastal ecosystem, particularly barrier islands, and believes that barrier islands are a critical component of a long-term restoration strategy.

13. Why is our nation's existing capacity to deliver an accurate depiction of subsurface movement limited? Is it a lack of resources or expertise?

From its inception, NOAA has been largely tasked with providing detailed information about weather, fisheries, and oceanography. The subsurface plume most notably associated with the Deepwater Horizon oil spill is at greater than 1000m, well below the depths that are of significant interest for weather prediction, hurricane forecasts, and fisheries research. However, NOAA has emphasized the need for complete three-dimensional data collection to improve subsurface oil modeling and to increase deep ocean observations.

As the Deepwater Horizon oil spill is demonstrating, there is a need to enhance three-dimensional models to better understand how oil behaves and disperses within the water column when released at deep depths. This is an emerging advancement in modeling that can greatly enhance response operations and mitigation efficacy. The FY 2010 President's Budget included $1.4 million for NOAA's Office of Response and Restoration to develop tools and techniques related to response and natural resource damage assessment with a strong focus on building and maintaining state-of-the-art three-dimensional models to predict contaminant movement in the

environment. As this is the first year funding has been provided for these specific activities, implementation is currently underway.

14. What lessons did NOAA learn from the Ixtoc I deepwater oil spill in 1979 and the explosion of the Mega Borg off the coast of Galveston, Texas in 1990?

The Ixtoc I and the Mega Borg were both large oil spills in the Gulf of Mexico. The Ixtoc was a wellhead blowout that resulted in the release of 145 million gallons of oil. The Mega Borg was a release of approximately 5 million gallons from a vessel.

Partly in response to these events, NOAA established a dedicated office to focus on such environmental disasters. As a component of NOAA, the Office of Response and Restoration can draw upon a significant range of expertise today, compared to 20 and 40 years ago. The current response to the Deepwater Horizon oil spill has drawn expertise from all NOAA line offices and the agency is fully mobilized. The response to Ixtoc I was limited and took months compared to a full mobilization of NOAA resources within a matter of weeks.

15. How much research has NOAA conducted on the use of dispersants on spilled oil in subsurface conditions? Has NOAA funded any University research on the use of dispersants?

Research on the effectiveness and effects of dispersants and dispersed oil have been underway for more than three decades but important gaps still exist. Much of what we have learned from both research and real world experience is presented in detail in the 2005 National Research Council (NRC) book *Oil Spill Dispersants: Efficacy and Effects.* The NRC identified gaps in our knowledge. These gaps were narrowed by research and development activities carried out through projects conducted by the Coastal Response Research Center (CRRC) at the University of New Hampshire, state and federal agencies, and other academic institutions. NOAA provided funds for the CRRC, a successful joint partnership established in FY 2004 between the University of New Hampshire and NOAA's Office of Response and Restoration, from FY 2004–FY 2007. NOAA and CRRC examined the toxicity and long-term effects of dispersants and dispersed oil on sensitive marine life.

16. Has NOAA voiced any objections or concerns with regard to the fact that we know virtually nothing about the short-term or long-term impacts of dispersants on your trust resources?

When an oil spill occurs, there are no good outcomes. Once oil has spilled, responders use a variety of oil spill countermeasures to reduce the adverse effects of spilled oil on the environment. The goal of the Unified Command is to minimize the environmental damage and speed recovery of injured resources. The overall response strategy to accomplish this goal is to maximize recovery and removal of the oil being released while minimizing any additional damage that might be caused by the response itself. This philosophy involves making difficult decisions, often seeking the best way forward among imperfect options.

The use of dispersants is an environmental trade-off between impacts within the water column, on the sea surface (birds, mammals, and turtles in slicks), and on the shore. For the Deepwater Horizon oil spill, the Unified Command's response posture has been to fight the spill offshore and reduce the amount of oil that comes ashore, using a variety of countermeasures including subsurface recovery, booming, skimming, burning, and dispersants. Dispersants have reduced the amount of oil impacting the shorelines.

Dispersants are applied directly to the spilled oil in order to remove it from the water surface by dispersing it into the upper layer of the water column. Once applied at the surface, dispersants help break up the oil into tiny droplets (20–100 microns across; a micron is the size of the cross section of a hair) which mix into the upper layer of the ocean. Dispersed oil does not sink; rather it forms a "plume" or "cloud" of oil droplets just below the water surface. The dispersed oil mixes vertically and horizontally into the water column and is diluted. Bacteria and other microscopic organisms then act to degrade the oil within the droplets more quickly than if the oil had not been chemically dispersed. Smaller oil droplets have larger relative surface area, which allows for higher than normal rates of biodegradation or dissolution of the oil droplet. It should be noted that oil spilled from the Deepwater Horizon oil spill is also naturally dispersing into the water column due to the physical agitation of the wind, waves, and vessel operations.

17. Which agency is responsible for making the call that Corexit 9500 and not a more benign dispersant would be extensively used in the Gulf?

The United States Coast Guard, as the Federal On-Scene Coordinator in the Gulf spill response, in consultation with EPA, DOI, NOAA, and the State of Louisiana,

authorized BP to apply dispersants on the water surface to mitigate the shoreline impacts on fisheries, nurseries, wetlands and other sensitive environments. Under the National Contingency Plan (NCP), the Environmental Protection Agency (EPA) is responsible for maintaining the NCP Product Schedule, the approved the list of dispersants and other chemicals and products that can be used in an oil spill response; Corexit 9500 was on the list of approved dispersants prior to the Deepwater Horizon oil spill.

18. Do you agree with the statement of Ms. Lee that NOAA has "Never collected a systematic and thorough compendium of known toxic effects for the various species? Why is this the case?

NOAA's responsibilities in the coastal and ocean environment are articulated through a number of laws. NOAA does not have a specific mandate to collect "a systematic and thorough compendium of known toxic effects for various species."

However, NOAA has directly conducted or sponsored numerous systematic, long-term monitoring studies thoroughly analyzing the toxic effects of contaminants, such as spilled petroleum, on endemic coastal and marine species in the Gulf of Mexico. For example, since 1986, the NOAA Mussel Watch program has managed the longest running estuarine and coastal pollutant monitoring effort conducted in the United States, including more than 100 sites from Texas to South Florida. At each site, more than 140 chemical contaminants, chosen through consultation with experts and scientists from academia and government, are measured and have served as a baseline for hundreds of scientific journal articles and technical reports since the program's inception. In response to the Deepwater Horizon oil spill, three teams of NOAA scientists and partners were mobilized to the Gulf to collect oyster, sediment, and water samples in advance of oiling in coastal Louisiana, Mississippi, Alabama, and Florida; thus, providing valuable pre-spill contaminant data and continuing the unbroken quarter-century record of the status and trends of chemical contaminants in the Gulf of Mexico.

Given the spatial extent of this spill and the biological diversity of the Gulf of Mexico, NOAA is working closely with other federal agencies and academic partners to gather existing historical base-line information and pre- and post-spill data for the Natural Resource Damage Assessment.

Ms. BORDALLO. Thank you, Mr. Kennedy, for your insight on NOAA's response capacity and capabilities. Dr. McNutt, please proceed with your testimony.

STATEMENT OF MARCIA McNUTT, PH.D., DIRECTOR, U.S. GEOLOGICAL SURVEY

Dr. MCNUTT. Good morning, Chairwoman Bordallo and members of the Subcommittee. I am Marcia McNutt, Director of the U.S. Geological Survey and Science Advisor to the Secretary of the Interior. Today, I am joined by Jeff Underwood, who is sitting directly behind me, Acting Director of the U.S. Fish and Wildlife Service.

Before I begin, I would also like to extend my sympathies to the families of those who lost their lives in the explosion and the sinking of the *Deepwater Horizon*, to those who are injured, and to those whose way of life has been changed for years to come, as my life has also changed since this tragedy began to unfold, as I have been consumed 17 hours a day, 7 days a week in my work schedule, focused on this tragedy.

I want to thank you for the opportunity to discuss the importance of data and analysis about the complex estuarine, coastal, and marine environments of the Gulf. Accurate scientific information is essential for effectively targeting response activities and for assessing damage to the natural resources in the aftermath of this oil spill. The greatest challenge in characterizing the fate and transport of contamination resulting from the flow of oil and gas from the *Deepwater Horizon* site lies in a combination of factors:

the volume of the oil; the expanse of air, sea, and land into which it flows; and the biodiversity of the ecosystems that it is impacting.

The first step is to document the amount of oil and create an improved mass balance of the various natural and anthropogenic sinks in the deep sea and at the ocean surface as a function of time since the spill began. Next, we must understand the physical processes that control the movement of contaminants from the open ocean into the coastal zone. Oil and oil dispersant mixtures will be a source of contamination to coastlines and the seafloor for a long time, and will be transported long distances by surface and subsurface currents.

A complete understanding of the preexisting condition of the water, sediment, and biota is vital to any scientific investigation of the effects of an oil spill on the environment. The USGS science centers in the Gulf region have coordinated efforts to sample material from coastal wetlands, DOI lands onshore, and the barrier islands most likely to be impacted. The long-term impact of the *Deepwater Horizon* oil spill on the northern Gulf and other coastal systems will depend on how the oil and oil degradation products are incorporated and cycled among the various components of the coastal system.

A wide range of data and analyses will be needed over the coming months and years, including chemical signatures of oil and dispersant; estimates of volume of oil released; visual and meteorological records of surface conditions and the surface slick; landfall data, including dates, locations, estimated volumes, and characteristics of the oil and tar.

The department's natural resource damage assessment and restoration program allows DOI agencies with trust responsibilities to document injury to natural resources as a result of oil spills or hazardous substances releases, assess damages, and restore those injured resources. Currently, USGS scientists are providing scientific support to DOI and NOAA programs on more than a dozen technical workgroups, investigating topics that range from aerial imagery to deepwater corals to data management to terrestrial and aquatic species.

While current USGS efforts are focused on response to the oil spill, USGS managers and scientists are also planning for future research needs associated with the spill. The team, which includes personnel from Fish and Wildlife Service, the National Parks Service, and MMS, is developing a long-term science plan designed to address the research needs as we move from an immediate response to a more mature response phase of this event and into recovery.

Lessons learned from the *Exxon Valdez* oil spill suggest that a long-term—on the order of decades—multi-level ecosystem perspective will be essential. Therefore, we recommend that studies include investigations at the landscape level, as well as those that are localized and include process-based research. Impacts of the oil spill to communities and ecosystems will be far-reaching and long-term throughout the Gulf of Mexico, where many coastal communities depend on ecosystem services for their livelihood, quality of life, and protection from natural hazards.

Information on these impacts on economic activities, demographics, ecosystem services, as well as options for adaptation, resilience planning, are needed to help communities try to regain pre-spill productivity and social well-being.

In conclusion, the impacts of disasters such as this must be considered in the time frame not of weeks and months, but of years to decades. Oil can remain toxic in the environment over the long-term, and its chronic harmful effects will impact the interconnected systems and communities of living things, including people, throughout the Gulf region. The USGS will continue to work closely with other Department of the Interior and other Federal and state agencies, as well as the private sector, in response to this spill.

Thank you for the opportunity to testify today, and I am pleased to answer questions.

[The prepared statement of Dr. McNutt follows:]

Statement of Marcia K. McNutt, Director,
U.S. Geological Survey, U.S. Department of the Interior

Good morning, Chairwoman Bordallo and Members of the Subcommittee. I am Marcia McNutt, Director of the U.S. Geological Survey and Science Advisor to the Secretary of the Interior. The Department of the Interior and its bureaus have responsibility for a spectrum of natural resources in the Gulf that may be impacted by the oil spill, including 35 National Wildlife Refuges and 10 National Park units, migratory birds, and threatened and endangered species, such as manatees, and sea turtles.

Before I begin, I would like to extend my sympathies to the families of those who lost their lives in the explosion and sinking of the Deepwater Horizon, to those who were injured, and to those whose way of life has been changed for years to come.

The impacts of a disaster such as this must be considered in the time frame of not weeks and months, but of years to decades. Oil can remain toxic in the environment over long periods, and it has chronic harmful effects that will impact the interconnected systems and communities of living things—including people—throughout the Gulf region for many years.

The USGS is home to a breadth of multidisciplinary science expertise, an extensive, national, on-the-ground presence, and a wealth of biologic, geologic, geographic, and hydrologic monitoring capabilities and existing data, in scales ranging from microscopic to global. Long-term monitoring capabilities have positioned the USGS to understand changes in the environment – from water quality to ecosystem structure and function to land cover. This broad capacity, combined with a presence in all 50 States and Puerto Rico, enables the USGS to bring science immediately to bear not only on natural hazards such as earthquakes, floods, and volcanoes but also on environmental hazards. For more than a century, the USGS has been on point in response to natural disasters; this experience and expertise have uniquely prepared the USGS for dealing efficiently and effectively with the challenge that lies before us today and the challenges that will face our Nation in the weeks, years, and decades to come.

Thank you for the opportunity to discuss the importance of data and analysis about the complex estuarine, coastal, and marine environments of the Gulf. This kind of scientific information is essential for effectively targeting response activities, such as determining the volume of the spill as well as providing information useful for mapping. The USGS will work closely with other DOI agencies, such as the U.S. Fish and Wildlife Service (FWS) and the National Park Service (NPS), as well as National Oceanic and Atmospheric Administration (NOAA), the states, and affected tribes to provide scientific information necessary to conduct damage assessment and restoration activities.

EXISTING DATA GAPS

The greatest challenge in characterizing the fate and transport of contamination resulting from the flow of oil and gas from the Deepwater Horizon drilling site lies in a combination of factors: the volume of oil, the expanse of sea, air and land into which it flows, and the biodiversity of the ecosystems that it is impacting.

The first step is to document and understand the physical processes that control the movement of contaminants from the open ocean into the coastal zone. Both surface and submerged oil and oil-dispersant mixtures will be a source of contamination to coastlines and the sea floor for a prolonged period of time and may be transported long distances by surface and subsurface currents. The goals of dispersing oil are to make oil more readily processed by organisms that can break it down and to enhance dilution to reduce the toxicity of oil. In order to understand the long-term extent and impact, predictions are needed to determine where and when new coastal and sea exposures are expected. Remobilization of stranded oil or surfacing of submerged oil may occur during hurricanes; forecast models of storm impacts and oil transport will be needed to identify the worst case scenarios and help prioritize cleanup and protection efforts.

The coastal zone is a dynamic system at the land/sea interface. The individual components of the system – including the continental shelf, deep and shallow coral reefs, barrier islands, beaches, bays, estuaries, and marshes – are interconnected and influence each other. The barrier islands of Louisiana, Mississippi and Alabama are an especially dynamic component of the coastal zone in the northern Gulf of Mexico and are critical to the health and function of the entire system. The barrier islands provide a defense against waves, currents, and storm surge for estuaries and wetlands. They also contain important habitat types, such as beach, dune, barrier flats, back-barrier saline marsh, and intertidal flats that are used by a variety of plants and animals including migratory birds. The physical presence of the barrier islands and locations of inlets influence salinity of waters behind them and, in combination with associated wetlands, help maintain water quality. The components of the coastal system are constantly changing due to the movement of sediment (deposition and erosion) driven by action of winds, currents, waves, and storms. Comparative shoreline studies by the USGS and others of the Louisiana coast over the past century show high rates of retreat, land loss and movement of barrier islands at widely different rates, resulting in 13 feet or more of shoreline retreat per year. In the past decade, a number of devastating hurricanes have severely damaged the barrier islands of the northern Gulf, further reducing their effectiveness in mitigating the impacts of storm surge, waves, and, now, oil spills to the mainland.

The long-term impact of the Deepwater Horizon oil spill on the northern Gulf and other coastal systems will depend on how the oil and oil degradation products are incorporated and cycled among the various components of the coastal system. A wide range of data and analyses will be needed in the short-term as well as the coming months and years to fully understand the extent and trajectory of the oil from the spill:

- Detailed characterization of the extent, concentrations, and chemical signatures of source oil and dispersant;
- Information on migratory birds and other fish and wildlife that might enter an oiled area; this information may be used to help deter species away from oiled areas as well as to prioritize clean up actions;
- Detailed organic component analysis of samples taken across a range of locations and time frames, to develop compound-specific information about dispersal, dissolution into water-soluble forms, settlement onto sediments or surface soils, and eventual degradation by microbes;
- Data for describing attenuation and biodegradation/mineralization/photo-oxidation of the oil over time and space;
- Better accounting for the oil in space and time in the subsurface;
- Visual and meteorological records of surface conditions and the surface slick; and
- Landfall data—dates, locations, estimated volumes/mass, and characteristics of the oil and tar.

Using a variety of techniques, a group of federal scientists, independent experts, and representatives from universities around the country are participating in the Flow Rate Technical Group (Group) to estimate the volume of oil resulting from the Deepwater Horizon oil spill. We are continuing to analyze data and refine the estimates including an evaluation of the flow rate after the riser was cut.

The USGS and other Federal agencies are providing support to the NOAA, which has the primary responsibility for mapping the extent and trajectories of oceanic oil plumes. For example, NOAA and MMS are working together to drop sensors to map the extent of oil plumes. The USGS is collecting baseline data along the coastline, developing maps that show NOAA projections of spill trajectory with respect to DOI lands, and developing models that depict how local tidal and current conditions will interact with seafloor bathymetry to carry oil over barrier islands. We have worked with the National Aeronautics and Space Administration (NASA) to provide a combination of satellite and airborne imagery to assist NOAA in forecasting the trajec-

tory of the oil and to document oil impacts on the coastal and nearshore ecosystem and are collecting satellite imagery to assess the impact on coastal wetlands.

PRE- AND POST-IMPACT SPILL DATA

Important to any scientific investigation of the effects of an oil spill on the environment is a complete understanding of the pre-existing condition, or baseline condition, of the water, sediment, and biota prior to landfall of the spill. For the most part, the data needed after the spill will be the same as the baseline data collected pre-spill, so that changes related to oil spill or oil spill mitigation efforts can be quantified and characterized by how these relate to the baseline condition.

USGS Science Centers in Texas, Louisiana, Mississippi, Alabama, and Florida have coordinated efforts to sample water and bottom material from coastal wetlands, DOI lands onshore, and the barrier islands most likely to be impacted now that the oil has come ashore. The USGS has documented current conditions at these sites and the existence of any historic oil present, including "fingerprints" of existing oil, polycyclic aromatic hydrocarbons (PAHs), oil and grease, trace metals, volatile organic compounds, surfactants, dissolved organic carbon (DOC) characterization, bacterial populations capable of digesting oils, nutrients, and bottom-dwelling invertebrates. Scientists are monitoring radio-tagged manatees for deviations from normal behavior in priority areas on the Gulf Coast of Florida. Aerial surveys of mangroves and wetlands along the Gulf coast of Florida are being conducted to differentiate between damage from the January 2010 freeze and any potential impact from the oil spill. Aerial surveys and sub-bottom profiling of sea grass beds along the Louisiana coast to document current pre-spill conditions were completed during May 2010.

Trust species are a major focus of DOI management agencies and include threatened and endangered species, as well as migratory birds such as waterfowl, wading birds, shorebirds, and neotropical songbirds. The Department's Natural Resource Damage Assessment and Restoration (NRDAR) Program allows DOI agencies, such as the FWS and NPS, with trust responsibilities to document injury to natural resources as a result of oil spills or hazardous substances releases, assess damages, and restore those injured resources. The USGS provides information and science support to FWS, NPS and other federal agencies to assist them in all phases of the NRDAR process. Currently, USGS scientists are providing scientific support to the DOI NRDAR Program and NOAA Damage Assessment, Remediation, and Restoration Program (DARRP) with regard to the Deepwater Horizon incident on more than a dozen technical work groups, investigating topics that range from aerial imagery to deepwater corals to data management to terrestrial and aquatic species.

While current USGS efforts are focused on response in the aftermath of the oil spill, USGS managers and scientists are also planning for future research needs associated with the Deepwater Horizon oil spill. A longer-term Science Planning Team was launched in early May 2010. The team, which includes personnel from the FWS, the NPS, and the MMS representing their bureaus' science and resource management needs, is developing a long-term science plan designed to address the research needs as we move from an immediate response to a more mature response phase of this event and into recovery. The team has identified priority baseline data that should be collected; a few examples are briefly described below:

- *Mapping and resource characterization.* Habitat maps are lacking for many of the estuaries, sea grass beds, coral reefs and salt marshes in parks and refuges that will be directly or indirectly affected by the oil spill, and their plant and animal communities are poorly understood or quantified, all of which hinders the NPS and FWS from responding. Scientifically valid habitat maps and information on extent, abundance and distribution of marine habitats and species are needed. The barrier island systems in the northern Gulf (especially MS, LA) are very dynamic, and some are on the verge of disappearing. The USGS has joined with the U.S. Fish and Wildlife Service's National Wetlands Inventory program to produce wetland maps that highlight resource-rich areas that are protected by federal, state, or non-governmental agencies to aid in prioritizing response efforts. While the USGS has collected good post-Katrina bathymetry, shoreline, and geomorphology data on the Louisiana and Mississippi barrier islands, but additional island surface and marine habitat data are still needed to complete updated maps.
- *Surveys and assessments.* Specific resources of interest include submerged aquatic vegetation (SAV); near-shore and marsh vegetation and associated invertebrate and vertebrate communities; near-shore fish; shorebirds with emphasis on roosting/nesting areas; sea-turtle nesting areas; shallow-water coral reefs; deep-water coral communities; water quality; and sediment. A portion

of the water quality and sediment monitoring stations should be targeted at SAV beds and shallow and deep coral communities.

- *Surveys to document the occurrence of oil and oil-related materials.* The surveys should include sediment and pore water sampling, seafloor and shoreline imaging with both geophysical and optical techniques, and oil detection LIDAR. The results will be used to map the occurrence and amount of oil and oil-related materials.
- *Surveys at berm and borrow sites.* In addition to physical characteristics, the surveys will need to include water column and sediment measurements to determine if oil-related or previously sequestered harmful materials have been resuspended and reintroduced to the system. The berms will decrease the tidal flows, on which the coastal marshes depend; surveys should also document the effects on the marshes of reduced tidal flow.

Sources and sinks of oil and oil-related materials will vary through time and will be affected both by natural processes and oil spill mitigation activities. Repeated surveys of the coastal zone will need to be performed to determine changes in the physical systems and document changes in the character and distribution of oil and oil-related materials. The repeated surveys will be used to develop "change maps" that will track the migration of oil and oil-related products in the systems. Repeat surveys to track movement of sand in areas of borrow and oil-protective berms will need to be done frequently because analysis of the berm construction plan suggests that the artificial structures could be unstable.

Processes involved in transmitting oil and oil degradation products through the coastal system will need to be monitored. Analyses of sediment and pore water samples taken during repeat surveys can be used to investigate the processes responsible for mobilizing, transmitting, and degrading oil within different components of the coastal system and to document how the presence of oil and its degradation products affect the structure and function of these ecosystems. These analyses also will provide information on interaction of oil and the degradation of oil with other processes such as development of hypoxia and mobilization of toxic metals in different components of the coastal system.

Wildlife Resources and Coastal Ecosystem Impact Recovery

DOI will need to understand the impacts of the Deepwater Horizon oil spill on wildlife and coastal ecosystems in the Gulf of Mexico and track their recovery. Lessons learned from the Exxon Valdez oil spill suggest that a long-term (on the order of decades), multi-level, ecosystem perspective will be essential. Therefore, we recommend that studies include investigations at the landscape level as well as those that are localized and include process-based research. The studies should include habitat monitoring, characterization, and mapping using ground-based data collection, and remote sensing systems. Trust species, including migratory birds, manatees, and sea turtles, which are of concern to the public and resource managers in the DOI, should be emphasized. In addition, the effects of the oil spill on ecosystem structure and function, especially in relation to the health of coastal ecosystems, need to be monitored to measure the impacts to the natural resources of the Gulf.

At the ecosystem level, studies will be needed to

- determine how oil and dispersants will impact multi-level pathways in coastal ecosystems, from the nearshore to coastal wetlands;
- understand the influence of oil and dispersant exposure on the resilience of coastal ecosystems;
- determine extent and degree of damage to coastal ecosystems; and
- use assessments of coastal habitat impacts to model long-term recovery and support the development of remediation/restoration plans.

At the population level, research should focus on

- impacts to wildlife populations and estimated recovery times;
- effects of the oil spill on distributions of marine fauna and wildlife populations;
- impact of sand berms on coastal wetlands and wildlife habitat;
- the efficacy of other remediation methods such as fire or low-pressure hydrocleaning in wetlands; and
- habitat management techniques to restore, enhance or establish conditions necessary to establish or maintain native plant and animal communities.

At the species level, monitoring and analysis will be needed to determine

- sub-lethal effects of oil and dispersant on marine, aquatic and terrestrial organisms;
- impacts of burial and later ingestion of oil and dispersants on wildlife health, life history, and behavior;

- effects of oil and dispersants on marine, aquatic, wetland and terrestrial plants; and
- effects of disturbed conditions on plant community structure and function.

These studies will help to inform the U.S. Fish and Wildlife Service's developing Information, Planning, and Conservation (IPaC) decision support system, which the FWS is currently attempting to secure the needed resources to deploy for the Gulf spill response activities. This system is designed to aid in streamlining emergency section 7 consultation while improving efforts to conserve trust resources, assess impacts to species conservation, and identify appropriate mitigation activities for the NRDAR process. This system is currently being integrated with NOAA's Environmental Response Management Application (ERMA) to allow users to seamlessly move between the two systems to obtain information about FWS trust resources and recommended best management practices. This system integration results in users only having to visit one location to obtain information regarding both agencies' trust resources.

Socio-economic Issues and Ecosystem Services

Impacts of the oil spill to both communities and ecosystems will be far-reaching and long-term throughout the Gulf of Mexico, where many coastal communities depend on ecosystem services for their livelihoods, quality of life, and protection from natural hazards. Information on these impacts on economic activities, demographics and ecosystem services, as well as options for adaptation and resilience planning, are needed to help communities try to regain pre-spill productivity and social well-being. Restoring economic activity and quality of life is best achieved through an adaptive management framework: a structured, iterative process of optimal decision making in the face of uncertainty, with an aim of reducing uncertainty over time via system monitoring. In this framework, science will inform resource managers of specific options for restoration, and consequently the restoration effort will guide the science that needs to be done.

Research on the socio-economic impacts of the oil spill is important to comprehensively assess the impacts of the oil spill on coastal communities, by comparing the social, economic and demographic changes that have occurred as a result of the oil spill as well as the social and economic impacts of restoration activities. A comprehensive geographic analysis of the socio-economic impacts of the oil spill to communities in the Gulf would include:

- Characterization of pre-spill socioeconomic conditions in coastal communities across the Gulf to set the baseline;
- Assessment of current community exposure to hurricane storm-surge hazards relative to areas containing significant oil residue, providing decision makers with an idea of where post-hurricane clean-up would be complicated by oil residue in flood waters;
- Characterization of socio-economic conditions in coastal communities one year after the initial oil spill, to assess the immediate impacts of the oil spill;
- Trend and regression analyses of demographic shifts in coastal populations and business distributions;
- Community-based workshops in communities identified as hot-spots of significant socio-economic change after the oil spill, identifying system-level consequences of the spill to local community structure and function; and
- Models to evaluate the economic impacts of various restoration plans, including the number of jobs created within various economic sectors. Outcomes should include application of these models to inform decision-making.

Ecosystem services are the multitude of resources and processes that are supplied by natural ecosystems to humans, enabling our continued existence and our complex social systems. A science-based Gulf restoration strategy requires examining the value of all ecosystem products and services that have been impacted by the oil spill, including: provisioning services such as food and water; regulating services such as water purification and storm protection; and cultural services such as recreation, and aesthetics. Individual livelihoods and community viability will depend on the success of long-term efforts to restore natural ecosystem functions, native species, and natural structure (e.g., channels, islands, and shoreline). Quantifying and valuating ecosystem services will provide information that is critical in assessing tradeoffs and the consequences of alternative restoration actions. Their valuation will link directly to effective adaptive management restoration methodologies promoting conservation efforts, sustainable economic development and community resilience. Specific components of a comprehensive ecosystem services assessment include:

- Developing assessments of the value derived from, and risks to, Gulf coastal ecosystems, in order to better understand the risks of off-shore petroleum development;
- Identifying degraded and missing ecosystem services and prioritizing restoration efforts toward missing or impaired functions;
- Developing integrated models linking biological, hydrological, and physical data with ecosystem services;
- Delineating the social values derived from ecosystem services, thus prioritizing areas for restoration, including understanding the impacts of the oil spill on commercial, recreational, and subsistence fishermen;
- Combining valuation maps with hazard probabilities to characterize the risks associated with oil spills from existing and future oil development; and
- Modeling the probability of oil from any given well encountering various marine and coastal ecosystems.

OTHER ISSUES

Transport, fate, and potential impacts of oil and dispersants

The use of chemical dispersants has added to the challenge of understanding the fate and transport of oil (along with the dispersant) in the Gulf of Mexico region. Chemical dispersants have converted the oil into microscopic water-soluble droplets, facilitating their movement away from the surface oil slick and into the water column to the seafloor. This procedure results in potential impacts not only to surface and shore biota but also to the vast ecosystems that reside beneath the surface of the Gulf of Mexico. To understand these impacts, the USGS will address the fate and transport of not only oil and dispersant but also the mixture of oil and dispersant to determine their impact on coastal and marine ecosystems, such as wetlands, estuaries, reef communities, beaches, and the associated species that reside in these critical habitats.

Deep-water coral sampling

The USGS, in collaboration with the MMS, NOAA, and other agencies, has been conducting research on a variety of deep-sea and outer shelf habitats in the Gulf of Mexico for more than a decade. The comprehensive data archive, diverse skills, and technical capabilities of this group are ideal for investigating the impacts of the Deepwater Horizon oil spill on deep-water coral ecosystems in the Gulf of Mexico. The September 2010 research cruise, part of the USGS DISCOVRE (Diversity, Systematics, and Connectivity of Vulnerable Reef Ecosystems) expedition and scheduled prior to the spill, would be the basis for short- and long-term studies that would begin with the collection of sediment and bacterial community samples. Samples such as these would allow for a comparison of the pre-spill habitat to the post-spill habitat to measure the effect of contaminants on these deep-water coral ecosystems.

Use of Sand Berm/Barrier

The State of Louisiana requested emergency authorization on May 11, 2010, to perform spill mitigation work on the Chandeleur Islands and also on all the barrier islands from Grand Terre Island eastward to Sandy Point to enhance the capability of the islands to reduce the movement of oil from the Deepwater Horizon oil spill to the marshes. The proposed action, building a barrier berm (essentially an artificial island fronting the existing barriers and inlets) seaward of the existing barrier islands and inlets, "restores" the protective function of the islands but does not alter the islands themselves. Building a barrier berm to protect the mainland wetlands from oil is a new strategy and depends on the timeliness of construction to be successful. Because of the scope of this strategy, there are concerns about the availability of sufficient sand resources, the impacts of depleting these resources and the possible negative effects to existing ecosystems. Prioritizing areas to be bermed, focusing on those areas that are most vulnerable and/or where construction can most rapidly be completed may increase chances for success.

The USGS recommends long-term monitoring of the berm to determine its performance and possible impacts on or benefits to the surrounding environment. Repeated surveys to update bathymetry, topography, sea bed characteristics and seabed images, along with sediment sampling, should be done to document changes through time. The observations and analyses will provide data needed to identify movement of oil and oil-degradation through the system, determine impacts, and identify the processes involved. For example, monitoring changes in barrier topography, and bathymetry along with analyses of sediment cores and oil-residue changes will show linkages between oil mobilization and sedimentary processes. Monitoring turbidity and salinity within the back-barrier environment will provide information on estuarine health.

CONCLUSION

The USGS will continue to work closely with other Department of the Interior and other Federal and State agencies as well as the private sector in response to the Deepwater Horizon oil spill. The USGS Environmental Incident Science Team is leading the effort to develop a plan to identify the Department's long-term research needs in the aftermath of this disaster. As we move from response to recovery, the DOI Bureaus will provide our best efforts to inform and guide decisions. I want to thank the Subcommittee for its support for USGS science. Without your recognition of the importance of USGS long-term monitoring and data collection, the USGS would not have the tools, data, and information that have allowed our rapid response to this crisis, and our Nation would not have the science necessary to begin its recovery from this tragedy.

Thank you for the opportunity to testify before you today. I will be pleased to answer any questions that you may have.

Ms. BORDALLO. Thank you, Dr. McNutt, for describing what we know and what we do not know about the oil spill. Dr. Coddington, please begin your testimony.

STATEMENT OF JONATHAN A. CODDINGTON, PH.D., ASSOCIATE DIRECTOR FOR RESEARCH AND COLLECTIONS, NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION

Dr. CODDINGTON. Thank you, Chairwoman Bordallo and members of the Subcommittee, for the opportunity to testify today. I am the Associate Director of Research and Collections at the National Museum of Natural History at the Smithsonian Institution. I, too, would like to extend my sympathies to those who lost their lives and those who lost their livelihoods due to this disaster.

Our collections at the Smithsonian are among the largest in the world. We have approximately 126 million specimens. That is about 94 percent of everything that the Smithsonian has. About one-third of those collections are marine. Scientific collections are a vital part of the national scientific infrastructure. Time and again, they prove their worth by answering important questions and solving important problems.

To give you one recent example, U.S. Airways flight 1549 collided with birds and crash landed in the Hudson River. It was our DNA and our specimens that identified the birds as Canada geese. It is important to know which birds cause accidents.

We are also often involved with the early detection of invasive species when they invade the United States, and we also support threat assessments to our Armed Forces by developing profiles of disease vectors specific to regions where they are fighting or stationed, for example, in both Iraq and Afghanistan today.

As another final example, climate change is predicted to be especially detectable at the North and the South Poles. For the last many years, we have been collaborating with the U.S. Antarctic program to develop the largest and best collections of the biota of the Antarctic available today. We are ready to provide baseline data for scientific studies to measure climate change, just as we can provide baseline data today on the Gulf of Mexico's pre-spill environment.

As others have pointed out, this is the worst man-made ecological disaster in U.S. history. Its impact and extent at this moment are only estimates, not known facts. All of the stakeholders in this

event will benefit from facts, and therefore solid information on the pre-spill environment is important. For the last 30 years, we have collaborated with the MMS, which is the Minerals Management Service, to archive their collections from their environmental studies program.

Most of these collections focused on the Gulf because that was where most drilling occurred. I would like to emphasize how unusual it is and how lucky we are to have these quantitative collections. Because of the cost of ship time and the difficulty of the work, marine surveys are extremely expensive, especially at great depths. In total, these collections amount to more than 330,000 samples. Of these, more than 93,000 are from the Gulf of Mexico. They were collected at over 500 depths at over 1,000 different locations.

However, about a third of the relevant collections have not been catalogued and been made publicly available to science. The map on display you can see here gives you some idea of the geographic coverage. The red dots are the collections from the MMS quantitative samples. Each one of those red dots is a place that may have yielded hundreds of species and thousands of specimens. The yellow dots represent the regular Smithsonian marine collections.

I brought two examples with me today just to show you what these things are like. This large specimen here is a giant isopod collected at about 500 meters in depth. They get almost three feet long. They are creatures of the deep. I also have, I hope, circulating among you in a plastic box specimens of corals. Those corals are keystone species because they create the environment on which other organisms depend. These make deepwater reefs, which can be hundreds of meters high, hundreds of meters wide, and even miles long.

Most of the specimens we have, of course, are not this spectacular, but these are the most extensive collections of marine organisms from the U.S. continental shelves.

In summary, these Smithsonian collections are now a unique and irreplaceable resource to characterize the Gulf pre-spill environment. However, until we know exactly what questions are going to be asked, I can't say exactly how these collections will help us to answer these questions, but they are likely to be critical in many contexts. Research and assessment of impacts will go on for decades, and most of that will need pre-spill data.

However, I would also say that getting more pre-spill data is important. We don't have much time left to gather data of that sort. We should also make sure that we are gathering and archiving baseline data and information from whenever oil and gas exploration is going on on the outer continental shelf. All stakeholders benefit from the facts. This is relatively cheap and easy to do. And I would also like to emphasize that about a third of the MMS collections and other Smithsonian collections, which would be scientifically valuable for pre-spill environments, are not yet fully worked up, catalogued, and publicly available for science. Finishing that now is a high priority for us.

Finally, thank you for the opportunity to testify, and I look forward to answering any questions you may have.

[The prepared statement of Dr. Coddington follows:]

Statement of Dr. Jonathan Coddington,
Associate Director of Research and Collections

Thank you Chairwoman Bordallo and distinguished members of the Subcommittee for the opportunity to provide testimony today. My name is Jonathan Coddington. I am the Associate Director of Research and Collections at the National Museum of Natural History, Smithsonian Institution. I have a PhD in Invertebrate Zoology and have published frequently on design and analysis of biological inventories and inventory design theory. As Associate Director I oversee about 90 scientists and 240 technical staff at the National Museum of Natural History in Washington, D.C., at the Museum Support Center in Suitland, Maryland, and at the Smithsonian Marine Station at Fort Pierce, Florida. Collectively we care for an estimated 126 million specimens, approximately 94% of all Smithsonian collections. About one third of our collections and staff focus on the marine realm.

Introduction:

The National Museum of Natural History (NMNH, previously the US National Museum, in part) has, since its beginning, been linked to the collection activities of the U.S. Government. The 1846 legislation that created the Smithsonian Institution identified the U.S. National Museum as the repository for natural history specimens belonging to the United States, "All collections of rocks, minerals, soils, fossils, and objects of natural history, archaeology, and ethnology, made by the National Ocean Survey, the United States Geological Survey, or by any other parties for the Government of the United States, when no longer needed for investigations in progress shall be deposited in the National Museum" (20 U.S.C. § 59). In fact, it was research in the marine environment, the 1838–1842 U.S. Exploring Expedition that made clear the national need for such a repository. The role of the Smithsonian as the primary repository for federally funded collections has been repeatedly affirmed by Congress by legislation in 1879, 1965, 1970, and 1991.

Scientific collections are an essential and irreplaceable component of the national scientific infrastructure, as documented in the 2009 report of the ***Interagency Working Group on Scientific Collections*** (OSTP, 2009). Speaking just for the Smithsonian, we collaborate with the Federal Aviation Administration, the U.S. Air Force, and the U.S. Navy to identify birds involved in over 5,000 collisions with airplanes annually. Last summer, a number of Canada geese famously forced US Airways Flight 1549 to land in the Hudson River, luckily with no loss of life. Knowing the species of bird in each collision allows humans, as far as possible, to design systems to minimize collisions. We collaborate with the United States Department of Agriculture (USDA) by hosting 40 USDA entomology staff at NMNH because the collections are critical to their mission of protecting U.S. Agriculture. When the citrus leaf miner invaded the U.S. in 1993, the NMNH collections contained the only identified material in the country. Our scientists rapidly identified the pest, which enabled targeted control programs throughout citrus agriculture regions. Smithsonian collections also played a crucial role in the identification and control of many other invasive species, for example, the veined rapa whelk that damages Chesapeake oyster populations, or the Asian longhorned beetle, on track to cause billions of dollars of damage to urban trees. Our unique database on volcanic eruptions is the international standard for basic science in this area, supporting plans to mitigate threats to human life near volcanoes, as well as threats to aviation. We also support our armed forces by hosting the Walter Reed Biosystematics Unit, a component of the Walter Reed Army Institute of Research. Mosquitoes, in particular, spread some of the most deadly and debilitating diseases, and NMNH therefore supports the largest and most comprehensive mosquito collection in the world. Another recent example is *Hyalomma* ticks, which are particularly common and diverse in Iraq. They transmit viral hemorrhagic fevers. Luckily, we have the world's best reference collection of *Hyalomma* ticks. Wherever our soldiers are, the ability to rapidly identify disease vectors in their environment is crucial to mitigating risk. Our collections have been used repeatedly to answer basic and historical questions regarding many diseases: Lyme disease, influenza, and hemorrhagic fevers, to name a few.

In the near future our collections may play crucial roles in two areas: climate change and ocean acidification. Since 1963 we have archived the results of environmental monitoring in the Antarctic, a partnership with the U.S. Antarctic Program (USAP). Climate models predict that the climate change may be particularly evident at the North and South Poles. The density and scope of our historical collections can provide the "before" to climate change's "after." Ocean acidification, itself caused by climate change, threatens keystone species—reef builders—of many marine ecosystems. Clams and corals, for example, record growth rates in their skeletons.

Those growth rates depend on the availability of calcium carbonate, and that depends on ocean acidification. Growth rates as reflected in the skeletons of marine organisms are an important record of environmental change.

Regarding the Deepwater Horizon oil spill, knowing what the conditions were like before the event is essential. The Smithsonian is committed to long-term studies of ecosystems and biodiversity, and the data and collections that have resulted can play a crucial role in situations such as that posed by the gulf oil spill. For example, in 1986 more than 50,000 barrels of oil impacted the coast of Panama, including the habitats adjacent to the Galeta Marine Laboratory of the Smithsonian Tropical Research Institute. Because the Smithsonian had already studied this site for many years, the Minerals Management Service (MMS) chose the Smithsonian to assess the impact of the spill. This study was one of the first to clearly document the long term effects of oil on soft bottom marine habitats such as are found along the U.S. Gulf Coast. Collections documenting this study (see below) are archived at NMNH. Throughout history, scientific collections have helped to resolve the issues of the day.

My testimony today focuses on the assistance the National Museum of Natural History can provide to a coordinated national response to the Deepwater Horizon oil spill. This spill already has been described by many experts as the worst man-made ecological disaster in U.S. history. The extent of the ecological impact, its geographic extent, and possibilities for remediation at this point are only estimates, not known facts. Given the likely economic impacts of the spill and future costs, the accuracy of before and after comparisons are important. Assembling an accurate and detailed description of the Gulf of Mexico marine ecosystem as it existed prior to the spill is the chief topic I will address today.

NMNH Collections, MMS, and the Gulf of Mexico:

Since 1979, NMNH has collaborated with the Environmental Division of the Minerals Management Service to archive the collections generated by their Environmental Studies Program. The Minerals Management Service (MMS) has been conducting intensive environmental studies on the Outer Continental Shelf (OCS) for more than 30 years to support information needs for managing oil and gas development on the continental shelf and slope. Through its initial design, and during the first four years of program activity, the MMS Environmental Studies Program established baseline environmental conditions based on a large number of biological, chemical, and physical parameters. With these baseline conditions, future monitoring studies during and after development would, presumably, have allowed an assessment of the long-term effects of development. After a review and recommendations from the National Academy of Sciences, this program design was revised in 1978. Subsequently, a new program of directed studies has provided data to inform critical decisions before they are required. These baseline surveys took place from 1974 to 1978, and the Smithsonian has all or most of the specimens they generated in our collections. Specimens from numerous additional MMS-directed studies are also in our collections. Data from these studies, including site and collecting event specific physico-chemical, oceanographic, sedimentary and biodiversity data are available in the various technical reports prepared by program contractors. These reports, available on-line at the MMS Environmental Studies Program Information System, (https://www.gomr.mms.gov/homepg/espis/espisfront.asp), provide information that document not only the biodiversity of these sites, but the population characteristics and environmental conditions at the time the samples were collected. For the Gulf of Mexico alone, from 1974–2010, this site provides 109 "baseline" reports, 252 "biology" reports, 86 "fate & effects" reports, and 340 "technical summaries." The availability of this extensive supporting data in conjunction with the specimens themselves makes these collections an irreplaceable research resource for comparative studies on the invertebrate biodiversity (animals without backbones) of the Gulf of Mexico.

These specimens represent one of the most extensive collections of marine organisms from U.S. continental shelves and slopes, in terms of geographic coverage, sampling density (spatial and temporal), number of phyla represented, and associated data collected concomitantly (other organisms, chemical, hydrographic, geologic). The MMS therefore established a system for the archiving of, and access to, these specimens. Through a series of contracts, MMS has partnered with the Smithsonian's NMNH–Department of Invertebrate Zoology (in its role as the repository for federally-funded collections) to ensure the long term maintenance of and access to invertebrates collected during these studies. The MMS Environmental Studies Program deserves praise for the foresight and initiative shown in conducting and preserving the results, especially the collections, from these surveys.

Details of MMS surveys as represented in NMNH Collections:

NMNH to date has received material from 21 continental shelf, slope and canyon surveys as well as two special oil spill surveys. These are: the Atlantic Slope and Rise Program (ASLAR); George's Bank Benthic Infauna Monitoring Program (BIMP); Central Atlantic Benchmark Program (CABP)**;** California Monitoring Program (CAMP); Central and Northern California Reconnaissance Program (CARP); the Canyon and Slope Process Study (CASPS); Central Gulf Platform Study (CGPS); Gulf of Mexico Chemosynthetic Communities (CHEMO); Deep Gulf Shipwrecks of World War II (Deep Wrecks); Northern Gulf of Mexico Continental Shelf Habitats and Benthic Ecology (DGoMB); the special Ixtoc oil spill survey in the Gulf of Mexico (IXTOC); the South Atlantic Outer Continental Shelf Area Living Marine Resources Study (LMRS); Gulf Of Mexico Hard Bottom Communities (Lophelia); Mississippi, Alabama, Florida Benchmark Program (MAFLA); Mississippi-Alabama Marine Ecosystem Program (MAMES); Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring Program (MAPTEM); the New England Environmental Benchmark Program (NEEB); the Northern Gulf of Mexico Continental Slope Study (NGOMCS); the special Panama Oil Spill Study (POSP); the South Atlantic Benchmark Program (SABP); the Southern California Baseline Study (SOCAL); the Southwest Florida Shelf Ecosystems Study (SOFLA); and the South Texas Outer Continental Shelf Program (STOCS). In addition to the biological material, more than 200 color slides of animals *in situ* were received from the MAPTEM program.

During the 30+-year tenure of the contracts between MMS and the Smithsonian, more than 337,012 lots of sorted and identified material and 20,000 lots of unprocessed samples or mixed taxa have been received. "Lot" means a single jar or vial of specimens that have identical collecting data. One lot may comprise one or dozens or thousands of specimens. Therefore lot statistics always underestimate the actual number of specimens involved. Of this number more than 93,000 lots originated from studies in the U.S. Gulf of Mexico and more than 18,000 lots originated from the studies following the oil spill in Panama. In that case, Smithsonian marine scientists also led a scientific study (funded by MMS, see above) of the ecological consequences of the oil. It remains a benchmark study in the field.

In the aggregate these collections document at least 4,000 species of marine invertebrates from 602 families from 22 phyla. Recent scientific publications document that the Gulf as a whole contains roughly 15,000 species, with perhaps another 3,000 species still undiscovered. These represent everything from ecological keystone species to economically important species to potentially threatened or endangered species. "Keystone" species are those on which most of the rest of the ecosystem depends. The North Atlantic cold water coral (*Lophelia pertusa* (Linnaeus, 1758) is a keystone species because it is one of the most important deep water reef-builders, and thus fundamental to deep marine ecosystems. It occurs within 20 or so miles of the Deepwater Horizon well-head, as documented by trawl samples from 1984 and direct observation from submersibles during MMS-funded studies between 2004 and as recently as September of last year. Economically important species are the focus of the National Oceanic and Atmospheric Agency's National Marine Fisheries Service. Examples are the three commercially important Gulf shrimp species (pink and brown shrimps, *Farfantepenaeus duorarum* and *F. aztecus,* and the white shrimp, *Litopenaeus setiferus*), all of which are well-represented in NMNH collections. Endangered or "at risk" species include several populations of genetically distinct bottlenose dolphins, and the Florida manatee, which is particularly vulnerable to oil fouling of the plants on which they feed. Finally, many of the species collected through these surveys were entirely new: between 300 and 400 new species were described based on these collections and many more await description.

As many as six persons have been employed at any one time on the joint Smithsonian-MMS project with responsibilities for inventorying the material as it was received, cataloging the identified specimens, sorting and identifying additional specimens from unprocessed lots, and other curatorial tasks necessary to meet NMNH curatorial standards. However, approximately one third of MMS collections deposited at the Smithsonian need further work in order to optimally support research related to the oil spill.

Importance of Collections:

To give the committee some idea of the importance of these collections, my staff recently estimated that fully 58% of publicly available specimen-based records from the Gulf of Mexico represent Smithsonian collections. I would like to emphasize that many marine research institutions around the Gulf and elsewhere will play key roles in assessing damage and measuring remediation and recovery in the years ahead. The Smithsonian is ready to collaborate and support that work in any way it can. It is also likely that many scientists and institutions have data or collections

that are not publically available (i.e. accessible via on-line databases) that are highly relevant to the Deepwater Horizon oil spill. However, the massive size and quality of the MMS survey collections at the Smithsonian will surely continue to be an important resource.

These collections, therefore, represent a unique and now irreplaceable resource to describe quantitatively the pre-spill Gulf of Mexico ecosystem. The depth range of these collections is enormous, ranging from five to nearly 3,000 meters (nearly two miles). From the label data I calculated that specimens were accessed at 459 distinct depths. The deep collections are especially valuable because survey work at such depths is extremely expensive and limited. Given the depth of the Deepwater Horizon well-head, data on abyssal communities are especially important. A Gulf-wide MMS-funded deepwater study listed above as DGoMB was recently published and includes a number of these deep stations very near the spill site in its database. The total number of distinct geographic points sampled is roughly 1,000. In short, by the standards of biological sampling in general, and especially considering the rarity of deep-water samples, these collections are truly impressive.

Distinct Roles of Smithsonian and MMS:

The Smithsonian role in this partnership has been the archiving of the collections that support these technical studies, the improvement of the scientific quality of the collections as resources permitted, and making them publicly available in digital form through our website. MMS conducted the surveys, received reports from the scientists and contractors involved, and is therefore the final authority on data and analyses extracted from the collections. The Smithsonian enhances the value of the collections by meticulously creating digital records for each sample of specimens, including precise georeferenced locality data and other important ecological aspects. Few other museums have the resources to create so many records of such high quality. The quality and quantity of digitally available data will make these collections in particular extremely valuable to scientists seeking information on the pre-spill ecosystem.

Future Work:

Ideally, the scientists that will carry out inventories and surveys of the post-spill environment will want exactly comparable pre-spill surveys, using the same methods, and designed for the same analytical protocols. There is one ongoing MMS and NOAA-funded study of deep corals in the vicinity that is ideally suited to this task. We cannot say at this time to what extent the 1974–1978 baseline surveys, and most surveys since then, fulfill these stringent requirements. While such surveys may be in retrospect imperfect, or imperfectly archived in some ways, they certainly provide one of the most comprehensive available resources on biodiversity and abundance data prior to the spill. Even if the background raw data are not available, it is possible that such data could be regenerated directly from NMNH collections. Although it is already obvious that NMNH collections have had, and will have, an important role to play in describing the pre-spill ecosystem, we must wait until post-spill questions are more precisely formulated before we can assess their role more specifically.

In addition to the more than 333,000 lots of invertebrates originating from MMS studies in the Gulf of Mexico, the NMNH Invertebrate Zoology collections also include 39,000 lots of invertebrates that have been at least partially inventoried (have a corresponding record in our catalog database). Of the 39,000 lots represented in our database, the majority were collected between 1951–2010. Our collection also includes an estimated 75,000–120,000 lots that have not been inventoried at all. We have, however, completed an initial digitization assessment in which collections have been prioritized for improvements in curation. In order to make these high-priority collections available to researchers we would need to inventory and digitize them. Direct digitization is the most efficient way to make the information widely available. Although these collections are not as extensively documented as the MMS specimens, many were collected from shallow near-shore and in-shore areas, and are an important source of comparative material from Gulf of Mexico locations not sampled by the MMS programs.

Recommendations:

1. The MMS baseline surveys in the 1970's, and special applied project studies conducted thereafter, are now a unique and irreplaceable resource to provide factual and objective data on the Gulf of Mexico pre-spill environment.
2. Precise assessment of the ability of these collections and associated data to support quantitative comparisons of pre- and post-spill conditions will require additional work, contingent on the exact questions to be answered.

3. Survey work in the Gulf region in advance of oil damage has commenced already, but it needs to be well-organized and quantitative. We have a short window of time to increase our baseline knowledge of these ecosystems before damage occurs.
4. Post-spill ecological research would be enhanced by working up and making publicly available Gulf of Mexico pre-spill collections that are not yet publicly available.
5. Gathering baseline ecological data (similar to the MMS Environmental Program) is a proactive and precautionary step wherever offshore drilling may take place. The Gulf of Mexico MMS baseline surveys were refocused in 1978, yet today, 32 years later, they are suddenly of national importance and significance. All stakeholders benefit from objective and factual information. Advances since then in the ability to archive and exploit such data now make such activities both economical and routine.

Thank you for the opportunity to testify today and I look forward to answering any questions you may have.

Response to questions submitted for the record by Jonathan Coddington, Associate Director for Research and Collections, National Museum of Natural History, Smithsonian Institution

Questions from Chairwoman Madeline Z. Bordallo (D–GU)

1. How well known is the biodiversity in the Gulf of Mexico? Are there still new species to discover?

The Gulf of Mexico is one of the best known marine regions in the world. The recent encyclopedia of biota from the Gulf (*Gulf of Mexico: Origins, Waters, and Biota. Volume 1. Biodiversity,* 2009, eds. Felder and Camp) lists 15,419 species from the Gulf, but also implies that only 80% of the biodiversity is known. Thus, one might expect to find another 5000 new, as yet undescribed species of nematodes, polychaetes, copepods and amphipods from the Gulf, especially from the deepest waters. Indeed, species are being described, on average, every week, if not on a daily basis from this body of water.

New species, especially from poorly studied invertebrate groups, have been, and continue to be described from the Department of Interior's Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) programmatic collections maintained at the NMNH.

2. Have steps been taken to begin to integrate information from the collection into the necessary baseline data for the natural resource damage assessment process?

Yes, to date more than 57,000 lots of invertebrates from 12 distinct Gulf of Mexico research programs funded by BOEMRE have been accessioned into the collections of the National Museum of Natural History (NMNH) and cataloged. Each of these 57,000 lots is represented by an electronic record in a web-accessible database at http://collections.nmnh.si.edu/emuwebizweb/pages/nmnh/iz/Query.php. These specimen records are also accessible through the Ocean Biogeographic Information System, at http://www.iobis.org/. NMNH collections were used to create an interactive context sensitive Google Earth map that shows the species collected at each BOEMRE Gulf of México locality. This map was provided to BOEMRE and is available for download at http://www.invertebrates.si.edu/mms/files.htm.

The Smithsonian continues to work to increase the publicly available data about these collections, as reported quarterly to BOEMRE. NMNH-generated data is regularly integrated into data used by scientists performing research for the BOEMRE.

Does the Smithsonian Institution need additional resources to complete this work?

As explained elsewhere in my responses to questions, NMNH's Gulf of Mexico invertebrate collection baseline data are used by many stakeholders for their particular purposes. Normally, collection processing is an ongoing background activity. Our usual priority is collections that can be processed and put on-line quickly, or high-value research materials. The remaining collections have been prioritized to emphasize, first, those specimens that are well-identified but need cataloguing, and second, those that still need to be sorted and identified. The Gulf of Mexico collections that still need to be processed require sorting and physical preparation, cataloging and describing, and data capture and geo-referencing. BOEMRE and NMNH will plan to continue working together to develop and build this valuable resource.

Questions from Ranking Republican Member Henry Brown, Jr. (R–SC)

1. Dr. Coddington, you mentioned that your baseline surveys in the 1970's are "Now a unique and irreplaceable resource". What are some of the conclusions of those surveys? Has this data been provided to appropriate federal agencies? If yes, how has it been used?

The baseline surveys to which you refer were conducted by the BOEMRE, not the Smithsonian. The design, implementation, and analysis of the survey were the responsibility of BOEMRE. However, the collections produced were transferred gradually to the Smithsonian, and thus are still available for further research. The Smithsonian and NOAA have also conducted surveys, although not as extensive as BOEMRE.

The recently published 500+ page book on the Gulf of Mexico edited by Felder and Camp (2009) is an excellent example of the results of surveys. Fifteen Smithsonian scientists contributed, reviewing various groups of organisms and providing lists of species that occur in the Gulf. The surveys are why we know that about 15,500 known marine species live in the Gulf and about 10% live nowhere else. It also identifies introduced and invasive species. Collections, keys, checklists and analyses that depend on them are the fundamental basis of knowledge on the pre-spill Gulf environment.

Our data and analyses are freely available to everyone, including federal agencies, universities, independent research laboratories, and the general public at http://collections.nmnh.si.edu/emuwebizweb/pages/nmnh/iz/Query.php. The data are used by the Depts. of Interior, Commerce, Defense and others whenever their work requires environmental knowledge. For example, one specific way the coral records have been used is to document NOAA's "The State of Deep Coral Ecosystems of the United States: 2007", a comprehensive analysis of all corals by geographic region that occur off the U.S. and territories. Without our records and publications, this kind of compilation would not have been possible.

2. How much money has the Smithsonian Institution spent on its Gulf of Mexico surveys? How many staff do you currently have assigned to the Gulf?

Since 1979, the Smithsonian has received more than $5 million from BOEMRE to maintain, manage, and database Gulf of Mexico collections. From other sources, including federal appropriations to the Smithsonian for scientific research, at least another $2 million has been expended since 1979. Currently, we have two full time and one part time employee assigned to work on our BOEMRE collections. These positions are funded through a contract from BOEMRE.

3. On page 6, you stress that "we have a short window of time to increase our baseline knowledge of these ecosystems before damage occurs." What type of baseline information was available before the spill?

Over many decades scientists have conducted ecological and biological surveys, including the various BOEMRE Gulf of México surveys, in the Gulf of Mexico. These studies document important biological processes, for example, reproductive success, dispersal, and establishment of diverse species (see references in Felder and Camp, 2009). These biological processes will likely be affected by the oil spill. There is also a significant body of research on invasive species, commercially important species, and long term ecological change. However, now we are dealing with one specific oil-spill, at a particular place, being dispersed by particular currents at a particular time of year. We should move quickly to survey habitats likely to be impacted by this particular event.

Ms. BORDALLO. Thank you, Dr. Coddington, for informing us about the valuable collection and resources at the Smithsonian that can help address recovery activities. And next, we will hear from Dr. Fingas.

STATEMENT OF MERV FINGAS, PH.D., COMMITTEE ON OIL IN THE SEA,

Dr. FINGAS. Good morning, Chairwoman Bordallo and Subcommittee members. Thank you for the opportunity to testify.

First, I would like to reintroduce the National Academy of Sciences, who have conducted some recent studies that are quite

relevant to the Gulf oil spill. The academy has regularly conducted studies of several facets of oil spills in the past 30 years. These are technically carried out by independent, unbiased scientists who are involved in the field and have specific expertise to bear on the topic at hand. I will highlight two such studies. The first study is "Oil in the Sea III," which is already highlighted by Mr. Cassidy, this study here.

This study focused on two facets of oil spills, first estimating the amount of oil discharged into the sea from various sources, and second, to assess the fate and effects of that oil in the environment. A number of recommendations were made in that report, probably the most important being the importance of obtaining real data sets from real spills, such as the current Gulf spill.

The second study is a study of oil spill dispersants, which was published in 2005-2006. Oil spill dispersants are surfactant mixtures along with solvents, which are intended to enhance the production of small droplets in the water column. There are many issues with oil spill dispersants which are covered in this book, including the fact that dispersants ultimately break down and the oil rises to the surface again, the toxicity of such dispersants, and the effectiveness of products.

Again, a number of recommendations are made on the study and use of dispersants in this report. Again, I should emphasize the importance of one recommendation, being that of obtaining real data sets such as in the current spill.

Finally, I have made a number of comments on initiating research programs. I have been involved my whole life in developing and carrying out research programs, and felt it necessary to share some of these lessons. I am pleased to be here, and will answer any questions that you may have. Thank you.

[The prepared statement of Dr. Fingas follows:]

Statement of Merv Fingas, Private Individual, Edmonton, Alberta

Foreword: This is the personal testimony of Merv Fingas, a private individual from Canada. I have extensive background as an oil spill researcher and have participated in several NAS committees. I will describe briefly some NAS studies, one on oil-in-the-sea and one on oil spill dispersants. I had extensive involvement in these studies especially the oil-in-the-sea study. Further, I will give some of my impressions of where R&D emphasis should be placed.

1 Introduction—Oil Spills

Major oil spills can attract the attention of the public and the media. In past years, this attention had created a global awareness of the risks of oil spills and the damage they do to the environment. In recent years, major spill incidents are fewer in number however the recent Gulf spill may increase these spill numbers back to the previous high levels. The public becomes aware of very major spills, but generally is unaware that spills are a daily fact of life. Oil spills are a frequent occurrence, particularly because of the heavy use of oil and petroleum products in our daily lives.

Spill statistics are collected by a number of agencies around the world. Unfortunately these are sometimes not as accurate as they could be. They can sometimes be misleading to compare oil spill statistics, however, because different methods are used to collect the data. In general, statistics on oil spills are difficult to obtain and any data set should be viewed with caution. The spill volume or amount is the most difficult to determine or estimate. For example, in the case of a vessel accident, the exact volume in a given compartment may be known before the accident, but the remaining oil may have been transferred to other ships immediately after the accident. Some spill accident data banks do not include the amounts burned, if and when that occurs, whereas others include all the oil lost by whatever means. Sometimes the exact character or physical properties of the oil lost are not known and

this leads to different estimations of the amount lost. Spill data are often collected for purposes other than future improvement of spill response. Further, reporting procedures vary in different jurisdictions and organizations, such as government or private companies. The number of spills reported also depends on the minimum size or volume of the spill. In Canada for example, there are about 12 such reportable oil spills every day, of which only about one is spilled into navigable waters. These 12 spills amount to about 40 tons of oil or petroleum product. In the United States, there are estimated to be about 25 spills per day into navigable waters and an estimated 75 spills on land.

The public often has the misconception that oil spills from tankers are the primary source of oil pollution in the marine environment. While it is true that some of the large spills are from tankers, it must be recognized that these spills still make up less than about 5% of all oil pollution entering the sea. The sheer volume of oil spilled from tankers and the high profile given these incidents in the media have contributed to this misconception. In fact, as stated earlier, half of the oil spilled in the seas is the runoff of oil and fuel from land-based sources rather than from accidental spills.

In conclusion, it is important to study spill incidents from the past to learn how the oil affected the environment, what cleanup techniques worked and what improvements can be made, and to identify the gaps in technology.

3 The Oil-in-the Sea Study by the National Academy of Sciences—2003

(Note: this is my paraphrase of a NAS summary but all opinions are mine. NAS report recommendations are given in quotes.)

Oil in the Sea III is the third report from the National Academies on oil spill sources and fates, the last of which was published in 1985. Since the date of the last report, several governmental and private agencies have created databases with more information on petroleum releases and their impact on the environment. This 2003 report proposes a clearer methodology for estimating petroleum inputs to the sea and makes recommendations for further monitoring and assessment that will help policymakers prioritize next steps for prevention and response.

Sources of Oil in the Sea

Petroleum inputs into North American and worldwide marine waters were computed for four major sources – natural seeps and releases that occur during the extraction, transportation, and consumption of petroleum. The last three include all significant sources of anthropogenic petroleum pollution. This summary highlights the major findings about each major source.

Natural Seeps of Petroleum

Natural seeps occur when crude oil seeps from geologic strata under the sea floor into the water. Seeps are often used to identify potential economic reserves of petroleum. They contribute the highest amount of petroleum to the marine environment, accounting for 45 percent of the total estimated annual load to the world's oceans and 60 percent of the estimated total load to North American waters. The presence of these seeps, though entirely natural, significantly alters the nature of the local marine ecosystems around them. Seeps serve as natural sites for understanding adaptive responses of organisms over generations of oil exposure. The report recommends that programs be implemented to understand the fate of petroleum from natural seeps and ecological responses to them.

Author's Comment—Few, if any studies on natural seeps have been carried out since the NAS study.

Extraction of Petroleum

World oil production continues to rise, from 8.5 million tonnes (1 tonne equals about 294 gallons) in 1985 to 11.7 million tonnes in 2000. In that same time, the number of offshore oil and gas platforms rose from a few thousand to approximately 8,300 fixed or floating offshore platforms. Historically, oil and gas exploration and production of petroleum have represented a significant source of spills. The second largest marine spill in the world was a blowout that released 476,000 tonnes of crude oil into the Gulf of Mexico in 1979. The current Gulf blowout may soon approach this level of significance. The amount of oil transported over the sea continues to rise. Since 1985, the Middle East's exports of oil to the United States have almost tripled, and exports to the rest of the world have doubled. While the devastating impact of spills has been well-publicized with images of oil-covered shores and wildlife, releases from the transport of petroleum now amount to less than 4 percent of the total in North American waters and less than 13 percent worldwide. The four major sources of petroleum discharges in the transportation sector include

pipeline spills, tank vessel spills, operational discharges from cargo washings, and coastal facilities spills. Transportation-related spills are down for several reasons. The enactment of the Oil Pollution Act of 1990 placed increased liability on responsible parties, and other regulations required the phase out of older vessels and the implementation of new technology and safety procedures. By 1999, approximately two-thirds of the tankers operating worldwide had either double-hulls or segregated tank arrangements – a vast improvement over older single hull ships. Operational discharges from cargo washing are now illegal in North America, a law that is rigorously enforced. However, there still remains a risk of spills in regions with less stringent safety procedures practices. The report recommends that federal agencies expand efforts to work with ship owners domestically and internationally to more fully enforce effective international regulatory standards that have contributed to the decline in oil spills. In the United States, nearly 23,000 miles of pipeline are used to transport petroleum. In some regions, much of this infrastructure is more than 30 years old, and unless steps are taken to address the problem, the likelihood of a spill from this source is expected to increase. The report recommends that federal agencies continue to work with state environmental agencies and industry to evaluate the threat posed by aging pipelines and to take steps to minimize the potential for a significant spill.

Author's Comment—The first recommendation on improving discharges has certainly improved in North America. Both Canada and U.S.A. have increased surveillance efforts and enforcement efforts. This is resulting in decreased dumping.

The second recommendation relates to the aging pipeline infrastructure. Although some effort has been undertaken an accelerated effort is required.

Consumption of Petroleum

From 1985 to 2000, global oil consumption increased from 9.3 to 11.7 million tonnes per day, an increase of more than 25 percent. Releases that occur during the consumption of petroleum, whether by individual car and boat owners, marine vessels, or airplanes, contribute the vast majority of petroleum as a result of human activity. Land-based activities contribute to polluted rivers and streams, which eventually empty to the sea. Consumption related inputs contribute one-third of the total load of petroleum to the sea and represent 85 percent of the anthropogenic load to North American marine waters and 70 percent worldwide. Land-based inputs are highest near urbanized areas and refinery production. More than half of the land-based inputs in North America are estimated to flow to the near shore waters between Maine and Virginia, a region with many urbanized areas and also many sensitive coastal estuaries. In North American marine waters, land runoff combined with marine boating and use of jet skis account for 22 percent of total petroleum inputs and 64 percent of inputs from human activity.

The threat of pollution from urban areas is expected to rise. Current trends indicate that by the year 2010, 60 percent of the U.S. population will live along the coast. Worldwide, two-thirds of the urban centers with populations of 2.5 million or more are near coastal areas. In 1990, heightened awareness of the large number and design inefficiencies of two-stroke engines commonly used in recreational vehicles led the U.S. EPA to begin regulating the "nonroad engine" population under the authority of the Clean Air Act. The marine industry responded by developing cleaner engines in the late 1990s, but the report recommends that federal agencies continue efforts to encourage the phase-out of the older inefficient two-stroke engines and establish a coordinated enforcement policy.

Author's Comment—The recommendation that the old-style inefficient 2-stroke engine be increasing phased out has been partially carried out. Since the report, there have been many improvements in the efficiency of 2-stroke engines and many of these have been replaced.

Significant Cross-Cutting Issues

Studies completed in the last 20 years confirm that no spill is entirely benign. Further, there is no correlation between the size of a release and its impact. The effects of a petroleum release are a complex function of the rate of release, the nature of the petroleum, and the local physical and biological character of the exposed ecosystem. Some petroleum components are more toxic than others. Polycyclic aromatic hydrocarbons (PAH) are known to be among the more toxic components of petroleum, and their initial concentration is an important factor in the impact of a given release. Growing evidence suggests that toxic compounds such as PAH in crude oil or refined products at very low concentrations can have adverse effects on biota. This suggests that PAH from chronic sources may be of greater concern than was thought 10 or 15 years ago and that effects of petroleum spills may last longer

than expected. The report recommends that federal agencies take several actions to better understand the behavior and effects of petroleum hydrocarbon releases.

These actions include:

- Studying the fate and hydrodynamic transport of petroleum in the sea.

Author's Comment—This recommendation has not been addressed significantly, perhaps because of poor economic times.

- Developing and implementing a rapid response system to collect in situ information about spill behavior and impacts.

Author's Comment—This recommendation has not been addressed significantly.

- Significantly enhancing research efforts to more fully understand the risk posed to humans and the marine environment by chronic release of petroleum, especially the cumulative effects of petroleum-related toxic compounds such as PAH.

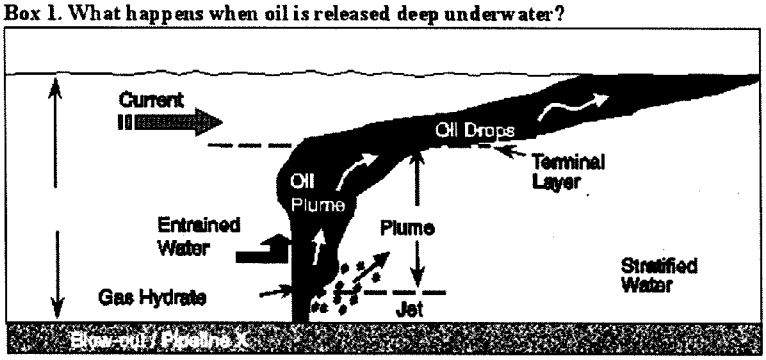
Author's Comment—This recommendation has not been addressed significantly.

- Continuing research on effects of releases on wild populations, including a program to assess ecosystems in areas known to be at risk from spills or other releases of petroleum.

Author's Comment—This recommendation has not been addressed significantly.

The oil in the sea report also summarized the overall behavior of a sub-sea blowout. The following two boxes summarize this behavior.

Box 1. What happens when oil is released deep underwater?



Surface oil slicks capture public attention, but a substantial percentage of accidental spills occur beneath the surface, typically from the seafloor. Examples include blowouts of exploration wells, such as the BP-Gulf of Mexico disaster, pipeline ruptures, and shipwrecks. Oil leaking from a pressurized underwater spill like a pipeline blowout doesn't simply rise to the surface—it forms underwater plumes of oil and natural gas that billow and drift beneath the oceans surface. Water temperature and salinity, the depth of the leak, and the density of the gas and oil all impact the physics of plume formation, but there are three distinct phases of any pressurized, underwater spill:

Jet Phase: The speed of the oil and natural gas being expelled from the pressurized, confined space of the pipeline to the open ocean makes the oil form droplets and the gas form bubbles.

Plume Phase: The momentum of these tiny droplets and bubbles drags significant volumes of sea water upward into the water column, forming a plume. In deeper water, so much water is incorporated into the plume that eventually, the oil-natural gas-water mix is no longer buoyant, and the plume will stop rising, suspended in the water column at the terminal layer. If heavier components sink out of the suspension, the plume may reform and begin to rise again past that terminal layer in a process known as "peeling".

Post-terminal Phase: Once the plume reaches the final terminal layer, the rise of the oil-gas-hydrates is driven purely by the buoyancy of the individual droplets and bubbles.

Once the oil reaches the surface, it tends to form a surface slick thinner than that seen during a typical shallow-water release, in part due to the diffusion and dis-

persal of oil droplets as they rise, and in part due to the layers of oil arriving at the surface at different stages. Much, if not all, of the gas associated with the oil be dissolved into the water column. Natural gas released at depths below 300 meters can form hydrates, a mix of natural gas and water similar to ice. Hydrates are dense, so if they form it is likely that the buoyancy of the plume would be greatly reduced, increasing the time that it takes for the oil and gas to reach the surface.

From: Oil in the Sea III: Inputs, Fates, and Effects, National Research Council, 2003.

4 The Oil Spill Dispersants by the National Academy of Sciences—2006

(Note: this is my paraphrase of a NAS summary but all opinions are mine. Direct recommendations are given in quotes.)

Oil spill chemical dispersants are surfactant mixtures along with solvents which are intended to enhance the production of small oil droplets in the water. This is similar to the use of surfactants in oil-based or Italian salad dressings. There are many issues with oil spill dispersants including: the fact that the dispersions ultimately break down the oil rises; the toxicity of such dispersions and the effectiveness of products. These issues are covered in the main report. The major recommendations in the report are:

1. "Decisions to use dispersants involve trade-offs. Oil dispersants break up slicks, enhancing the amount of oil that physically mixes into the water column and reducing the potential that a slick will contaminate shoreline habitats or come into contact with birds, marine mammals, or other organisms in coastal ecosystems. At the same time, using dispersants increases the exposure of water column and sea floor life to spilled oil."
2. "The window of opportunity for using dispersants is early, typically within hours to 1 or 2 days after an oil spill. After that, natural "weathering" of an oil slick on the surface of the sea, caused by impacts such as the heat from the sun or buffeting by waves, makes oil more difficult to disperse. Therefore, failure to make a timely decision regarding dispersant use can be a decision not to use dispersants."
3. "Better information is needed to determine the length of the window of opportunity and the effectiveness of dispersant application for different oil types and environmental conditions. Given the potential impacts that dispersed oil may have on water-column and seafloor biota and habitats, thoughtful analyses are required so that decision makers can understand the potential impacts of a spill with and without dispersant application. A focused series of studies is needed to provide the information needed for an effective response to oil spills of all types and in various environments using both laboratory research and, in the event of a spill, field research in areas treated with dispersants."

Author's Comment—This recommendation has not been addressed significantly. Dispersant use in the Gulf has largely ignored any of the above considerations.

4. "More accurate methods of predicting the behavior of dispersed oil are needed to better predict the amount of oil that will mix into the water column. Limitations of current methods for predicting concentrations of dispersed oil in the water column include inaccurate representation of the natural physical processes involved in dispersal. Improved representations will allow."

Author's Comment—This recommendation has not been addressed. Further, the significant issue of the re-surfacing of oil after dispersion has not been addressed.

8. "Exposure to the air, the heat of the sun, and the turbulence of the waves can "weather" oil on the surface of the water, creating an emulsion; but no wave-tank or laboratory studies have investigated how dispersants would work on an oil and water emulsion. Studies are needed to investigate the chemical treatment of weathered oil emulsions."

Author's Comment—This recommendation has not been addressed. Further, the researchers have not addressed the technical definition of emulsions.

5. "The recent introduction of safer chemical dispersants means that the toxicity of dispersed oil now typically results primarily from compounds within the oil itself. It is known that breaking up oil slicks into smaller droplets exposes more of the toxic compounds in oil, such as polynuclear aromatic hydrocarbons (PAH), but in general the mechanisms of toxicity are poorly understood. With a better understanding of the toxicity of dispersed oil to marine organisms, data can be generated on toxic levels and thresholds for use by decision makers."

Author's Comment—This recommendation has not been addressed.

6. "The factors controlling the biological and physical processes which determine the ultimate fate of dispersed oil are poorly understood. Dispersed oil could accumulate in more stagnant areas, or could be consumed by plankton in the water column and enter the food chain. More detailed information on weathering rates and on the ultimate fate of dispersed oil are needed."

Author's Comment—This recommendation has not been addressed.

7. "Data from field studies on the concentration and behavior of dispersed oil are needed to validate models and provide real-world data to improve knowledge of oil fate and effects. Detailed plans should be developed, including the pre-positioning of equipment and human resources, for rapid deployment of a monitoring effort for dispersant applications in the event of a spill so that the consequences can be recorded."

Author's Comment—This recommendation has not been addressed.

5 Spill Research

Spill research is an important facet to develop capability to deal with oil spills. Many of the current capabilities to deal with oil derive from research programs. Research programs/projects may be divided into 12 general areas:

a) Recovery—This includes physical recovery methods such as skimmers, booms, and sorbents. While there was extensive development in this area in the 1970's, there has been little research other than commercial activity in this area. Since physical recovery is the prime recovery method suggested by several governments, this area should receive much more attention.

b) Treatment—This includes chemical treatment such dispersants, solidifiers, surface washing agents, biodegradation agents, etc. It is felt that far too much effort has been put into this area compared to the other areas resulting in generally disappointing outcomes. The agents have never performed as hoped and have consumed great amounts of resources that could have otherwise been devoted to other priority areas.

c) Arctic spills—This includes countermeasures in special areas such as the Arctic and the tropics. Performing a variety of countermeasures and understanding spill behavior in special areas such as the Arctic and tropics, requires special efforts and special studies. Similar to recovery projects, extensive efforts had been carried out in the late 1970's and early 1980's, but funding stalled out quickly and little work has been done since.

d) Burning—In-situ burning has been use sparsely in the past 20 years. Several studies have examined emissions and other factors. Some work has been carried out on other facets such as ignition and the use of fire-resistant booms. Only a moderate amount of work would be needed in the future.

e) Fate—The fate of oil includes long-term behavior and effects. This area has mostly been studied by post-assessment of spills. Problems with this include the lack of good starting data and the inability to measure critical parameters—especially at the start. Good experimental studies of this are very few. Since this is a very important area for assessing the long-term effects of oil spills on the environment, priority resourcing is suggested.

f) Behavior—The behavior of oil includes processes such as evaporation, emulsification, dissolution, dispersion, and many others such as plume rise and behavior during sub-sea blowouts. While evaporation and emulsification are now reasonably understood, there remains a large gap in knowledge of the other behaviors. These are fundamental studies and thus in-depth academic/research study is required. It is suggested that this is also an area where more research is required.

g) Effects—this includes the toxicological effects of oil on various biota and ecosystems. It is indeed a broad area. Much of the work in the past has consisted of acute toxicity testing on typical test organisms. Much more work is needed on specialized toxicity testing such as genotoxicity, endocrine disrupting capacity, and studies of sub-lethal effects. Long-term studies are particularly insufficient. This area is felt to be a priority for the future.

h) Analysis—This includes the development, improvement and testing of chemical and in some cases, biological test methods for oil. This area has received little attention in the past. Further, several groups are still using non-standard and in some cases, inappropriate methods, in their work. Some research efforts are needed in this area.

i) Remote Sensing—This includes the detection, tracking and remote sensing of oil spills. In the past this area had received moderate funding in the 1970's

and early 1980's, after which resources fell off. More efforts in this important area are needed.

j) Modeling—Modeling includes the prediction of oil location and state in the future as well as backtracking, evaluating environmental damage and predicting sub-sea rise and behavior. Modeling inputs are highly depending on information gathered in other categories such as behavior, fate and effects. This area had some funding in the past and is suggested to receive similar funding in the future.

k) Risk Analysis and Planning—This is a broad category including such studies as various forms of risk analysis, contingency planning, management analysis, etc. It is suggested that this area receive similar funding in the future, with emphasis on developing new methods.

l) In-Situ Remediation—This includes studies of bioremediation and natural attenuation. This area has received some funding in the past. It is suggested that similar funding should be placed in the future.

My own summary assessment of these research areas appears in the attached table along with assessments of project costs, durations, and input from the private sector.

Table on Proposed Research Priorities

Study Area	Expense[1]	Time[2]	Private Sector[3]	Effort to date[4]	Future effort[5]
Recovery	0.1-5	1 - 2	some	poor	more
Treatment	0.1-5	1 - 2	more	too much	little
Arctic	0.1-10	1 - 10	none	ok	more
Burning	0.1-2	0.2- 1	some	ok	some
Fate	1 - 5	1 - 10	none	poor	priority
Behavior	1 - 5	1 - 5	none	ok	more
Effects	1- 10	1 - 10	none	ok	priority
Analysis	0.1-2	1 - 2	none	poor	more
Remote Sensing	1 - 10	1 - 5	some	some	more
Modeling	0.1-2	1 - 2	some	ok	some
Risk Analysis	0.1-1	0.1 - 1	some	ok	some
In-situ Remediation	0.1-2	1 - 10	some	ok	some

Notes

1 - The projected project cost range in $ X 100,000

2 - The time in which one could run a project - in years

3 - The current input investment from the private sector rated as none, some, OK,

4 - The perceived research effort in the past - rated as poor, some, OK, too much

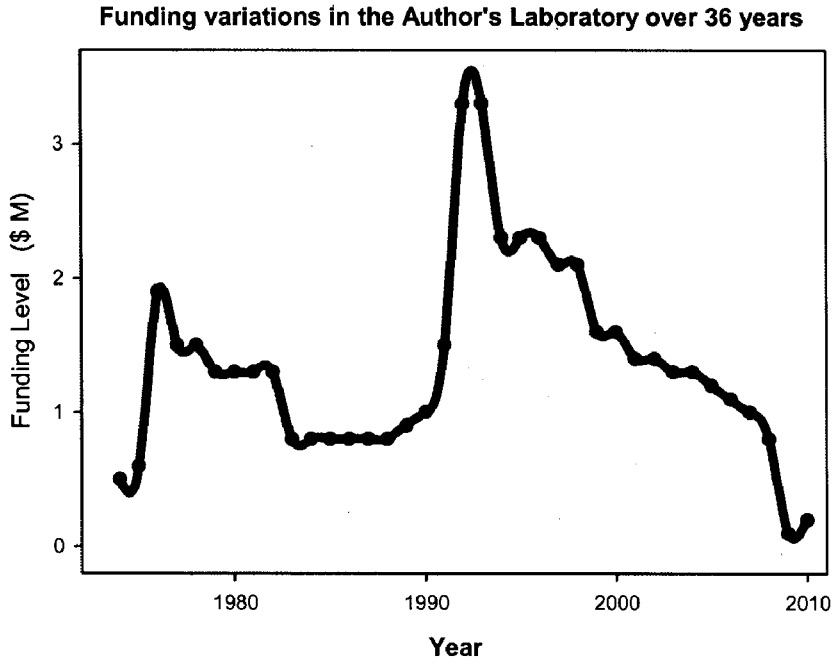
5 - The perceived future effort to be put into this field in the future, rated as little, some, same, more, priority

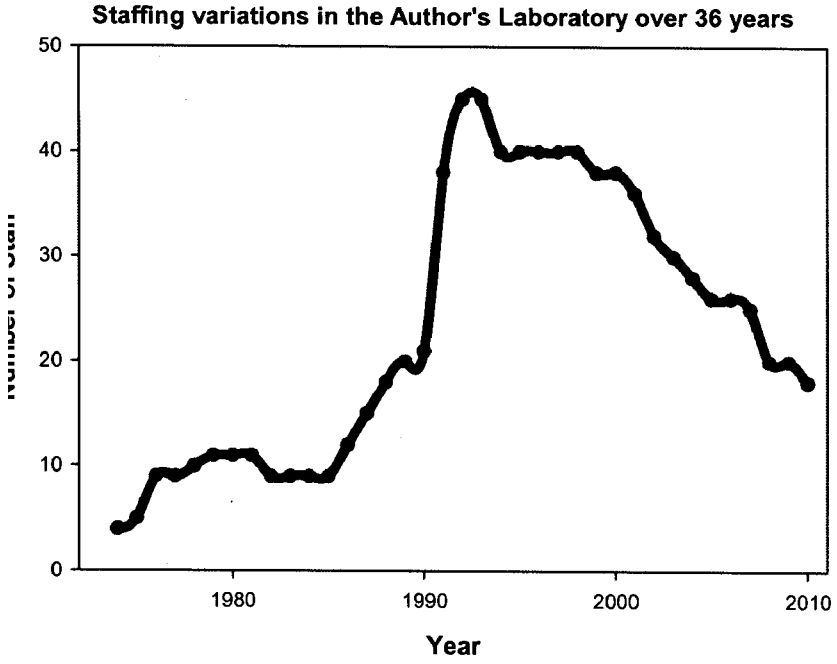
6 Issues in Spill Research

There are a number of issues in spill research for which I wish to present my views.

A) Highly Variable Funding Researchers in oil spills have, in the past, received highly variable funding. This is largely due to management perception about the priority of this area. A funding cycle typically goes up to high levels after a major spill such as the recent Gulf spill. Then two years later, 'other priorities' siphon off funding and soon the researchers are scrambling just to keep the labs operating. It is more typical that the research unit is then closed. New units are then opened after the next big spill. This type of cycling obviously does not lead to productive research, rather it is a waste of resources. It would be much better to fund the programs at a moderate level of funding for at least 10 years. It requires 2 years to have a new researcher become familiar with the oil spill field and 5 years to become fully productive. Many funding cycles do not enable new researchers to become productive in the field.

To illustrate the variability of funding the following two charts show my own research funding over more than 25 years. This is the funding given to the group by their own government agency. These figures show the high variability in resources over time. During this time the mandate and expectations of the program were about the same.


Funding variations in the Author's Laboratory over 36 years
Funding Level ($ M)
0
1
2
3
1980
1990
2000
2010
Year


Staffing variations in the Author's Laboratory over 36 years
0
10
20
30
40
50
1980
1990
2000
2010
Year

B) Impartial 'Research' An issue that does arise in the oil spill field is that of 'biased studies'. There are cases, particularly in chemical oil dispersants, where there are results completely contrary to those from similar studies. One of the problems is that proponents, often oil companies, have funding some of the studies. While this in itself is actually good, there are too many cases in which the 'opposing' points of view are funded by persons or groups having an interest in the matter. Rules might be established such as in the pharmaceutical industry, to ensure studies are conducted in a conflict-of-interest-free environment.

C) Re-Invention Because research is often started and stopped with the various funding cycles, there is much re-invention occurring. The start of many research groups is often marked by starting projects which had already been done in the past. Often 3 years are wasted in this type of re-invention. This is usually due to poor communication, lack of proper literature review (topics that will also be covered) and sometimes due to regional or local pride.

D) Literature The literature on oil spills and oil spill research is not used by some researchers. The reasons for this are not apparent. Currently most important literature is indexed on the searching program SCOPUS, to which can be accessed in almost all libraries or institutes in the world. Further SCOPUS also accesses important conferences on oil spills such as AMOP and IOSC. A personal story illustrates the issue. The author of this was recently present at a spill conference in Europe and presented a paper in an oil spill behavior session. Upon reading the proceedings it was noted that all of the other four authors had no references newer than 1982! These were more than 20 years old and many significant findings had been made in the meantime. Needless to say, all four of these presentations and papers were irrelevant.

E) Scientific Communication There are few communication fora for scientists—especially on an international basis. There are the annual AMOP seminars in Canada, the annual Environment Canada Research meetings and after that triannual conferences in USA, Europe and South East Asia. This has also created somewhat of a problem in that often communication occurs in only one of these three world areas and little communication sometimes occurs between scientists in the three world areas. Unfortunately many scientists, especially those from state or local organizations, are unable to attend these fora. Sometimes researchers never have the opportunity to meet their counterparts in other parts of the world or country in their lifetimes. Collaborative research is a good way to improve communication. It must be recognized that researchers need to directly communicate with each other and to attend the usual conferences and meetings as well as to engage in collaborative research.

F) Myths and Re-evaluation A number of myths have been developed regarding oil spills, and because of the many communication issues noted above, these myths persist to this day. Examples of these include: that dispersing oil improves biodegradation, that pour point is solidification point, etc. The opposite of these is true. It is important that new researchers to the field consult with experts long in the field to begin their work on a solid footing. It is important to avoid re-invention, but at the same time it is important to ensure that essential information is re-evaluated before proceeding.

G) Transient Research Because the funding for research is transient, often research institutes come and go within 5 to 8 year periods. This causes several problems. First there is a massive loss of resources with much output. Second, the new research institutes often draw away resources from older existing institutes. Thus, there is a net loss in research.

H) Good Field Data For most projects there is a strong need for good, reliable field data. 'Real' spill data would be particularly good. Plans have been developed for data collection, but never implemented. Collection of such field data was also a recommendation of both of the NAS studies noted above. Because of response priorities, research data is rarely collected during actual spills. This data would be priceless for future work. Further, access to good, qualified data should be given to any researcher with a legitimate need.

Response to questions submitted for the record by Merv Fingas, Committee on Oil in the Sea, National Research Council

Questions from Chairwoman Madeline Z. Bordallo (D–GU)

1. Given the scale and complexity of this oil spill and the unprecedented volumes of dispersant that have been used, do you think any of the recommendations in the 2003 and 2006 National Research Council reports should be reviewed or reevaluated based on these events?

Fingas response—I believe that the recommendations in the report are largely valid. Unfortunately, most of the recommendations were not followed. I believe both the report and some of the actions in the Gulf spill should be re-evaluated after the spill is over.

2. The 2003 report by the National Research Council predicted that the oil in a deepwater blowout could break into fine droplets, forming plumes of oil mixed with water that would not quickly rise to the surface. Why then are we apparently unprepared to manage the current situation?

Fingas response—Unfortunately the oil will still rise to the surface, albeit in 1 or more days. Thus the dispersants really do not make an overall difference in a situation such as the Gulf spill where the currents largely keep both the surface and subsurface oil in the same general area. Over one week about the same amount of oil is in the near surface area in the Gulf, irrespective of the amount of dispersants used.

3. Can you explain why studying the "fate" and "effects" of an oil spill should be given priority in future efforts?

Fingas response—The fate and effects of oil spills are important in that we need to understand these in the context of oil spill countermeasures as well as for environmental purposes. The fate and effect of dispersed oil, as an example, is very important in deciding whether to use dispersants or not. In some cases the long term fate and effects of an oil will make a very large difference to decision-making on spill countermeasures at the time of the spill.

4. The 2006 report by the National Research Council recommended the development of detailed plans, including pre-positioning assets for rapid deployment of a monitoring effort for dispersant application in the event of a spill. How could such a plan have changed efforts to respond to this oil spill? Should such planning, training and prepositioning and deployment of assets and equipment be required as a precondition to any new offshore oil and gas permits for drilling in OCS regions previously held under moratoria?

Fingas Response: There was little pre-positioning in the Gulf spill case. Several monitoring efforts were carried out, however for short periods of time. Because of the vastness of the area and the large amount of oil, it was impossible to truly assess effectiveness over a longer period of time, a day for example. Future planning should primarily focus on developing a strong scientific plan to measure dispersant effectiveness over at least a 12 to 24 hour time span. However, rather than strengthen monitoring plans, I suggest the use of dispersants be re-evaluated. In my opinion, there is no scientific evidence that dispersants contributed to improving the situation in the Gulf of Mexico.

Questions from Ranking Republican Member Henry Brown, Jr. (R–SC)

1. Dr. Fingas, you mentioned that: "Oil spills created a global awareness of the risks of oil spills and the damage they do to the environment". If that is true, why do you believe that most of the recommendations contained in your 2003 Oil in the Sea Report have been ignored?

Fingas response: I believe that the recommendations in the 2003 report were largely ignored because of the lack of funding and also because of a significant turnover in staff in the last decade. Many of the researchers and oil spill staff in governments and industry have changed in the past decade. Most organizations reduced staffing during this time period, thus existing and new staff had too many priorities to deal with. Examples of that also occurred in my own organization where during this same decade we saw a reduction in funding of over half, both in staff and in direct funding.

2. Could you update the Subcommittee on the top five sources of oil being spilled into our seas?

Fingas response: The major sources according the NAS 2003 report are:

a) Seeps—These account for about 57% of the estimated 2003 discharge. It must be stressed that seeps discharge oil slowly over a large area, an area that has long since been acclimated to deal with oil.
b) The second largest discharge is the release by consumers of petroleum hydrocarbons. This includes direct discharges into waters and land runoff. This is estimated to account for 32% of the discharge into the sea.
c) The third largest source is the discharge at sea through spills, such as tanker accidents and operational discharges. These spills are believed to account for about 12% of spills.
d) The fourth largest source of spillage was estimated to be associated with extraction processes such as discharges from offshore drilling platforms. This was estimated to account for 3 percent of oil releases.

There was no fifth source defined as the sources were grouped according to the above categories.

3. Based on your assessment of the causes of oil spills, as a matter of public policy are we better off encouraging greater imports of oil transported on tankers or offshore energy development?

Fingas response: I still believe that offshore energy development should be the focus. AS a cause of spills the Gulf oil spill is a very rare event.

4. What is the status of the National Academy of Sciences efforts to update its 2003 Report?

Fingas response: The National Research Council (the operating arm of the National Academy of Sciences) does not have independent resources to undertake studies or update reports. Studies are funded through federal agencies in response to requests from Congress, through a direct request from federal or state agencies, or, in some cases, private foundations. The Ocean Studies Board, the lead unit of the National Research Council on the Oil in the Sea report, would certainly consider a request to update the 2003 report. I cannot speak for the Academy, but in my opinion, priorities for updating the 2003 report include: the sharing of scientific information at this time, re-evaluation of all previous reports, and examination of the many gap areas. Examples of gap areas include the development of good data sets on real spills for further studies, studies of other countermeasures such as physical recovery and burning and longer-term studies of fate and effects.

5. How much oil is naturally seeping near the Santa Barbara spill in California? How does this compare with the actual amount spilled in 1969? How is this oil being removed from the coastal environment?

Fingas response: The amount of oil seeping naturally near Coal Oil Point (near Santa Barbara) is estimated to be 100 to 150 barrels per day. The oil well blowout near Santa Barbara released an estimated 80,000 to 100,000 barrels of oil over a 6-day period. This amounts to about 1000 times the oil released in one day by the adjacent seep.

It might also be noted that the Coal Oil Seeps release a large amount of petroleum gases as well (methane and other gases like propane), which are not counted in the liquid discharge rates.

The oil released from the Coal Oil Seeps are dealt with (by nature) in several ways: evaporation, tar ball formation, oil mat formation, plant coating and by biodegradation and consumption. Some of the oil leaves the seep area as slicks or in tar balls. There are many tar balls along the nearby shorelines. Some of these are manually removed by locals.

6. You make a comment that: "Using dispersants increase the exposure of the water column and sea floor life to spilled oil." Can you expand on why this is a problem and if it would be a better option to not using dispersants?

Fingas response: Increasing exposure to oil increases the toxicity and the uptake of oil by organisms. Previous experience and data show that the use of dispersants will sometimes increase the exposure of oil to marine organisms such that toxicity is the result.

The use of dispersants in near shore (water depth of less than 50 to 100 feet) is not a good option as toxicity is often the result.

7. If the best time to use dispersants is 1 or 2 days after an oil spill, is it appropriate to still be using them on Day 57?

Fingas response: Using dispersants after 1 or 2 days is futile and will not result in significant effectiveness. It is not appropriate to use dispersants on oil on Day

57, given that this oil has been out there—or is this fresh oil? The issue is how long has the target oil been out in the environment.

8. What is the impact of using Corexit as a subsurface dispersant on marine life in the water column?

Fingas response: This is relatively unknown as it has not been studied. The first approximation is that it would be similar to surface studies, but this may not be correct.

9. Would you have recommended the use of dispersants in this spill? Why or why not?

Fingas response: In the Gulf spill situation, I would not have recommended the use of dispersants because the surface and subsurface oil do not move much, thus negating any benefits from using dispersion techniques. Dispersed oil re-surfaces after time (1/2 day to 2 days) thus if the sub-surface and surface oils remain in the same area, there is no benefit. Further, a sub-surface release results in highly weathered and often emulsified oil, on the surface. Dispersants are not effective on such weathered or emulsified oils.

10. Why do you believe federal agencies were unable to learn any lessons from the Exxon Valdez spill, the Ixtoc I spill or more recent tanker spills?

Fingas response: I believe that the previous spill experiences were largely ignored because of the lack of funding and also because of a significant turnover in staff in the last decade. Many of the researchers and oil spill staff in governments and industry have changed in the past decade. Most organizations reduced staffing during this time period, thus existing and new staff had too many priorities to deal with. Further, there was little education on past spill lessons for a variety of other reasons. Many people believed that 'new' techniques and procedures negated the value of prior experiences.

Ms. BORDALLO. Thank you very much, Dr. Fingas, for your expertise and your recommendations. And we do have questions for all of the panelists, and I will begin with myself. David Kennedy from NOAA, this incident has exposed the liabilities of not having in place an integrated ocean observation capability in the Gulf, which has been pared back substantially over the past two years due to the cuts in the NOAA budget. Fortunately, NOAA has recently found funds to redeploy some of the assets, such as high frequency radar and gliders, to bolster ocean observations and improve our ability to forecast and project the movement of the spill.

Can you please, Mr. Kennedy, update the Subcommittee on what NOAA has done to restore ocean observation assets in the Gulf?

Mr. KENNEDY. As I stated in my testimony, those observations are essential to us being able to provide some of the products and services. Everything we would like to do in observations in this country we haven't been able to do, obviously. Funding is limited, and you always have to make decisions. We have as a result of this spill been able to bring many, many other assets that we didn't have funded, or haven't been able to acquire the funding for, to the scene, and actually execute everything from, as you suggest, gliders to some additional HF radar ships that are all on the water that wouldn't otherwise have been, AUVs. The list goes on and on. There is a partnership with the community in the Gulf, including Department of Defense, to bring those other assets to bear in this crisis. The funding for all of those types of things either is funding that has been diverted from other places or funding directly in support of the incident command, the unified command. So, that is the Coast Guard and so on.

So, we have provided a whole suite of new observational tools, but they come from communities where that was not standard practice and things that we were able to fund. So, we have the tools there, but it is because of the crisis, and we could always use more.

Ms. BORDALLO. Mr. Kennedy, how long does NOAA intend to maintain these assets?

Mr. KENNEDY. Well, certainly for the extent of the crisis now. And so as we look at there being oil into whenever the additional wells are drilled and the well release is stopped, we will keep those assets in place, and the probably beyond because there will be oil in the water and need to continue to track it for some time after the well has stopped. So, certainly into the fall, but we don't have the long-term funding stream to keep all those assets in place.

Ms. BORDALLO. So, until the fall. Is that what——

Mr. KENNEDY. Certainly into the fall. It depends on how many times we have interruptions in the drilling process over the course of the summer, but we are thinking September, October, at a minimum.

Ms. BORDALLO. So, for the Subcommittee records, do you agree that the Federal Government and BP's understanding of the spill, and response to it, could have been far more efficient and cost-effective had a regional, integrated, ocean observation system been up and running?

Mr. KENNEDY. Well, we had a system up and running. But what I am suggesting is that we have additional assets that we have had to bring on beyond what the Integrated Ocean Observing System had available to it.

Ms. BORDALLO. So, the system that you had up and running wasn't adequate?

Mr. KENNEDY. It was not comprehensive. We have a budget that is a national budget, and we have to very carefully look at how those assets are deployed nationally, so we could always do more than we have done, and you have heard about all the things we have put in place.

Ms. BORDALLO. All right. I have a couple of other questions for you. As you know, NOAA's Office of Response and Restoration has been severely underfunded for the past several years, and as a result had to initiate a stringent workforce restructuring plan to downsize operations. Do you feel that this downsizing impaired NOAA's ability to respond to the *Deepwater Horizon* spill? And what additional skill sets does NOAA need to restore the capabilities?

Mr. KENNEDY. Over the last several years, yes, we have seen decreases in that budget, and as a result have had to right-size, if you will, that organization. And as a result, we lost contractors and Federal employees to get to that location, or at least transferred Federal employees to other places. Our feeling, for some time, has been that capacity, if it were stretched by a very significant spill or two events at once, could certainly compromise our ability to respond nationally, and this crisis has certainly shown that those limited resources have made it difficult for us to do everything we would like to do.

That having been said, we have managed within NOAA to bring back retirees, some retired as long as 10 years, and tap other sources within NOAA, taking them away from their primary missions, to supplement the activities that the Office of Response and Restoration is responsible for on-scene and operationally. So, I believe we have been able to be creative, but if we hadn't done that, our capacity is somewhat limited, and we can do more.

Ms. BORDALLO. When did you bring back these former employees? Was that just for this spill, or were there on——

Mr. KENNEDY. No. Just for this spill, as our responsibilities increased. And as you have heard, command post and area command and an incident command, and one in Mobile, and so on and so forth, across the country. Every place there is a Coast Guard, NOAA needs to be there to provide the operational scientific support. And so as our responsibilities and the complexity of the issues increased, we started looking for other people to bring in, and we probably have as many as 10, 12 retirees back, but as a result of working for us directly on this spill.

Ms. BORDALLO. Now has this under-funding limited NOAA's ability to aggressively pursue the creation of a new oil spill?

Mr. KENNEDY. Of a new——

Ms. BORDALLO. Trajectory models.

Mr. KENNEDY. We have been working on a three-dimensional model. That has been one of the things that we felt, as we have looked at the deeper and deeper exploration, needed to be in place, and we have invested where we could. Obviously, if we had more resources, we could have moved that along quicker. We have been doing the best we can with the resources we have, though, to look at new models that we think are absolutely essential as we get into these kind of complex issues.

Ms. BORDALLO. Thank you very much, Mr. Kennedy. I now recognize the Ranking Member, Mr. Cassidy.

Mr. CASSIDY. Mr. Kennedy, we have had all of these people speak, and I have had the opportunity of going to my university in my home town, LSU, which has done a lot of this work. And I see Dr. DePortier has a microbe that they used, I think, in the Lake Barre spill that had been chewing up bacteria in that spill, and they felt like it has proven efficacy. So far, it has not been considered for this marshland spill. It makes me think that all of our responses are ad hoc. It is not like, OK, if there is a spill in a marshland area, this is how we do it. Rather, it is kind of like, oh, my gosh, let us bring the ship back from Africa. Let us try and hire a couple of boats that don't belong to us. Let us marshal resources, and let us figure out how we do this going along.

Now, is that a fair or unfair perception I have?

Mr. KENNEDY. I think every spill is unique, no question about it. And as a result, you have to be adaptive. Every spill is different, and you have to be adaptive.

Mr. CASSIDY. But, nonetheless, physics and biology are principles which apply in all situations. If there is a marshland spill in Lake Barre or Lake Peigneur, and we know that there is a certain marshland there, which granted there are issues peculiar to that, it seems like there are lessons that can be applied.

Mr. KENNEDY. The rest of my answer was that having been said, there is a significant amount of research that has been done for marsh cleanup, for instance. We have an international oil spill conference every two years, been doing that for 30, 40 years, something like that. We went back just recently, as a result in part of listening to some of your questions in previous hearings, and I think dug up 70-some specific presentations at the last several oil spill conferences that looked at marsh cleanup, and either research or direct experience from cleanups, and how they came out, and lessons learned.

So, we have many experts on the ground working directly on this spill that have either been involved in that research, been involved in a hundred spills in their careers, that have a lot of expertise on marshes.

Mr. CASSIDY. So, let me ask you again just because I haven't spoken to him directly, but I saw a press report.

Mr. KENNEDY. Yes.

Mr. CASSIDY. Dr. DePortier, who again was involved, I think, in *Exxon Valdez*, but also, I gather, in coastal Louisiana. He has got this bacteria that he says chews it up. We lay it out now; it is gone by—or at least mitigated by Christmas. And yet somehow he feels like he can't get a hearing on that.

Mr. KENNEDY. So, there has been a lot of work done on that bacteria. I am not specifically referring to the one you are——

Mr. CASSIDY. Yes.

Mr. KENNEDY.—addressing, but in general. And so we have a lot of experience with that kind of approach. I was at the *Exxon Valdez* and involved in the science there. I worked to look at some of those types of applications. What we have been saying pretty clearly to those—and I get calls daily, many of them being from folks that have some sort of a microbe-eating or an oil-eating microbe—our experience is that if you have a controlled environment, like a lake, that the application of those microbes may do some good. But when you have an open ocean environment, the one thing that we have research on is very clear, is that the microbial activity quadruple—oh, much more than that, that the microbial activity, those microbes that are eating the oil, just exponentially expand, and you have a natural environment where those microbes are actually very, very aggressively at work. And to apply another type of thing to what Mother Nature is doing a great job, in an uncontrolled environment, where you don't know where it is going to be next.

Mr. CASSIDY. Now, let me interrupt you because this is very good. Thank you for the interchange. When you say Mother Nature is doing a great job, it suggests you have a measure of optimism about how Mother Nature is currently dealing with the oil in the marshes.

Mr. KENNEDY. I do have a measure of optimism, quite frankly, and that comes from a lot of years of my own experience and the type of oil that we currently have at that marsh. That oil is highly degraded. The very, very toxic ends that are of the greatest concern to us in a marsh are missing by the time it gets to shore. That having been said, are there issues? There most certainly are issues, and they have to be addressed. But there are a number of tech-

niques for cleaning marsh that we have been recommending that I think may be used. And quite frankly, one of those is to leave it alone because if you get in there and start messing around with it, you may make it worse than it is already going to be.

Mr. CASSIDY. Now, let me ask you two more things, if I may. I was told—and again, I have learned in this job to say what I have been told, not what I know—that about a year or two ago, that NOAA was approached. It was recommended by academics that you purchase an ROV to begin to do research in the ultra-deep and the deep, and NOAA said, no, we don't need to do that. Now is that true or not true, or no money, or what?

Mr. KENNEDY. I don't have firsthand knowledge of that. I know that in NOAA we have been discussing ROVs and their application for some time. We certainly have been using private enterprise to do some of that. But I may have somebody on the panel that can help me. I can't specifically answer. I would be happy to get back to you.

Mr. CASSIDY. Dr. McNutt is raising her hand.

Mr. KENNEDY. She is writing me a note, and I would just prefer she speak, if she has the right——

Dr. MCNUTT. NOAA is commissioning, through their ocean exploration program, an ROV for their flagship, the *Okeanos Explorer,* and that ROV is coming online.

Mr. CASSIDY. Is that in reaction to this, or was that a plan?

Dr. MCNUTT. No, no. That is a plan that has long been——

Mr. CASSIDY. Got you. Last, just because I am out of time, not that I don't have more questions, you mentioned that there are a lack of dollars, and I look at your budget for your—I don't have the acronym. Ocean Observations Regional Observations program, your Fiscal Year 2010 enacted budget is 27 million. Your Fiscal Year 2011 present request is 14.6 million. It seems like you are saying that you don't have enough money, but you are cutting your budget, which requires, I guess, a note of explanation.

Mr. KENNEDY. Well, I would like to submit something specifically, but it is my understanding there is an anomaly in those numbers you have that the budget is stable. It hasn't increased, but that the budget over the last two or three years has been pretty much stable. So, there is an anomaly in there, and I can't give you the exact reason for that, but I would be happy to get back to you.

Mr. CASSIDY. Yes, because it looks like your request is down 12 million relative to last year.

Mr. KENNEDY. There is an anomaly in there, but I have been told by the IUS people that there hasn't been—they specifically tell me that there has not been a decrease, but there is an anomaly in there that I can't address you.

Mr. CASSIDY. I yield back.

Ms. BORDALLO. I thank the Ranking Member. I have one question before I recognize the next member of the Committee. Last week, I was in Guam, which is my home district, and I boarded the NOAA research ship out there. I understand it is equipped with the latest scientific—would this ship be of any use in something like this? I was very impressed with what they can do.

Mr. KENNEDY. Possibly. You should know that we have a number of vessels throughout the Nation stationed in different places, and over the last couple of months, a number of the missions of vessels that are more directly in and around the Gulf area have been repurposed and now are on sometimes their second and third mission, specifically supporting the oil spill response.

What we have tried to do is understand that the whole agency shouldn't grind to a halt to do this, that we have many, many other very compelling responsibilities. And to the extent that we can we haven't tried to bring the whole fleet back from the world to do this. If we felt like we could either contract with academic institutions or use our ships more closely to the scene—and that is what has happened. And so those ships that are far, far away, we are trying to let continue to do their very, very important missions where they are.

Ms. BORDALLO. Well, I know, Mr. Kennedy, you have approximately 10, is it, NOAA vessels. But this is supposed to have the very latest scientific equipment on board, and they are over there in the Marianas Trench area. So, I just wondered. I mean, that is a deep area.

Mr. KENNEDY. I am not familiar with the specific vessel, but I think the technology that you may be referring to is actually on a vessel that is in the theater in the Gulf now and doing similar work. And I think it has to do with some of our surveying and charting side of the house.

Ms. BORDALLO. Well, thank you. I would like now to recognize the gentleman from CNMI, Mr. Sablan.

Mr. SABLAN. Thank you very much, Madame Chair, and thank you for leadership on all these important issues facing us today, not just the spill, but on every day with wildlife. I believe that whenever oil touches water, we have lost the fight. But also lives have been lost in this disaster. Livelihoods have been disrupted. And, of course, living organisms may be affected for a very, very long time. I also think that the response by Federal agencies have been inadequate.

I am very happy that our President is down there for the fourth time, and that he is going to be addressing the Nation tonight. And I hope he could start kicking some behinds, not just for the private sector, but with Federal agencies. I really believe that the response there has actually been no response. We have been reacting to some of these things. And, of course, again today, you know, we are saying that if we had the resources, if we had more money, we would have been able to respond. But this is something I hear every time there is a major event in the nation, if we had more money, and we never seem to have enough money going anywhere.

But again, I am not blaming anyone at the table today. Some of you have done really good jobs, too. But, Dr. McNutt, your testimony, you mentioned that the U.S. Geological Survey's presence is in all of the 50 states and Puerto Rico. What about the territories? You know, there are other places. We have American Samoa, Guam, the Virgin Islands, and the Northern Marianas, which right now has three active volcanoes that are always spewing something up there.

We had people actually on one of the islands just right next to the volcano, and it erupted because there is no way for them to tell that it was going to erupt. There was ground shaking, and then the next thing we know, they erupted, and those places don't even have radios. And other Federal agencies send people up there. I mean, I am not talking about a couple of people at this time. There were over two dozen people up there doing surveys for eventually for something we have absolutely no—what happened? Is it more money?

Dr. MCNUTT. Well, we have a volcano hazards program. And the truth is that volcano hazards and volcano eruptions are one of the hazards that is forecastable with instrumentation in place.

Mr. SABLAN. Exactly.

Dr. MCNUTT. And in this particular case, we are working through our funding to make sure that volcanos that are viewed to be in imminent danger or forecast to be in populated areas are indeed monitored. And I don't know in the case of these particular volcanos whether they were being monitored. I do know that there have been a number of wonderful examples of volcano warnings that were put out in a timely fashion. And for the record, we can get back to you on this particular one, as to whether—where it is on the schedule to be instrumented, and whether it will be or not. But——

Mr. SABLAN. Thank you. And actually, you know, these are uninhabited islands, and I fly over them all the time, going to catching a flight, trying to get to the East here back. Airplanes fly over these islands.

Dr. MCNUTT. Yes.

Mr. SABLAN. And that is the last thing we need, is for one of these volcanos to explode and hit an airplane. Then we would be hearing if we had more money. And we are here for a different reason.

Dr. MCNUTT. Yes. The truth is that our focus has been on inhabited islands, and through a program that we had in conjunction with the FAA, we did have funding for the aircraft safety.

Mr. SABLAN. But I am just bringing this up, and thank you. But no. Thank you for all of the things that you have done. NOAA has been a good partner in the islands. And USGS, too, has done some good for us. Madame Chair, I thank you, and I yield back my time.

Ms. BORDALLO. I thank the gentleman from CNMI, and now I would like to recognize the gentleman from Virginia, Mr. Wittman.

Mr. WITTMAN. Thank you, Madame Chairwoman and members of the panel. Thank you so much for joining us today. I want to begin with Mr. Kennedy and Dr. McNutt. I was interested in your comments about this idea of lack of resources, and that resources were directed in other areas outside of research toward the effective oil spills and, specifically, in these deepwater areas. I am wondering that in the decision making process, it seems to me that there were some decisions about priorities, some decisions about risk.

I would be interested for you to tell us then if this scenario, understanding a deepwater spill, understanding the effects on the environment in these areas, under this sort of condition, what took a higher priority in funding outside of understanding a spill? What directed both of your agencies to say, you know, we are not going

to put any more resources to understand what a catastrophic spill may look like in a deepwater area, Gulf area, or otherwise. But we are going to make a decision to direct the resources elsewhere.

Tell me, what else out there is a bigger risk? What took priority over understanding the full scope of what a spill like this would create for the Gulf region?

Mr. KENNEDY. That is a tough question. However, again, I don't want to overplay the years of being involved in oil spills, but I have been involved for a long time, 25-30 years. And historically, what you see is a cycle. That is exactly where we are now. This cycle over the course of the majority of my career was about five years. You would have a major event, then a number of other things would come up. The event was over, you didn't have anything new, you lost the publicity you had, whatever the issues of the day were. And certainly, there are many that I can think of that have been pressing and concerning us, including climate change, of course, but a variety of other things that you could list as priorities.

But with the passage of the Oil Pollution Act, an extended period of time beyond the five years, to where, you know, a major spill is considered 100,000 gallons or more, we haven't had that many major spills since the *Exxon Valdez*, and certainly nothing that even begins to approach the *Exxon Valdez*. And so there is a very difficult challenge in any organization. And when you think of all of the challenges in, say, for instance, NOAA, as an agency, oil spill response is one of 100, 200, 300. And to compete when there is some of that lack of urgency, and the Oil Pollution Act seems to be extremely effective, you have a difficulty. And so it is not that we haven't continued to plug along. We have. And that is why we have some of the expertise we have today. That is why we have trajectory models that have been quite effective. That is why we have a damage assessment program that has been out there since the inception of this spill, with our other Federal and state partners.

So, it is not like we haven't been there. But I think it is a fact of life that when you don't have a major event, it is a hard time to convince people that it is the most pressing thing until you have the next one.

Mr. WITTMAN. Dr. McNutt?

Dr. MCNUTT. Yes. The USGS has a very vigorous hazards program that is quite distinguished in its work in earthquake hazards, volcano hazards, flood hazards, fire hazards. And we can't get through a year, a season, without making major headlines for the lives we saved and the property we have saved through the forecasting and the hazard reduction through those programs. And the good work through those groups and the industries that back them, through their efforts, by saying, you are helping through your collaborative work with the industries to show where hazards are great by working with the industry to make buildings better, by making highways safer, showing people where to build, showing how to work in the wildland fire-urban interface, and work to make that zone safer, et cetera, how to help people who are in flood districts understand how to mitigate their flood risk, et cetera, whereas when we look at the oil problem, we have the industry telling us over and over again there is no problem. You don't need to

worry about this. Ships are safer. Platforms are safer. Drilling is safer. We have everyone telling us that there is no problem. And whereas in all of these other areas, the industry is working hand-in-glove with the USGS to help us identify those hazards and reduce the hazards, and every season we find the risk happening and the hazards. We work to reduce the hazard and make the American people safer.

Mr. WITTMAN. Thank you, Madame Chairwoman. I would say in this case, though, that what the industry was telling you obviously was wrong.

Ms. BORDALLO. I thank the gentleman. And now I would like to recognize one of more senior members of our Subcommittee, the gentleman from Michigan, Mr. Kildee.

Mr. KILDEE. Thank you, Madame Chair. First of all, I would like to commend the witnesses. Collectively and individually, I admire you for what you are doing. Knowledge is power, and very often we have little or no idea where that knowledge may lead us or how that knowledge may be used. But we must constantly pursue that knowledge. And I have been here in Congress now for 34 years, 12 years in the State Legislature, and every year you will have someone offering an amendment, amending a bill, cutting out this research. Very often it is the reproductive life of some species, and say this is a silly waste of taxpayer money. But we have to be aware. As a matter of fact, one famous senator, Senator Proxmire was someone for whom I had high regard, but not in this area.

He used to award the Golden Fleece award, and would offer amendments to cut research. But research is extremely important. And what you do very often, you may not know where that may lead or how that may be useful. But just research itself and the funding of research is very important. So, I commend you for what you do. We want to make sure we don't have any intellectual Luddites in the area of research or in the area of lawmaking.

So, something that you may have started, or one of your partners may have started, years ago in research leads on to more and more. And the more we know about the earth, the planet earth, and that around it, what it is made up of, what its various living organisms can do, the more that can help us in addressing problems.

So, I just wanted to make a statement that I have great admiration for those of you who really have dedicated yourself to that area of our search for knowledge. And I thank you very much. Thank you, Madame Chair.

Ms. BORDALLO. I thank the gentleman from Michigan, Mr. Kildee, and I would like to now recognize Carol Shea-Porter, the gentlelady from New Hampshire.

Ms. SHEA-PORTER. Thank you very much. Mr. Kennedy, I listened with great interest. You said you had about 25 years experience. Am I correct in that? And how long have you worked for NOAA?

Mr. KENNEDY. About 21 years.

Ms. SHEA-PORTER. OK. So, let me just read a little bit of your testimony again. Let me tell you where I am going with this. I appreciate the fact that everybody is working so hard on this. I appreciate the fact that everybody worked so hard after Valdez. I appre-

ciate the work we always do afterwards. But I need to know, my constituents need to know, Americans need to know, why we are always on the job afterwards. What happened between Valdez and now? What was NOAA doing? What were these conversations about? Why, why could we be in this mess right now?

The more we learn about this, the more disgraceful it is. When you are saying don't worry, don't worry, the oil company is in charge, this is of great concern because I thought NOAA was in charge of our coastline and protecting our assets. I thought other Federal agencies were in charge. I thought the MMS was supposed to be in charge.

So, I am trying to look back because otherwise we are going to sit here again. I don't know if it will be a year, five years, ten years. We will be sitting here again, and we will be talking about my personal favorite phrase, "lessons learned," whatever that means, lessons learned. So, please let me ask you a couple of questions. First of all, you said that NOAA is a natural resource trustee, and it is responsible for protecting, assessing, and restoring.

Well, if it is a natural resource trustee, and you said that you were at hearings—I don't know if NOAA held them or you just attended international oil spill conferences. What did you talk about? Did anybody ever say—let me add this. Did anybody say—like when my boy was ten years old, he and his friends would get together in a room and imagine the worst thing that could happen. Did you ever talk about the worst thing that could happen?

Mr. KENNEDY. I think we did. And let me just back up and say that at the time of the *Exxon Valdez* spill, we heard the same sort of indignation in hearings that I was involved with then. That really resulted in the Oil Pollution Act. The Oil Pollution Act has a title, a research title, Section 7. Meetings were held across all of the Federal, state, and local academia to talk about what that plan should look like, a research plan. It was developed. We can go back and show you that plan.

For the most part, the investment that would be required to follow through with that, from lessons learned, never occurred, as far as I know. Did NOAA and a few others go out and try and do what we could with the resources that we had? We have done long-term studies as a result of the *Exxon Valdez*, not only looking at cleanup methodologies that worked and didn't work. During that spill, we actually got Federal, state, and local entities to allow us to leave some areas unclean so that we could go back and look.

So, we have done a variety of things, including, as we saw more and more dollars dry up across the rest of the Federal agency and industry. There was something called the Marine Spill Response Corporation developed by industry after *Exxon Valdez*. This was a nationwide effort, $60 to $70 million a year in research and development to look at these kinds of things. That lasted for three or four years, then it dried up. We looked at the American Petroleum Institute that had money for research. It went away.

So what happened, at least in NOAA's case, is we developed a partnership with the University of New Hampshire and developed a small research——

Ms. SHEA-PORTER. I know. And they didn't get money. They haven't received money since 2007 for their——

Mr. KENNEDY. Correct.

Ms. SHEA-PORTER.—for their coastal cleanup.

Mr. KENNEDY. Correct.

Ms. SHEA-PORTER. So, let me pull us back into focus again. You said it went away. Under which Administration? And was there any protest? It is not good enough to say the money went away. I feel that if you knew and feared this, and others in your job and in these agencies feared that this could happen, I think the response should have been a lot larger than it was. I hear your frustration, and I am glad that you did reports. But I think if the average American had known—and I think it is the job of Federal agencies to be those bulldogs for us—and had stood up there and said, hey, guess what, they are putting leases out there; we have no idea what to do. And we just thought that the American public needs to know that. There needed to be a very, very public challenge.

What we are uncovering right now is astounding, absolutely astounding. And I am just wondering if the agencies, the Federal agencies that were involved in protecting and assessing, were ever invited to the table to talk to the oil industry when we had a previous Administration developing oil policy? Were Federal agencies involved, or was this all just the oil company making their own decisions, running everything, and telling agencies like yours that, don't worry, we have it under control, because if we don't get more aggressive, and if we don't take on the role of guardian, then we will fall victim to this again and again and again.

So, when you have that oil spill conference, was that a central topic, that this could happen, and were there Federal agencies there saying, we don't know what to do? We have had several hearings now, and the general consensus is that we didn't know enough of what we were doing. We didn't know the impact on the oil. We don't know if this would actually have a blowout. We wouldn't know how to stop it. It is unbelievable what we didn't know. And I talk about the arrogance of moving forward when we don't know this. And now here we are.

So, at the international oil spill conference, can you tell me who attended?

Mr. KENNEDY. It was a cross-section of everybody, from industry to all the Federal agencies to state and academia. It represents anyone that has an interest or an investment or academic research.

Ms. SHEA-PORTER. OK. So, in the very basic, simple terms, did any of you walk up to any of the guys in the oil industry and say, hey, do you know how to cap a well?

Mr. KENNEDY. I don't recall asking that specific question, but it is a forum to get people together to say what is the state of the state and what else needs to be done.

Ms. SHEA-PORTER. Yes, but here is the question, OK? You may talk about oil spills, but did anybody with the oil companies sitting right next to you, right—you are all there together. Did anybody say, does anybody know what to do if we have a problem like this in the Gulf? Was did you ever have a tabletop model exercise?

Mr. KENNEDY. I cannot recall that. Does that mean it didn't exist or didn't get asked that way? Maybe. But I certainly wasn't involved in that, and I can't recall it.

Ms. SHEA-PORTER. This seems to me to be the very first question when you start talking about oil spills, not what do we do and how will we do the science, but how do we prevent it. And so far, I am bitterly disappointed that I haven't heard anybody say that we stood up to the oil companies and said, you know what, I don't think you guys know what you are doing yet. Thank you. I yield back.

Ms. BORDALLO. I thank the gentlelady from New Hampshire. We have a second round of questions here that have been asked, and I do have a few myself. Dr. McNutt, I have a question for you. This has to do with flow rates. Recognizing that future estimates of natural resource damages will depend on the total estimated volume of oil released, do you think it would have been important to do this at the outset of the spill?

Dr. MCNUTT. Ultimately, we will absolutely need to know what the flow rate is. I think response is very much an all-hands-on-deck, everyone doing the maximum they can, and that from what I understand, the ultimate response—or the ultimate damage recovery will not be determined until very far down the road, when we actually believe we can calculate what the damage to the environment has been. And we will probably have a very good handle on what the flow rate is at that point because it will have been captured, so it won't be based on looking at video or other calculations, which will probably always have uncertainty associated with it.

So, we have to know sooner or later. It is going to all be captured at some point. We will have a very accurate record at that point.

Ms. BORDALLO. The second question. It is my understanding that scientists from Woods Hole Oceanographic Institute were ready to take flow measurements, but the project was put on hold during deployment of the containment dome. And BP did not contact these scientists again. If the ability to take these measurements was immediately available, why didn't the Federal Government ensure that these flow measurements were taken right then and there?

Dr. MCNUTT. Woods Hole did get two deployments in the field with their sonar equipment to calculate flow rate, one prior to the cutting of the riser and another post-cutting of the riser. Their deployment post-cutting of the riser was with their high powered sonar, not with also the acoustic Doppler current profiler because their contractor had run out of time.

Ms. BORDALLO. OK. For the record, Doctor, I would like to just maybe repeat that question. In other words, did BP not contact these scientists again? Yes or no.

Dr. MCNUTT. I am not sure about BP. I was working through the Coast Guard, who had actually contracted with Woods Hole to do the work, and the communication with the Coast Guard and Woods Hole on the timing of it was very good, and they got in the field, and everything went well.

Ms. BORDALLO. So, in other words, it wasn't completed, in your opinion, because this is what we have on our record.

Dr. MCNUTT. The work was completed. There were delays simply because of problems cutting the riser so that Woods Hole wasn't able to get all of the measurements they wanted just because it took more time to cut the riser off than had originally been planned.

Ms. BORDALLO. All right. Are flow measurements being taken on the oil leaking from the lower marine riser package cap?

Dr. MCNUTT. Differential pressure readings are being taken that will help determine the flow, and we will find those measurements useful.

Ms. BORDALLO. So, the answer is yes.

Dr. MCNUTT. Yes.

Ms. BORDALLO. All right. Dr. Coddington, your testimony stated that approximately one-third of MMS collections at the Smithsonian need further work to evaluate the effects of the spill. What additional steps could be taken to enhance the value of these collections?

Dr. CODDINGTON. Well, these are collections that come to us. What MMS does is to contract with various contractors to do the work, and in that contract it stipulates that the collections will come to the Smithsonian. They come to us in whatever shape they are. In order for us to make them maximally valuable for science, we need to catalogue the collections, we need to make sure that all of the—it is called meta data, which are all of the physiographic, all the oceanographic, all of the chemical data that is associated with those specimens—is attached to each one of those specimens. And there are thousands of those left to go.

Ms. BORDALLO. Where does the funding for this come from?

Dr. CODDINGTON. For the last 30 years, it has come through an interagency transfer through the Minerals Management Service to the Smithsonian, at a relatively——

Ms. BORDALLO. So MMS then, yes.

Dr. CODDINGTON.—moderate level, yes.

Ms. BORDALLO. What resources would it take to make all relevant collections publicly available?

Dr. CODDINGTON. We have been working on a budget for that. I think it would be $9 million in two years.

Ms. BORDALLO. In two years, how long. So, that answers that question. All right. Thank you. I would like now to turn over the next set of questions to our Ranking Member, Mr. Cassidy.

Mr. CASSIDY. Mr. Fingas, is it Doctor or Mister?

Dr. FINGAS. Doctor.

Mr. CASSIDY. I see that you were on the oil dispersant task force way back then. Has there been any research that you know of or that you can inform us of, of the use of dispersants in the ultra-deep?

Dr. FINGAS. Not that I know of. There has been almost no research, either through coordinated committees such as the National Academy of Sciences, or by various agencies to study such. And perhaps the reason for that is simply that it has not really been attempted before, at least not to my knowledge anyhow.

Mr. CASSIDY. So, I scanned—the staff was nice enough to get me the executive summary—the conference you referenced. As I scanned it, you did have specific recommendations as to research going forward, but the use of dispersants kind of at the mud line, if you will, was not envisioned. I am just curious; I don't know. It was not envisioned, or it was not felt—you see where I am going with that.

Dr. FINGAS. That is right. It wasn't envisioned at that time.

Mr. CASSIDY. And not envisioned just because people had serious reservations about it, or just because they just didn't imagine its need?

Dr. FINGAS. I think for both reasons. I wasn't directly a part of that committee. I was a reviewer and contributor, but during part of this discussion, my recollection is that both issues came up.

Mr. CASSIDY. And do you have concerns about using dispersant at the mud line in the ultra-deep?

Dr. FINGAS. Yes, I do.

Mr. CASSIDY. Can you elaborate?

Dr. FINGAS. I am most concerned because the ability to measure their effectiveness is extremely limited because if they do enter the oil at that depth, the rise time to the surface is in the order of weeks and months perhaps, which means that you would never know if they worked or didn't work.

Mr. CASSIDY. Now let me ask you, Ed Overton—when I discussed this with him—he clearly was conflicted—at least I interpreted a conflict within his soul because he says, you have to break the stuff up. And if you don't have a lot of wave action, you are going to use a heck of a lot more dispersant on the surface. I am not speaking for him, but my impression was that he accepted the tension. He wasn't sure how he landed on the side of the tension, but what would be your opinion— you know, how many barrels are forming chocolate mousse on the surface, or just what are your thoughts about that?

Dr. FINGAS. Well, for a deep sea release, I think the major problem right now is that we really don't understand enough about it and enough about any emulsion formation. It does appear that the emulsions are actually formed underneath. So, with or without dispersant——

Mr. CASSIDY. Now, that is different from the oil plume of which we have been speaking because I gather the oil plume is actually very dispersed hydrocarbons measured only in parts per million. Do you feel as if there is a chocolate mousse beneath the surface?

Dr. FINGAS. Oh, absolutely. I mean, we have seen photos of it. And during the Ixtoc spill, we also saw that chocolate mousse was formed along with regular oil droplets.

Mr. CASSIDY. So, is there chocolate mousse under—I just missed that. Is there chocolate mousse beneath the surface in this particular spill, documented?

Dr. FINGAS. As I understand—and perhaps you might redirect that question.

Mr. CASSIDY. Let me kick it over to Kennedy, if you don't mind.

Mr. KENNEDY. I think you are right in characterizing the majority of the plume as microscopic droplets, and primarily parts per billion, not million. There are some parts per million, but primarily a lot of the results we are seeing are billions, not millions. The mousse is more of a surface event, and we certainly don't believe that below the immediate surface—now, you know, a meter or two or three, in that range, there could be mousse formations, but at depths we don't think——

Mr. CASSIDY. Let me ask you. It seems like just in a very fortunate way, we have a living lab right now. And clearly, what we don't have is a lot of research on these events. Are you currently

letting prospective studies on these effects to academic—frankly, coming from Louisiana, I want my universities involved because I know they will still be involved in 10 years and haven't moved on to whatever the next crisis is. So, have you involved academic in a prospective, well-funded study to look at these effects, and two, have you looked at the ones along the coastal region to specifically go with?

Mr. KENNEDY. As you probably know, Ed Overton has been a contractor for my organization for some time. I was just on a panel with him, the state of the coast in Baton Rouge, last Friday. And we have them actively involved in doing the analysis of the samples that are being collected. We do have a variety of different academic institutions out there, working for and with us.

Mr. CASSIDY. But prospective studies?

Mr. KENNEDY. Correct. I am sorry.

Mr. CASSIDY. Prospective studies.

Mr. KENNEDY. Prospective studies, we had a science summit two weeks ago to look at these very types of issues to develop some longer term studies. They have not been funded.

Mr. CASSIDY. But let me ask. It really seems as if, if the dispersant is being released at the mud line, and we hear from the guy that was on the panel that, well, we had concerns about it back at the panel, now is the time to study that. Do you follow what I am saying?

Mr. KENNEDY. I absolutely do. And certainly, the first step in studying that is to adequately sample and do all the other variety of things, whether it is——

Mr. CASSIDY. But in a peer-reviewed study, you would still have to have some sort—I mean, ideally, right now, on parallel, you are not only doing samples at baseline, but you are also coming up with the study criteria, what is my hypothesis, et cetera, so that as soon as you got your baseline, boom, you have let in an RFP, and you have somebody out there bidding on it.

Mr. KENNEDY. And if that particular—what you just described is already completely played out, I don't know. But are we thinking about it? We absolutely are. And are we doing the background work right now in terms of sampling, you know, in a series of concentric circles around the spill and looking at the subsurface plume so that we have the background data that could lead to that research, we are doing that.

Mr. CASSIDY. I yield back.

Ms. BORDALLO. I thank the gentleman, and would like to recognize the gentlelady from New Hampshire, Mrs. Carol Shea-Porter.

Ms. SHEA-PORTER. Thank you. As a natural resource trustee organization protecting our coastline, I have to ask a couple more questions about this. You know, children go and take collecting plastic bottles very seriously, and Americans of all ages have worked very, very hard in conservation. And the betrayal that they are experiencing right now, knowing that agencies, Federal agencies and other agencies that were charged with protecting the coastline, in some way stood at least passively, instead of as activists, watching what was happening in the Gulf. This is very painful. This is extremely painful for all of us.

So, did you have any authority or any voice or any opportunity to comment on the drilling in the Gulf, lease applications, these kinds of drill designs, anything? Was your agency ever consulted?

Mr. KENNEDY. Are you directing this at me, NOAA?

Ms. SHEA-PORTER. Yes.

Mr. KENNEDY. We are consulted. We don't have any final authority. We have no Yes/No vote whatsoever. But in the process of looking at leases, we have the opportunity to talk about our trust resources and concerns we may or may not have. So, we comment, but that is it. We comment.

Ms. SHEA-PORTER. Do you know if you commented on this particular well or any like this?

Mr. KENNEDY. I think we may have, but I would like to get back to you for the record on that.

Ms. SHEA-PORTER. I would like to know.

Mr. KENNEDY. Yes.

Ms. SHEA-PORTER. Can you think of any other wells that you may have commented on? Have you personally ever written a statement or expressed concern that the oil companies were going too quickly and they didn't have the safety procedures, and that they might not be able to cap?

Mr. KENNEDY. No, I have not.

Ms. SHEA-PORTER. Did you ever worry about it?

Mr. KENNEDY. I think in the course of understanding how things are, we always worry about an event. We know that anything is possible. You look at the probabilities, but certainly we have always been concerned about major issues, yes.

Ms. SHEA-PORTER. OK. So, you have been concerned about major issues. Such as this? In your worst case scenario, could you imagine this?

Mr. KENNEDY. Quite frankly, no. I did not think of this one, at least for this duration. I have been involved in other blowout situations. I was involved in the Ixtoc spill for a bit. So, I mean, we know that these things can happen, but——

Ms. SHEA-PORTER. When you were commenting on the various wells, did you ever discuss the possibility? I mean, if you had a voice—now you said you didn't have authority, but you had a voice and an opportunity to comment on this kind of drilling in the Gulf.

Mr. KENNEDY. My agency has the opportunity to do that. It is primarily through Endangered Species, Magnuson-Stevens, Marine Mammal Protection Act. None of those things are my expertise or my particular organization. But the organization does have an opportunity to comment, yes.

Ms. SHEA-PORTER. OK. Where I am going with this is that I don't know if NOAA expressed concern, reservation. I am trying to figure out how active your organization was because you are charged with protecting the coastal environment. And clearly, what we are talking about now shows an utter lack of attention to the risks here, on the part of many agencies, I might add. And I think that all of us have had a very sad and ugly wake-up call here about what we are doing.

But did anybody, anybody say to BP, you know, this doesn't look so good; what if? Is that your agency's job to comment like that?

Mr. KENNEDY. Our agency's job is to comment to MMS in particular when they are looking at leases and to provide our input and/or our concerns. We have expressed concerns about a variety of issues over some time. I know it has been brought up in some of these hearings. But again, it is not me specifically that can address that.

Ms. SHEA-PORTER. OK. I would appreciate if you would get back to me then very much. Thank you. And then I just have one last question. Was your agency ever consulted, Dr. McNutt?

Dr. MCNUTT. The USGS is a science agency, so we have no management and no policy no opportunity to say yes, no, up and down on anything. So, no, we would not have been consulted on this. But let me take this moment to give you a little bit of perspective on this particular situation, simply because having been in this job now for about six months, I think in a case like this hindsight is 20/20. And from the standpoint of the USGS, until April 20th, let me tell you what my life was like.

I came into this job in November, and for the first two months, it was pretty quiet. Then I had Haiti, Chile, 8.8 earthquake. I had Asian Carp invading the Great Lakes. I had a California water crisis that looked like it was going to put the sixth largest economy in the world on its knees. I also had Eyjafjallajökull that was closing down the most populated air route in the world, and that was still spewing out ash when this well blew up.

So, to say that was this on the USGS radar screen, absolutely not. But, you know, we were dealing with five crises in my first six months on the job.

Ms. SHEA-PORTER. And let me say, I first offer my sympathy, and second, we certainly understand from this perspective, too, because that is our world. Thank you. I yield back.

Ms. BORDALLO. I thank the gentlelady from New Hampshire. I would like to recognize the gentleman from Louisiana, Mr. Fleming.

Mr. FLEMING. Thank you, Madame Chairman. And I want to tell the panelists today that I appreciate your being here. I know that these hearings are going on and on and on about a very important issue, and I appreciate your willingness to come time after time to answer very tough questions.

I would like to start with you, Mr. Kennedy, with regard to NOAA. What is NOAA's position on Governor Bobby Jindal's proposal to build temporary berms to protect the wetlands?

Mr. KENNEDY. We have been involved. There has been, as you are well aware, an interagency discussion and comment period throughout the debate. We have been involved. We have expressed concerns as these berms are built—how that may affect circulation, what it may do to some of our trust resources. But in the end, we have not registered an objection that obviously stopped anything.

Mr. FLEMING. Who has been the final sort of—apart from the President himself, but what agency would be the final authority to give the—I guess the certificate or permission? Is that EPA, the Corps of Engineers? Who has the final say on that?

Mr. KENNEDY. I believe it is the Corps of Engineers, but I am not the expert there. I mean, obviously, the Coast Guard has been at the forefront of that table to make the ultimate decision. I think

you are right, Dr. McNutt. I think it was a tiered thing, the Corps of Engineers, but ultimately, you are right, the Coast Guard, I believe. But I am not the expert.

Mr. FLEMING. Do we have a final and complete decision on all of the requests? I know some have been allowed, but I think there may be others that have not. Anything on that?

Mr. KENNEDY. I am not the authority there. So, I think the Coast Guard would be the place to ask that.

Mr. FLEMING. OK. What lessons did NOAA learn from the Ixtoc deepwater oil spill in 1979 and the explosion of the Mega Borg off the coast of Galveston, Texas in 1990?

Mr. KENNEDY. I think probably a variety of things, but certainly in those two instances, a weathered oil versus a fresh oil have different impacts. When you have oil that comes ashore on sandy beaches, as opposed to getting through inlets and back into the marshes, you have a much better opportunity to attack the oil and clean it up with less impact than if you let it get into the inner marshes. So, those are a couple. There are others. One, transport of oil over a long, long distance, and the weathering process that takes place, certainly with the Ixtoc. That came from the Bay of Campeche, and that is hundreds—if not thousands—of miles, and so on and so forth. So, issues like that, I think.

But if you can isolate the oil on the sandy beaches before it gets into the back bays and marshes, that is the right thing to do. I think we also had an issue with oil coming ashore, then accreting, gathering sediment and forming tar mats at the base of some of those beaches. We certainly have been looking very carefully at that as a possibility in this spill and have been——

Mr. FLEMING. OK. Let me follow through on that.

Mr. KENNEDY. Sure.

Mr. FLEMING. I appreciate those answers. So, what you are saying is early response, and then certainly blocking the flow of oil onto the beaches or into the marshes. It has been reported that the Netherlands made available all sorts of devices that could have been very effective within three days of the spill, and yet they were not allowed in. And also again the berms would have done just the things that you are talking about.

So, it seems like even though we have the information from that one in 1990 for certain—but it doesn't sound like we implemented any of the knowledge that we learned from it.

Mr. KENNEDY. Well, I think we have. And in almost every instance—and I talked earlier about the complexity and the uniqueness of each spill. You always have that. So, you have to weigh your options. But I think when you look at what has gone on here, we have tried to take advantage of some of those things. There are always trade-offs. And so I am not at all familiar with the Netherlands advice that you are referring to. I have many, many people on the ground in Louisiana and elsewhere. Maybe that have. But we have tried very, very hard to evaluate other options. And as you know, there are phone numbers and committees that are trying to look through those.

So, I am not familiar with the Netherlands, but beyond that, I think each decision of what we do or don't do is based on a lot of the experience that we bring to the table, and then we are always

weighing those options and the trade-offs associated with it. So, to some extent, I think we have been using that information.

Mr. FLEMING. I can certainly ask more. Let me follow up, if you don't mind, with just one maybe half question, and that is, what did we learn about dispersants in those previous disasters? Because it seems that dispersants are controversial. And, you know, we are concerned in Louisiana that the dispersants may actually do more harm than good over the long term. So, what have we learned about that that we can apply in this situation?

Mr. KENNEDY. Well, I think this segues nicely to this idea of trade-offs. I think over a lot of years of research and discussion—and this includes all of the regional response teams, which I am sure you are familiar with, that include all of the state agencies right at the table as we make decisions. We had pre-approval as a result of a lot of what we learned of dispersants in the Gulf, and we had that because of this trade-off issue. And what we have determined from a lot of the research we have done is, if you can keep oil broken down and off the surface, it will biodegrade much better than if you let that oil come ashore.

Once the oil is ashore, you have a much more significant, serious problem that is much harder to deal with, and biologically, socially, socioeconomically it can be a bigger problem. So, if you can disperse at sea at appropriate depths—there are a whole bunch of caveats that go into this—that is the trade-off that actually was accepted by all of the responsible parties in the Gulf some time ago. I think we stand by that, although we are continually looking. When you get the numbers of dispersants that have been applied, now up into the hundreds of thousands of gallons, we have grave concern about that, and we actually had a small conference in Baton Rouge a couple of weeks ago to get some of the best experts in the world together to say, OK, with this much dispersants and this much oil in the water column, should we reassess the trade-off. And the answer from that discussion was, I think, that they thought we were still in a trade-off position that was appropriate to continue to disperse.

So, we are looking very carefully at it.

Mr. FLEMING. Thank you. And thank you, Madame Chairman.

Ms. BORDALLO. I thank the gentleman, and I wish to thank the witnesses on our first panel for their testimony today. And we will now call up the second panel of witnesses. Thank you very much, ladies and gentlemen.

[Pause]

Ms. BORDALLO. The witnesses on the next panel will be, first, Dr. Chris Reddy, Associate Scientist and Director of the Coastal Ocean Institute, Woods Hole Oceanographic Institution; Dr. Robert H. Weisberg, Professor, College of Marine Science, University of South Florida; the third witness, Ms. Valerie Ann Lee, Senior Vice President, Environment International Government, Limited; the fourth, Dr. Denise J. Reed, Interim Director, the Pontchartrain Institute for Environmental Sciences, and Professor, Department of Earth and Environmental Sciences, University of New Orleans; and Dr. Christopher D'Elia, Professor and Dean, School of the Coast and Environment, Louisiana State University.

I would like to greet and welcome our second panel of witnesses, and again note that the red timing light on the table will indicate when five minutes have passed and your time has concluded. We would appreciate your cooperation in complying with these limits. But I want to assure all our witnesses that your full written statement will be submitted for the hearing record.

Dr. Reddy, thank you for being here today, and you may begin.

STATEMENT OF CHRIS REDDY, PH.D., ASSOCIATE SCIENTIST AND DIRECTOR, COASTAL OCEAN INSTITUTE, WOODS HOLE, MASSACHUSETTS

Dr. REDDY. Thank you and good morning, Chairwoman Bordallo, Ranking Member Cassidy, and members of the Subcommittee. My name is Chris Reddy, and I am a scientist at Woods Hole Oceanographic Institution. I have studied, or am currently studying, numerous oil spills, including one that still exists from a 1969 spill, and I am currently active with the BP spill, and in a few hours, I am going to hop on a plane to go on a 12-day research cruise funded by the National Science Foundation to study subsurface plumes, and bringing along scientists from NOAA, EPA, the Coast Guard, and BP.

Last year, on the 20th anniversary of the *Exxon Valdez* accident, I wrote an editorial in the Boston Globe about how this country had successfully avoided a major oil spill since that iconic event. I argued then and I continue to believe that this country is one of the most experienced and effective in responding to spills.

About 10 days after the BP spill, I wrote another editorial in the Boston Globe, and I said, quote, "As military planners know well, learning lessons from past wars doesn't necessarily help you fight a different kind of enemy." Numerous factors, some unpredictable, such as weather, and some never encountered before, will come into play. And as this spill keeps on going, success in combating it will require an unprecedented stamina on the part of both personnel and equipment.

I concluded that if the *Exxon Valdez* was Pearl Harbor, a wake-up call for modern day oil spills and how to respond to them, then the BP oil spill would be more like the siege of Stalingrad. We are in for a long, exhausting, demanding process of observation, clean-up, and assessment. We need to bring all resources we can to the table. Unfortunately, one of our best resources, academic science, has had a diminishing role in oil spill research in the past two decades.

Following the *Exxon Valdez* spill and other spills, the Oil Pollution Act of 1990, referred to as OPA '90, was passed. This legislation provided a wide framework for diminishing the chances of spills and how to assess damages and restore the environment after a spill. The number of spill has significantly decreased. With the passage of OPA, the approach to damage assessment and restoration has become a well-defined process with legal and economic consequences. NOAA, other Federal scientists, consultants, and contractors now do most of the work. Independent scientists from academia, who have the capacity to pursue the outstanding, unanswered questions about oil and its interactions with the environ-

ment, are less often participants in spill science. And I have called this the industrialization of oil spill science.

My advice about how to move forward immediately and in the future, NOAA and other agencies should receive continued support to monitor and observe the Gulf. Time is invaluable. For example, knowledge about where the oil is, and how it is exchanging, is key to understanding processes acting on the oil, and also estimating damages to wildlife exposed to oil. It is paramount that a massive, organized, and sustained effort be directed at researching areas impacted in the Gulf of Mexico. And perhaps one way to think about this is that you might want to think about this oil spill as a crime scene. We want to collect all of the evidence, perhaps in a crime scene, before there is a rain or any other type of event.

I can't underscore the importance of getting such data. It would be unfortunate in the next several years, when scientists begin to develop a comprehensive view of the spill, that they lament the absence of key data that could have been obtained but was not because of a lack of funds, lack of access, and a lack of political will.

Academia is equipped to conduct some of the science, but needs direction. I have attended meetings with scientists both at the EPA here in D.C. and down at LSU, where there have been many recommendations. The National Science Foundation has commendably provided support to my colleagues via the rapid proposal, and these funds have contributed already.

Nevertheless, I believe there could be better coordination between what the academic research is doing and all that needs to be done. I recommend the following actions to be taken forward. I would allow NOAA and other key agencies to triage research, moving to the top of the list what is most pressing and communicate it broadly, clearly, and effectively to the academic community. It is NOAA and the other Federal agencies that are best suited to provide such guidance. They have the experience, and they have responded to all of the oil spills that haven't been on CNN over the last 200 years—200; since the Valdez spill.

And I would have this agency—then I would appoint a panel of science advisors through the UNH Research Center, and key science stakeholders, and they should use a very rapid way to reduce paperwork and get some of this research going very quickly. And I would encourage traditional studies, but also to push toward more advanced techniques.

In summary, NOAA and other responders have been handed an enormous challenge and need all available support. Time is precious. Academia, which has played a minor role in responding to oil spills over the past several decades, should be reengaged with direction from Federal experts who are most knowledgeable about the most pressing problems. Thank you.

[The prepared statement of Dr. Reddy follows:]

Statement of Christopher M. Reddy, Ph.D.,
Woods Hole Oceanographic Institution [1]

Salutation

Good morning Chairwoman Bordallo, Ranking Member Brown, and members of the Subcommittee. Thank you for the opportunity to speak today about the Deepwater Horizon Oil Spill. My name is Christopher Reddy, and I am a marine chemist at the Woods Hole Oceanographic Institution in Woods Hole, MA, principally investigating marine pollution. I have published >85 peer-reviewed scientific journal articles and several book chapters on the chemistry of oil and how it interacts with the natural environment and related subjects. I have studied or am currently studying the aftermaths of oil spills that occurred in 1969, 1974, 1996, 2003, and two in 2007 as well as natural oil seeps off the coast of Santa Barbara, CA, and more recently the Deepwater Horizon oil spill. I am leaving in a few hours to participate in a National Science Foundation (NSF)-funded 12-day research cruise to quantify and characterize oil in the water column below the sea surface in the Gulf of Mexico.

Introduction

Last year on the 20th anniversary of the *Exxon Valdez* accident, I wrote an editorial in the *Boston Globe* about how this country has successfully avoided and managed oil spills since that iconic spill. I argued then, and continue to believe, that this country is one of the most experienced and effective in responding to spills. Responders have worked on countless spills that have not made CNN, participated in drills, attended workshops, and published peer-reviewed manuscripts on oil spills.

Several weeks after the Deepwater Horizon spill, as the situation was appearing dire, I wrote another editorial in the *Boston Globe:*

> . . .as military planners know well, learning lessons from past wars doesn't necessarily help you fight a different kind of enemy. Numerous factors, some unpredictable such as weather and some never encountered before, will come into play. And as this spill keeps on going, success in combating it may require unprecedented stamina on the part of both personnel and equipment.

I concluded that if the *Exxon Valdez* were Pearl Harbor, a wake-up call for modern day oil spills and how to respond to them, then the Deepwater Horizon oil spill could be more like the Siege of Stalingrad. The latter has occurred.

We are in for a long, exhausting, demanding process of observation, clean-up, and assessment, and we need to bring to bear all the resources we can. Unfortunately, one of our best resources—academic science—has had a diminishing role in oil spill research in the past two decades. I would like to give you a little history of how that happened and what it means in terms of limiting our response to this spill, and suggest ways to get the academic science community more involved.

Impacts of Oil Pollution Act of 1990 on academic science

Following the *Exxon Valdez* spill and other spills, the Oil Pollution Act of 1990 (OPA 90) was passed. This legislation provides a wide framework for diminishing the chances of spills, and how to assess damages and restore the environment after a spill. The devastating impacts of the *Exxon Valdez* spill and lessons learned from it, along with the provisions of OPA90, have led to significantly decreased numbers of spills. For example, prior to the Deep Horizon spill, the annual number of oil spills greater than 5,000 gallons documented by the Coast Guard between 1991 to 2004 decreased from 55 to 14, with none over 1 million gallons.

In addition, there has been a growing trend that the spillers are freighters, such as the *Cosco Busan,* which struck the San Francisco – Oakland Bay Bridge in 2007, and not high-volume tankers like the *Exxon Valdez.* The responses to these relatively smaller spills by Coast Guard, NOAA, other government agencies, and representatives from the responsible parties have been swift and organized. But the overall role of academia in these spills has been significantly reduced in the last twenty years.

With the passage of OPA 90, the approach to damage assessment and restoration has become a well-defined process with legal and economic consequences, and Federal scientists, consultants, and contractors now doing most of this work.

Independent scientists from academia – who have the capacity to pursue the outstanding unanswered questions about oil and its interactions with the environment—are less often participants in spill science. I have called this the "industrialization of oil spill science."

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[1] The views expressed here are my own.

The limited number of spills and the protocols necessary to follow OPA90 have diminished academia's role in oil spill science. This has reduced the entry of young scientists into oil spill science and has suspended progress on the science used after most spills. The introduction of newer and advanced techniques, developed in other fields of science that may be applied to oil spills, has been sluggish. Financial support for the study of oil spills has dwindled. The Coastal Response Research Center (CRRC) at the University of New Hampshire has done admirable work in distributing sparse existing funds, yet no new funds were distributed in 2010.

Oil spill science has taken a back seat to other priorities such as homeland security and climate change science. It also has been a slow victim of its own success: why continue funding research when the number of spills was declining? It isn't until a whole new problem, of unprecedented scale, hits the headlines that we see that we have only a small Phillips screwdriver, when we need a high-power toolkit.

To underscore the dearth of academics in oil spill science, consider the following recommendation from the National Research Council's *Oil in the Sea III,* which summarized our knowledge of oil's inputs and fates as well as effects on the ocean (2003):

> Federal agencies, especially NOAA, MMS, the U.S. Coast Guard, and the USGS should work with industry to develop and support a systematic and sustained research effort to further basic science understanding of the processes that govern the fate and transport of petroleum hydrocarbons released into the marine environment from a variety of sources (not just spills).

Of course, it would be expected that the effort to "further basic science understanding" would involve academia but it is not explicitly stated. It is the research efforts of independent scientists that can help advance oil spill science where students, time, lab space, and equipment are available.

Comments on NOAA

In the past two months, NOAA and many other Federal agencies have faced enormous challenges responding to this disaster. They have performed admirably with the resources available to them.

I also commend the efforts of the CRRC in organizing a two-day meeting at Louisiana State University on May 26 and 27, 2010 that involved more than 50 experts from academia, the Federal government, Environment Canada, industry, and non-governmental organizations and resulted in "**Deepwater Horizon Dispersant Use Meeting Report**." This report recommended that dispersant usage was worthwhile. I agree with the finding on using dispersants in the surface ocean and reserve my views on injecting dispersants near the wellhead until more data become available.

Research on oil in the surface water and pre-assessment studies began quickly after the spill. Efforts to study deepwater plumes were delayed because of limited amounts of assets in the theater, but now have become a major objective. And for the first time that I know of, NOAA has been transparent about available data and their activities during the response phase of a spill. For example during the planning of my upcoming cruise, I have relied heavily on data posted on NOAA websites.

Last year, I participated in a workshop hosted by the CRRC at the University of New Hampshire (UNH) titled, **"Research & Development Priorities: Oil Spill Workshop."** (The CRRC was established as a partnership between NOAA, through the Office of Response and Restoration (OR&R), and the UNH). At that time, CRRC was co-directed by Professor Nancy Kinner (UNH) and Dr. Lisa Mertens (NOAA). This meeting was a productive three-day effort addressing eight broad ranging topics. The attendees were leaders in oil spill science from state agencies, including the Louisiana Oil Spill Coordinator, consulting groups, NOAA, Coast Guard, Environmental Protection Agency (EPA), international scientists, non-profits, and academia. Many of these participants are now playing key roles in the Gulf of Mexico. The final report is available on the Internet.

Several points with respect to this meeting and its final report: (i) NOAA was actively preparing for future oil spills and working with a broad spectrum of stakeholders, (ii) I do not recall any discussions on deepwater spills, even though the workshop was forward thinking with respect to spills in the Arctic and those from biofuels, and (iii) Of the 50 attending the meeting, nine were from academia with four from the University of New Hampshire. Hence, only five participants, or 10% of the participants, were from US academia outside of UNH. (There were seven international attendees).

How to move forward immediately and in the future

NOAA and other agencies should receive continued support to monitor and observe the Gulf of Mexico following the Deepwater Horizon disaster. Time is invalu-

able. Every day the oil content and composition are changing and moving in the surface and subsurface, and eventually once the leak is stopped, the oil will diffuse and weather to levels where it can no longer be accurately measured. Knowledge about where the oil is and how it changed is key to understanding processes acting on the oil and also estimating damages to wildlife exposed to oil. It is paramount that a massive, organized, and sustained effort be directed at researching areas impacted in the Gulf of Mexico.

It would be unfortunate if, in the next several years when scientists begin to develop a comprehensive view of the spill, they lament the absence of key data that could have been obtained but was not because of lack of funds, lack of access, or lack of political will.

Academia is equipped to conduct some of this key science but needs direction. I have received countless phone calls and emails from colleagues asking how they can contribute, but often I do not have answers. The National Science Foundation has commendably provided support via its RAPID proposal system to some scientists, and these funds have already contributed significantly to understanding this spill. Nevertheless, I believe there could be better coordination between what the academic research community is doing and all that needs to be done.

To enhance coordination, I recommend the following actions be taken immediately:

1. Allow NOAA and other key agencies to triage research, moving to the top of the list that which is most pressing and communicate it broadly, clearly, and effectively to the academic community. It is NOAA *and other federal agencies* that are best suited to provide such guidance. They have the experience and they are most aware of what is needed.
2. Appoint a panel of academic science advisors, via the CRRC, to liaise directly with key Federal stakeholders to fund research. They should use the NSF RAPID style proposal system, which reduces the paperwork and can be approved in days. Overall, means to provide clear pathways for submission and feedbacks must be aggressively sought.
3. Encourage traditional studies but also push towards more advanced techniques. For example, analytical techniques used to analyze oil have not changed much in nearly decades despite new methods available that are used in petroleum geochemistry.
4. Assure academics that their contributions are their own and can be published by them. (The lack of publication, especially to untenured scientists, can be a major roadblock for engaging them.)
5. Academia needs information or instruction about OPA90 and damage assessments. Academic scientists must recognize those strict protocols for custody of samples and the robustness of their techniques. What would be otherwise fine for a peer-reviewed manuscript may not pass the requirements of legal proceedings.
6. I recognize that the EPA and likely NOAA will set up scientific advisory boards regarding this spill. They are certainly necessary but the time needed to vet nominees and arrange these boards is too long. So, what I propose would be in addition to these long-term advisory boards.

Academia wants to contribute and has tremendous knowledge that needs to be directed toward the most pressing issues. NOAA and other Federal experts should have a process in place for providing the leadership to academia on how to proceed during this national disaster. As an academic, I may not appreciate the nuances for such a quick and directed effort, but we must move fast.

In summary, NOAA and other responders have been handed an enormous challenge and need all available support. Time is precious. Academia, which has played a minor role in responding to oil spills over the past several decades, should be reengaged with direction from Federal experts who are most knowledgeable about the most pressing problems.

Thank you for your time today.

Ms. BORDALLO. I thank you very much, Dr. Reddy, for your thoughtful input on how to enhance coordination between the Federal Government and the academic community. Dr. Weisberg, I look forward to your testimony. You may now proceed.

STATEMENT OF ROBERT H. WEISBERG, PH.D., PROFESSOR, COLLEGE OF MARINE SCIENCE, UNIVERSITY OF SOUTH FLORIDA, ST. PETERSBURG, FLORIDA

Dr. WEISBERG. Thank you, honorable representatives. My name is Robert Weisberg, from the University of South Florida, and I have been involved from day one with tracking oil at the surface and also performing subsurface tracking of where oil might be going there. It is my privilege to be here with you today to address the question whether the agencies have the resources to respond. My answer is no, and I will attempt to explain why and also to give a pathway forward.

When describing the workings of the ocean, the operant word is connectivity. Connectivity by the ocean is what gives rise to Earth's climate, and it is also what gives rise to the Earth's ecology. Without a firm grasp of ocean connectivity, phrases like "ecologically based management" and "marine spatial planning" are less than meaningful. The ocean circulation is fundamental to that connectivity.

The Loop Current, Florida current, Gulf Stream system provides the connection between the Gulf of Mexico and the southeast U.S. It is a deepwater current system, and deepwater currents cannot easily extend onto the continental shelf. Thus, the continental shelf circulation differs from the deep ocean circulation, and this results in mechanisms of connectivity that are distinctly different for the continental shelf. The coastal ocean also includes the estuaries, arguably the most productive and fragile of the ocean environments.

So, my point of these preliminary discussions is that we are dealing with very complex systems, each related through common physics, but each unique in how the governing physics organize to provide the connectivity within and between each region. This is not a simple problem. It does not have unique, simple answers. And that explains why NOAA and the Fish and Wildlife Service do not have all the resources to respond to the present crisis, and why the sub-questions have less than satisfactory answers.

So, what do we do immediately, and into the future? Immediately, we must marshal all of the talent and resources that exist to deal with the environmental crisis at hand, and this requires full partnerships between the agencies, the academics, and the private sector. The academic community has an essential role in bolstering the resources available to NOAA and the Fish and Wildlife Service, and the agencies, I would contend, cannot do this by themselves.

Data gaps abound, and my written testimony provides specific examples, which I will not repeat here. The fact is we do not really understand natural workings of our coastal ocean and estuarine systems well enough because these have not been studied in a truly system-wide, multi-disciplinary manner. We are now posed with a fully three-dimensional, time-dependent sampling problem that must take into account the various connections that exist between the deep ocean, the coastal ocean, and the estuaries. This is not business as usual. We must systematically sample our coastal ocean and begin to describe the space-time evolution of critical water properties and sentinel species to assess whether or not post-spill impacts will be occurring and where.

So, what is the pathway forward? The concept of an Integrated Ocean Observing System, IOOS, was advanced by Ocean.US in 2002. This concept remains valid today. Despite the ICOOS Act passed in 2009, which authorized IOOS within NOAA, the activity languages with little tangible support, and there is more concern for the concept of data management than for the actual implementation of coastal ocean observations and models. And without those observations and models, frankly there is little need to manage data.

It is time to implement the IOOS with funding levels sufficient to serve the regions and the nation, and with emphases on observations and models. IOOS must be approached in a comprehensive, systems-wide, multi-disciplinary manner. Regardless of whether the topic is an oil spill, fisheries, harmful algae, the same systems-wide approach is necessary. In other words, to understand our fisheries, we must understand all of the connections across space, time, and trophic levels. To describe and predict the present oil spill and its effect on the environment, we must do the same.

This is a large task, and an evolving one, requiring nurturing and sustenance. There is no point in engaging if there is no commitment to sustain the efforts. There is a compelling need for familiarity and commitment to one's locale. Local scientists must be involved. Is the effort worth the cost? Our approach to the questions addressed today would be much different if we had eyes in place. So, the answer is certainly yes.

Moreover, I can testify today from personal experience that the only reason my USF Ocean Circulation Group was able to respond to the crisis as we did is because we had resources in place from previous COOS activities, supplemented by small, competitive research grants. So, with some trepidation, I am also here today to tell you that not all earmarks are bad.

In summary, the unprecedented *Deepwater Horizon* oil spill shed an unwanted light on the environmental stewardship of our nation's oceans. An immediate response is required, followed by a staged implementation of an RCOOS concept akin to what was advanced by Ocean.US.

I thank you for the invitation to speak, and for your attention.

[The prepared statement of Dr. Weisberg follows:]

Statement of Robert H. Weisberg, Distinguished University Professor, Professor of Physical Oceanography, College of Marine Science, University of South Florida, St. Petersburg, Florida

Honorable Representatives on the Subcommittee on Insular Affairs, Oceans, and Wildlife, Committee on Natural Resources, U.S. House of Representatives; staff and associates, it is my privilege to be here with you today to address the question posed on "Ocean Science and Data Limits in a Time of Crisis: Do NOAA and the Fish and Wildlife Service (FWS) have the Resources to Respond? My succinct and candid reply is that they do not, and I will aim my testimony toward explaining why and offering a solution. I am not intimating that these agencies are not excellent in many respects. Instead, I believe that the resources are presently inadequate. Moreover, this is not a situation that can be remedied overnight. Scientific inquiry takes time, and while we must deal with an unprecedented crisis immediately, we must also lay the groundwork for the future.

In developing my case for improving environmental stewardship I will also address the sub-questions that were posed:

1) Are there existing gaps in observation data needed to predict the extent and trajectory of the oil spill, including information about plume formation and ocean currents?

2) What is the adequacy of pre- and post-impact spill data needed for conducting natural resource damage assessments?
3) What additional data are required to understand the impact of the oil spill on the marine environment?

Not all of these questions are within my expertise as a physical oceanographer, one who studies the physics of the ocean circulation, as contrasted with the living marine resources. Nevertheless, I will endeavor to provide my perspective on how the natural system that we call the ocean must be approached.

When describing the workings of the ocean in the context of the Earth system, one word immediately comes to mind: connectivity. Ocean connectivity controls the heat fluxes to the atmosphere and from the tropics to high latitudes, thereby determining the Earth's climate. Ocean connectivity unites nutrients (at depth) with light (at the surface), fueling primary productivity and thence all higher trophic level interactions, thereby determining the Earth's ecology. In fact, it can be stated that without a firm grasp of ocean connectivity, concepts like Ecologically-Based-Management and Marine-Spatial-Planning are less than meaningful. The ocean circulation is fundamental to the ocean connectivity.

For the Gulf of Mexico and the southeastern United States, the primary conveyance of mass, momentum, heat and other water properties is the Loop Current-Florida Current-Gulf Stream system. The Loop Current flows into the Gulf of Mexico through the Yucatan Strait, loops around inside the Gulf of Mexico and exits through the Florida Straits as the Florida Current. After rounding the bend near Miami and continuing up the United States east coast it is called the Gulf Stream. It is really one current system, which is always present and with remarkably little variation in total transport. All that really varies is the northward extent into the Gulf of Mexico, i.e., where it makes its loop. Generally, the Loop Current undergoes a cycle, whereby it extends ever farther into the Gulf of Mexico before a piece of it breaks free as a clockwise circulating eddy, that drifts westward and dissipates, while the main body of the Loop Current retreats back to the south. This cycle of eddy shedding occurs roughly every eight to 16 months, but with details that are hardly predictable. Before completely detaching and drifting westward, such eddies can reattach to the Loop Current, after which it is possible for the Loop Current to extend all the way to the Deep Horizon well head. The Loop Current is presently in such a state of eddy shedding. This is why we have not yet seen large quantities of oil transported to the Florida Straits and up the east coast, but this may still happen depending on the evolution of the Loop Current and its shed eddy over the next several weeks to months.

The Loop Current-Florida Current-Gulf Stream system is only one aspect of the circulation that we must be concerned with. It is a deep water current system in that it is constrained by mass and momentum conservation to stay in deep water. Shallow water regions, which I refer to as the coastal oceans of the United States, are where society literally meets the sea. It is within the coastal oceans where maritime commerce takes place, where commercial and recreational fisheries are situated, where environmental concerns, such as harmful algal blooms and over-fishing, abound, and where fossil fuels and alternative energy sources are potentially located. We define the coastal ocean as the region between the shoreline and the shelf break, and we refer to this region as the continental shelf, the relatively shallow water region adjacent to the continent extending seaward to the point where the water depth drops precipitously to the abyss. The region of precipitous drop-off is called the continental slope, and the Deep Horizon well head is situated on the continental slope in the northern Gulf of Mexico.

Deep ocean currents cannot extend onto the continental shelf unless the continental shelf is very narrow. Such is the case at the tip of the Mississippi River Delta, the head of DeSoto Canyon (offshore of Pensacola, Florida) and offshore of Miami, Florida, where the Gulf Stream can at times be almost a stone's throw from the beach. In contrast with these narrow shelf regions the West Florida Continental Shelf (WFS) tends to be very broad (roughly 100 nautical miles) and gently sloping, effectively decoupling the Loop Current from the nearshore. Thus the continental shelf circulation differs from the deep-ocean circulation, and this results in the mechanisms of connectivity also being different for the continental shelf.

The coastal ocean also includes the estuaries, the transition regions between the rivers and the ocean, where density contrasts between fresh and salt water play a major role in the circulation and hence connectivity between the rivers, the estuaries, and the continental shelf. The estuaries are also arguably the most productive and fragile of the ocean environments.

The point of these preliminary discussions is that we are dealing with very complex systems, each related through common physics, but each unique in how the governing physics organize to provide the connectivity within and between each re-

gion. Thus describing, understanding and predicting the behaviors of these natural systems are not simple problems with unique, simple answers, and that explains why NOAA and the Fish and Wildlife Service (FWS) do not have all of the resources to respond to the present crisis and why the sub-questions have less than satisfactory answers, and that is just within my own field of expertise, let alone the much broader range of subject matter of concern to this subcommittee.

So what are we to do, immediately and into the future? Immediately we must marshal all of the talent and resource that exists to deal with the environmental crisis at hand. This requires full partnerships between the agencies, the academics, and the private sector, recognizing, of course, that chain of command is of paramount importance. The agencies have organized, and I cannot speak to that. I can at least speak to some of the actions of the academic community, which are being of help in this crisis, and I can also speak to the future of how we can improve our ability to describe, understand and predict the ocean system and thereby become better environmental stewards.

Three particular actions at my own institution, the University of South Florida (USF), warrant mention. These include: 1) oil spill tracking tools that were implemented almost immediately after the Deep Horizon drilling platform sank on April 22, 2010, 2) shipboard surveys of both surface and subsurface hydrocarbons, and 3) deployments of gliders, drifters and profilers to help with sampling. For oil spill tracking we utilized existing numerical circulation models, our own at USF initially, plus several others added later on to produce an ensemble prediction with five different models. These are all re-initialized for surface oil location through the analysis of satellite images and then run forward in time to produce forecasts 3.5 days into the future. The forecast interval is determined by the availability of forecast winds (from NOAA/NCEP). Forecasting more than 3.5 days into the future is of little utility because of the errors inherent to weather prediction. Along with surface trajectories we also implemented the tracking of subsurface trajectories using the same USF numerical circulation model. Not knowing at what depth subsurface hydrocarbons might be located a priori, we chose to consider nine different depths ranging between 1400m and 50m. Virtual particles were released at these depths beginning on April 20, 2010 and then continually ever since, and the movements of these virtual particles were, and continue to be, tracked three-dimensionally using the model's velocity field. All of these model predictions and satellite analyses are available on the internet at http://ocgweb.marine.usf.edu and http://optics.marine.usf.edu/events/GOM_rigfire and have been since late April, they are provided to federal and state officials and they are in use as part of the overall forecast system. The subsurface trajectory forecasts were also instrumental in guiding the R/V Weatherbird II to sites where subsurface hydrocarbons were identified. We are also using these models and other observations to help guide the sampling by a combination of gliders, profilers and satellite tracked surface drifters. In fact, presently, the USF surface drifters along with some from the United States Coast Guard (that we helped to deploy) are the ones documenting the evolution of the Loop Current and its shed eddy (these drifter tracks are also posted on the above referenced web site).

Obviously, USF is not the only academic institution to respond. Notable for Florida are activities by the University of Miami (UM) and the Florida State University (FSU). Additionally, the State of Florida University System's Chancellor Frank Brogan facilitated an Academic Oil Spill Task Force situated at FSU to help coordinate and serve materials by all of the academics in the State of Florida from a central location (http://oilspill.fsu.edu). This Academic Oil Spill Task Force, introduced by Chancellor Brogan, briefed the Florida Congressional delegation in Washington DC on May 26, 2010, and its activities continue to be of service in this time of crisis. Other Gulf States have similarly responded, and we are now seeing a convergence of academic resources from states around the nation. My point is that the academic community, in general, has much to offer in bolstering the resources available to NOAA and the Fish and Wildlife Service.

Nevertheless, data gaps abound. Let's first consider data needed to predict the extent and trajectory of the oil spill, including information about plume formation and ocean currents. Predicting into the future requires that we have the best re-initialization data for the present. At USF (and for academics elsewhere) we are limited to what we can glean from satellite image analyses, but these are generally incomplete due to cloudiness and other limitations to interpretation. Satellite data could be supplemented by other means of ground truth; however, such information is not readily disseminated. *One immediate recommendation is that an accessible, easy to use set of surface oil location data be made available on a daily basis for use in surface trajectory modeling.* This will result in more accurate model predictions. The subsurface problem is even more acute because now, 52 days in to

spill, we have precious little information on subsurface hydrocarbon location, concentrations, fractionation and decay. There has simply been a dearth of sampling and an even more limited dissemination of results. Being that the scientific method is predicated on observations, these are critical. Similarly, even observations on the ocean currents are sparse. At a time when the evolution of the Loop Current and its shed eddy are determinant to whether or not oil will be entrained and transported to the Florida Straits and then up the east coast, there has been a seemingly lack of concern on the part of some who have even dismissed this as a factor until recently. As stated previously the USF surface drifters were among the first to be deployed in such a way as to outline the Loop Current path at this time of crisis. *Additional satellite tracked drifters, systematically deployed, are needed.* Similarly several organizations regularly post analyses of satellite altimetry used to estimate surface currents via the geostrophic approximation. *There should be an effort to better organize and disseminate these satellite altimetry analyses and also to improve upon some that up until now may even have been misleading.* Satellite altimetry is critical to constrain ocean circulation models via data assimilation (for instance, a reason why the Navy Global HYCOM has been so useful throughout this crisis is that it is well-contrained by satellite altimetry). Unlike the surface, there are very few observations being made subsurface for the Loop Current. With the HYCOM Consortium leading the data assimilation effort, *data assimilative models of the Loop Current would benefit from additional, systematically deployed AXBTs (Aircraft deployed expendable bathythermographs).*

While the previous paragraph dealt with surface spill location data in general and the deep-ocean currents, recall from my introductory remarks on connectivity that we must also be concerned with the continental shelf and the estuaries. Oil is now stretching along the northern Gulf of Mexico shoreline eastward to the northwest Florida beaches as well as westward along the Louisiana coastline. It has already damaged Louisiana wetlands and estuaries, and it is about to do so in Florida. There are very few measurement locations for ocean currents in the coastal ocean, especially for Florida, and there is also a dearth of well-tested and implemented models capable of predicting the interactions that occur between the coastal ocean and the estuaries. These data and model gaps will become increasingly acute as oil continues to impact an ever larger coastal ocean domain. It is not that such observing and modeling tools do not exist. Instead, there has been (over decades in some instances) a lack of commitment on the part of both state and federal agencies to implement and sustain their application and improvement. This may, in part, be a consequence of too many agencies having separate purview on too many related aspects of the coastal ocean and estuaries without adequate coordination between them. *We need to facilitate the implementation of appropriate coastal ocean and estuarine models to deal with the ever expanding domain of the spilled oil. We must then commit to sustaining and improving these into the future.*

Along with the deep-ocean, coastal ocean and estuary circulation inadequacies there are inadequacies for assessing spill impacts on natural resources. Whereas mappings may exist for many of the coastal ocean and estuary natural resources, it may be difficult to assess spill impacts without adequate knowledge on what the natural variability of these resources may be. Granted, catastrophic destruction or collapse will be assessable, but other longer-term or less obvious degradation may not be. Frankly, we do not really understand the natural workings of our coastal ocean and estuarine systems well enough because these have not been studied in a truly systems-wide, multidisciplinary manner. As an example, fisheries are generally studied as fisheries; harmful algal blooms are generally studied as harmful algal blooms; yet, the two are linked, along with intermediate trophic levels, and these linkages can result in trophic cascades affecting all forms of living marine resources.

As regards additional data that are required to understand the impact of the oil spill on the marine environment, this is almost an insurmountable task. I must assume that the state agencies have sufficient data bases to describe what existed prespill (although I might question whether or not the natural variability is adequately established). The question then becomes, what will be the impacts and how will these evolve. The first thing that we must recognize is that this is not simply a matter of going to the usual stations and making the usual measurements, whatever these may be. I must again recall my comments about connectivity. From whence will a threat arrive? Will it be from a large massive invasion of surface oil that will cause obvious damage, or will it be more subtle through the delivery of subsurface contaminants with less immediately obvious damage? For instance, the region of the shelf break is where major reef fish communities exist, such as the gag grouper, known to spawn there. Will these communities and their progeny be impacted by subsurface hydrocarbons upwelled across the shelf break? If fish larvae make their

way to the near shore via the bottom Ekman layer, as studies (in preparation) suggest, then will they be damaged en route if subsurface hydrocarbons make it onto the continental shelf? *We are now posed with a fully three-dimensional, time dependent sampling problem that must take into account the various connectivities that exist between the deep-ocean, the coastal ocean and the estuaries. This is not business as usual. We must systematically sample our coastal ocean and begin describing the space-time evolution of critical water properties and sentinel species to assess whether or not post-spill impacts will be occurring and where.*

What might be the pathway forward? The concept of an Integrated Ocean Observing System (IOOS) was advanced through the actions of the now disbanded Ocean.US, an interagency planning office established in 2000. Following numerous and broad reaching planning workshops and town hall meetings a document was published on May 23, 2002 putting forth a justification and a plan consisting of both global and coastal components to IOOS. The United States coastal component to IOOS was envisioned to have a federal network, referred to as the national backbone, augmented by Regional Coastal Ocean Observing Systems (RCOOS). Each RCOOS was to be organized through a Regional Association (RA), and there were to be 11 such RAs forming a National Federation of Regional Associations (NFRA). The May 23, 2002 IOOS pamphlet suggested a funding ramp up to 500M per year in support of IOOS, of which 138M would initiate the activity with an initial 50M going to the RAs. On September 20, 2004 the U.S. Commission on Ocean Policy endorsed the IOOS concept in their (An Ocean Blueprint) report and recognized that 500M was too small a ramp up – they recommended 750M per year. Whereas the concept remains valid the progress to implementation is at a stand still.

For the first half decade of the RCOOS process, through around 2005, the United States did organize into RAs and Coastal Ocean Observing System (COOS) assets were implemented, largely through federal earmarks. Beginning in 2005 the academic community at the request of the Consortium for Ocean Leadership agreed to eschew earmarks and look instead to NOAA as the lead agency for IOOS through competitive research grants, and that remains the situation through today. Unfortunately, new money has not materialized, and the funding levels for the RCOOS have diminished to the extent where many of the coastal ocean observing resources that were in place in 2005 are no longer available. Despite the ICOOS Act passed in 2009, which authorized IOOS as a program within NOAA, the activity languishes with little tangible support. Moreover, it is my impression that there may be more concern for the concept of data management than for the actual implementation of additional coastal ocean observations and models, without which there is little data to manage. While many within the agencies, academia and private sector may disagree on the details, *it is time to implement the RCOOS with funding levels sufficient to serve the regions and the nation and with emphases on observations and models.*

Details are always stumbling blocks, but these can be surmounted if we approach the problem in a comprehensive, systems-wide, multidisciplinary manner. The underlying concept is that of coastal ocean state variable estimation. By this I mean all properties pertaining to the coastal ocean, including sea level, velocity, temperature salinity, nutrients, plankton, fish, and surface meteorology; in other words, all variables that pertain to and hence comprise coastal ocean and estuary ecology. After all, coastal ocean ecology is not biology; it is the entire suite of processes that determine coastal ocean state variables. These same principles apply to all of the societal relevant coastal ocean problems espoused in the May 23, 2002 Ocean.US report. They also pertain to the present Deep Horizon oil spill crisis. Regardless of whether the topic is an oil spill, fisheries, harmful algae, search and rescue, etc, the same systems-wide approach is necessary, albeit with subsets highlighted. In other words, to understand our fisheries we must understand all of the connections across space, time and trophic levels. To describe and predict the present oil spill and its effects on the environment we must do similarly. The scientific approach to all of these problems is similar and inter-related.

Coastal ocean state variable estimation requires both observations and models. Observations alone are insufficient because the sampling problem is so enormous – there can never be enough data. Models are therefore required to extend the observations with proper dynamical (and for living resources, proper biological) constraints. However, models alone are less than useful, owing to the need for, and the uncertainties in, model initial and boundary conditions and parameterizations. Thus any coastal ocean observing system must coordinate between observations and models, with the goal of formally linking the two elements through data assimilation. It is a large task, and an evolving one, requiring nurturing and sustenance. There is no point in engaging if there is no commitment to sustain the efforts.

Additionally, it must be recognized that there is no single observing sensor or sensor delivery system that is adequate. Required are arrays of fixed moorings for time series of water column variables and surface meteorology, HF-radar for surface current mapping, gliders and profilers for water column variable mapping, conventional shipboard surveys, satellite imagery with both passive and active sensors, satellite tracked surface drifters for specific applications (as presently being used), and other sensors/sensor delivery systems to fill specific gaps or deal with specific local requirements. Emphasized again are sustained observations. For instance, the ocean circulation varies on times scales from diurnal to interannual. It is therefore impossible to define long term mean circulations, or the seasonal variations about the means, without years of sustained observations. The same can be said of biological variables, as alluded to earlier in my statement about separating natural variability from what may be oil spill related.

Similar can be said of models. No single model is adequate to cover all ocean processes. Deep-ocean models generally require larger domains than coastal ocean models (e.g., the Global HYCOM), but this comes at the expense of resolution. Higher resolution coastal ocean models require connection with deep ocean models, which can be accomplished through nesting (e.g., the WFS model nesting ROMS in HYCOM). Estuarine models require connection with coastal ocean models often through multiple inlets, necessitating unstructured grids and even the facility to flood and dry land. There is no single modeling solution, nor should there be because, given inherent errors, an ensemble of models is a reasonable approach.

Finally, and consistent with the RA/RCOOS concept, there is a compelling need for familiarity and commitment to one's locale. Harmful algal blooms provide a case in point. Not all "red tides" are the same so how one would model Alexandrium in New England is different from Karenia in Florida, two dinoflagellates that make their livings and manifest their toxins in entirely different ways. Processes such as these are just too complex to generalize.

Is the effort worth the cost? Our approach to the questions addressed today would be much different if we had the RCOOS in place so the answer is certainly yes. Moreover, I can testify today from personal experience that the only reason my USF Ocean Circulation Group was able to respond to the crisis, as we did, is because we had resources in place from previous COOS activities, supplemented by many small, competitive research grants. So with some trepidation, I am also here today to tell you that not all earmarks are bad.

The total costs are not insignificant. The original Ocean.US number, especially that for the RCOOS, is woefully small; the U.S. Commission on Ocean Policy number was an improvement, but still too small. Recently, in a N.Y. Times interview, I used a figure of 1B, and depending on how that would be distributed nationally between the RAs and the agencies, that to could be inadequate. In view of a recent estimate of 138B for the ocean-dependent economy in the United States (in normal times), provided to the Council of Environmental Quality by members of Congress, a less than 1% investment on describing, understanding and predicting ocean behaviors does not seen unreasonable. After all, there are individual corporate CEO salaries that have exceeded 100M, and ExxonMobil profits alone have exceeded 40B. Previous BP profits were another 22B. In contrast, a 1B investment in the coastal oceans of the United States does not seem unreasonable. Not only will it provide the knowledge needed to be better environmental stewards, it will help train the next generation of scientists, employ a highly skilled work force, and support the small (mostly United States) businesses that make the sophisticated instruments and instrument delivery systems that are required for implementation.

The discussions on IOOS, RA, RCOOS, and COOS are a pathway forward, but needed right now is an immediate and accelerated response to the Deep Horizon oil spill. Priority must go to the Gulf of Mexico and Southeastern United States regions while moving toward enabling the entire NFRA concept for the nation as a whole. The crisis now is in the Gulf of Mexico, but the future requires a build-up for the entire nation.

In summary, the unprecedented, Deep Horizon oil spill shed an unwanted light on the environmental stewardship of our nation's oceans extending out beyond the EEZ. An immediate response is required followed by a staged implementation of an RCOOS concept akin to what was advanced by Ocean.US. The immediate response, in addition to the outstanding efforts already in place by the agencies under the unified command, must be directed at the Gulf of Mexico and Southeastern United States, and these should entail individuals and institutions who have demonstrated performance in response to the crisis. Observations in support of oil spill trajectory modeling, both surface and subsurface are essential. Scoping out the nature of a potential subsurface threat, as quickly as possible, is necessary for contingency planning and possible mitigation. Similarly, with oil now approaching new shorelines in

addition to those already marred along coastal Louisiana, we must have improved observing and modeling tools in place to plan for the potential invasion of our estuaries by oil. It is not just a matter of taking stock of natural resources to potentially be lost, but understanding how these natural systems work so that maybe more of our natural resource can be spared damage or destruction.

My intention was not to be critical of the agencies, collectively or individually, instead to highlight certain data and model deficiencies as requested and to advance a pathway forward. The response by our agencies has been excellent, so has the response by many outside of the agencies. We must marshal all of our resources if we are to minimize the effects of this tragic occurrence.

I thank you for your invitation to speak and for you attention. I also thank everyone in the federal, state and local agencies, the private sector and the academic institutions who are working tirelessly to assist.

Response to questions submitted for the record by Robert Weisberg, Professor, College of Marine Science, University of South Florida

Questions from Chairwoman, Congresswoman Madeline Z. Bordallo (D–GU)

1. What are existing and new data-gathering assets that will be required to improve oil spill forecasting? Are these types of assets readily deployable? Would most of these assets be included in the architecture for most regional integrated ocean observation systems? Should they be included?

Answer:

I must begin my answer by stating that it is the fully three-dimensional ocean circulation that determines where oil will go. Even the surface currents themselves are determined by fully three-dimensional processes. Hence to successfully track oil either at the surface or at depth we must have sufficient information on the three-dimensional ocean circulation. No individual sensor (current meter, drifter, HF-radar, etc.) or sensor delivery system (moored buoy, glider/profiler, etc.) is sufficient. Needed is a mixture of such sensors and systems, either for this Deepwater Horizon oil spill presently of for IOOS going forward. Different approaches to these measurements are also needed in deep, versus shallow water.

In deep water we have been successful in modeling the Loop Current and its eddies as more data are assimilated into existing ocean circulation models. Specifically, sea surface height estimates from satellite altimetry, combined with internal temperature and salinity data obtained by airplane-deployed expendable bathythermographs (AXBT) and glider surveys have been of great importance, and these should be continued. The most reliable models in deep water (in my opinion) have been those run by the Navy (particularly the Global and Gulf of Mexico HYCOM), as these seem to have the best data assimilation. Other regional models nested into these (such as the WFS model run by my group) benefit from the data being assimilated into the larger scale, primarily deep ocean, models. Thus it is critical that these data assimilative larger scale ocean models remain assessable by all other researchers (as they are presently) so that we can also provide the best regional (coastal ocean) circulation products.

The coastal ocean presents its own set of requirements. Here we must account for the interactions between the deep ocean and the coastal ocean and between the coastal ocean and the estuaries. As with the deep ocean, observations and models must be coordinated because there can never be enough observations and models without observations are less than useful. Best results are obtained when these two activities are coordinated. Beginning with how the coastal ocean circulation is forced, we must have sufficient observations on coastal ocean winds, and this necessitates buoys deployed judiciously across the continental shelf, with surface meteorological sensors (winds and heat fluxes), in-water current sensors such as acoustic Doppler current profilers (ADCP), and in-water temperature and salinity sensors. These buoys must span the dynamically distinct regions of the continental shelf, including: 1) the outer shelf, defined as an internal Rossby radius from the shelf break, where deep ocean currents directly impact the shelf circulation, 2) the inner shelf, defined the region of interacting (through divergence) surface and bottom frictional (Ekman) layers, 3) near-shore, the region embedded within the inner shelf that is further modified by low salinity waters of estuarine origin, and 4) the mid-shelf for those continental shelves that may be wide enough [like the West Florida Shelf (WFS)] to distinguish inner from out shelf regions.

Complementing moored buoys are HF-radars that map surface currents and a combination of profiling floats and gliders that map the internal temperature and

salinity fields, all over areas larger than individual moored buoys. This ensemble of observing tools (moored buoys, HF-radar and profilers/gliders) form the nucleus of what is needed in a sustained fashion for the Deepwater horizon oil spill and for IOOS. Additionally, satellite tracked surface drifters are very useful, but only if these are repeatedly deployed, as we are presently doing on the WFS.

It is noted above that my attention is mainly on sensors for winds, currents, temperature, and salinity. Of course there is a need for biologically oriented sensors (chlorophyll fluorescence, light, nutrients, etc), but these sensors are still either developmental or suffer from fouling when deployed over long intervals. Every effort should also be made to include such sensors on buoys and profilers/gliders in ways that are feasible, and further developmental activities should be promoted. Certain measures of light may be capable of identifying subsurface hydrocarbons and once calibrated against actual in situ measurements these can become very effective tools for identifying subsurface hydrocarbons when deployed on moorings, profilers and gliders.

Lastly we cannot lose sight of satellite sensors for sea surface height, sea surface temperature and color. NASA or NOAA supplied, there must be sufficient funding for data acquisition, interpretation, and for new algorithm development, all of which are essential for both the deep ocean (as already stated) and the coastal ocean.

2. Predictive models are generated at multiple scales and resolutions, yet all of our attention has been focused on the open Gulf. How can we better integrate oceanic, estuarine, and coastal models into tools, which we can use to respond to oil spills? Should specific attention be given to encourage the development of innovative new technologies to detect, contain, characterize, model and respond to oil spills?

Answer:

My answer is certainly yes. In the same way that no individual sensor or sensor delivery system is sufficient, no single model is either. To model the coastal ocean, we must consider the interactions with both the deep ocean and the estuaries, and this requires models with different resolutions. For instance, a deep ocean model that may work very well with resolutions of a few kilometers cannot function as well across the inner shelf and estuaries where resolutions down to perhaps 10m to 100m are necessary to include the conveyances of mass (and oil) across inlets and embayments. These higher resolution models exist and are being used by academic scientists, but they generally remain in a research and development mode. This work must be encouraged if we are to advance the state of the art and provide necessary tools for environmental stewardship.

3. How are the Agencies, academia, and industry working together to share data? What have been the best practices? What is needed now to address this spill and to prepare for the next spill?

Answer:

Whereas I am loath to be negative, the answer (based on my recent experience) is cooperation remains poor. For instance, beginning on May 8 I began making formal requests for oil location information to reinitialize oil spill trajectory forecast models for the purpose of improving upon their accuracy. These requests were very specific and through around 7/8 they remained totally unfulfilled. This was despite assistance by my Congressman. I got the impression that the UC would prefer that people like me just go away. I would if I did not feel that I had something to offer in this time of crisis. There are excellent examples of some individuals in the agencies who are reaching out. The Coast Guard, for example, has shared their surface drifter data. NOAA Hazmat has effectively interacted, NAVY models are made available, but other than these (and I'm sure other) good examples, both the federal and state agencies remain largely insular, and this is a major disappointment. I did just receive acknowledgement of my request by the lead of the NOAA modeling group who will begin sending me flight information available to him; however, he is also without a unified product as I requested. It appears that no one in the Unified Command is driven to produce such a product, one that I continue to maintain would be very helpful to all trying to forecast where oil may go. Moreover, the sustained cloudiness over the past couple of weeks accentuates the need for such a unified oil location product. Why else are we spending so much public money on so many disparate groups gathering disparate data if these data are not being merged into one useful product? I now see that the email distribution lists for these disparate data are enormous. Of all these people, cannot one subset be tasked with providing a unified product? It was particularly troubling to me in a recent conversation with a Coast Guardsman to learn of just how much time is spent ferrying

dignitaries and reporters on overflights, versus sharing necessary data in a convenient, usable form.

As regards the possibility for oil beneath the surface I see virtually no sharing of information other than what several academic researchers found. I do not even know if NOAA has planned a systematic, repeated set of surveys to identify subsurface hydrocarbons and to map their evolution.

Addressing the spill now requires better information on the locations of oil both at the surface and at depth. How the Loop Current will behave over time will determine the threat to the Florida Keys and the Southeastern U.S., and monitoring this will require systematic deployments of satellite tracked surface drifters along with a continuation of AXBT drops. Whereas the Navy is not making their glider information readily available (at least as far as I know) they are using these for assimilation in models (and the model outputs are available) so those activities all continue to be very positive and necessary contributions. Additional data are required within the coastal ocean, and these needs are addressed in answer to question 1 above.

Longer term we need to implement the Coastal Ocean Observing Systems, as conceived by IOOS, but I contend that unless true partnerships are forged between the agencies, the academics and the private sector then the potential for these systems to be of long-term societal benefit will not be realized. By true partnerships I mean a significant portion of the funds being distributed outside of the agencies and in particular to the academic institutions geared toward the research and development necessary to describe, understand, and predict the workings of the coastal ocean. Without such mandate I fear that bureaucracies will grow at the expense of either advancing knowledge or improving environmental stewardship. Based on my entire career experience, I can emphatically state that the agencies cannot do this alone, nor should they attempt to.

Best practices as I presently see are those engaged by some referenced above. I can access several (Navy, NOAA, academic) models from open servers, NOAA/NCEP wind fields are readily available, the Coast Guard SAR group provides surface drifter data on a daily basis, satellite images remain readily available for many important variables. In essence, the more open access that there is for observations and models, especially at a time of crisis, when proprietary needs (duly recognized and appreciated) must take a back seat (within reason), the better off we all are in responding to the crisis

Questions from Congresswoman Lois Capps (D–CA)

1. This tragedy demonstrates the value of having a sustained ocean observing system – like buoys, HF radar, and satellites – running and sending data. Dr. Weisberg, you use instruments such as these to run your model simulations, which predict how oil will be transported by winds and ocean currents. At what capacity, would you say, is our system of ocean observing in the Gulf of Mexico?

Answer:

Interestingly, whereas a vast majority of offshore oil production occurs in the Gulf of Mexico and the President's (pre-oil spill) push for further exploration focused on the Gulf of Mexico and the southeastern U.S., these are the two regions of the contiguous United States that have the least developed coastal ocean observing systems assets. Why such a mismatch exists between environmental monitoring needs and resources is a mystery. Could it be that the Gulf of Mexico and the southeastern U.S. suffers from too much bureaucracy and not enough action. For instance, for years we have been treated to glossy brochures from the Gulf of Mexico Alliance and other such groups, but without any delivery of resources to put words into action. And when actions do occur they seem to be more political than substantive.

Immediate attention should be given to adding coastal ocean observing system capacity to the Gulf of Mexico and to the Southeastern U.S. In doing this we must identify what presently exists and build upon these extant resources in a systematic way, recognizing that there are individuals and groups with demonstrated performance that already provide a basis upon which to build. There is nothing wrong with a tried and true system of advancing knowledge through publication in refereed professional journals. IOOS, in my opinion, deviated from this practice when it put too much emphasis in "stakeholder" plebiscites. Interactions between "stakeholders" and providers, while obviously important, should not be allowed to stifle practicing the scientific method for advancing knowledge, without which "stakeholders" will never be properly served.

2. Would you say there is a fairly complete system of instruments? Or are there gaps in coverage that need to be addressed?

Answer:

My answer is no. However, there are nuclei for coastal ocean observing systems throughout the Gulf of Mexico and the southeastern U.S., which can be systematically added to for the purpose of filling data gaps. For instance, legacy programs from an era of previous earmarks and competitive research programs advanced observing system assets off 1) the Texas, Louisiana, Mississippi, and Alabama coastlines under the aegis of the Gulf of Mexico Coastal Ocean Observing System (GCOOS) and 2) the Florida, Georgia, South Carolina and North Carolina coastlines under the aegis of the Southeastern Coastal Ocean Observing Regional Association (SECOORA). While GCOOS and SECOORA overlap, it is important to note that SECOORA was designed in recognition of the connectivity between the eastern Gulf of Mexico and the Southeastern U.S. that is provided by the Loop Current—Florida Current—Gulf Stream system, and this connectivity trumped considerations based on static regional geography alone. Connectivity is of paramount importance to any discussion of ecologically-based-management or marine spatial planning, without which these phrases are lacking in scientific meaning. For instance, while definitions may have been made for so-called large marine ecosystems, these ecosystems are not independent of one another. We should not allow definitions to stand in the way of scientific inquiry and the advancement of knowledge.

A strong basis, therefore, does exist for coastal ocean observing system activities in the Gulf of Mexico and the Southeastern U.S. that can be readily built upon. Shoring up support for these and then incrementally adding moorings, HF-radar, profilers and gliders, plus other assets as spoken about in my earlier answers to questions provides a pathway forward.

I will reiterate that the pathway forward must recognize the requirement for true partnerships as mentioned earlier. The agencies (federal, state or local) cannot do this alone. In fact, I contend that the lack of true partnering has been a major impediment to achieving coastal ocean observing system implementation.

3. What would you like to have in place in the Gulf region so that you and your colleagues could have the information needed to respond?

Answer:

For the coastal ocean, the implementation of coastal ocean observing systems as envisioned by IOOS and as presently organized under GCOOS and SECOORA. The basic observational set would include moorings for surface winds (and heat flux), water column currents and temperature and salinity, plus other variables pertinent to biology (as evolving sensors technologies permit); hf-radar for surface currents; profilers and gliders for 3–D water property structures; satellite tracked surface drifters; and a limited number of wave gauges. These would be in additional to elements from the national backbone of coastal tide gauges and NDBC weather buoys, plus satellite sensors.

For the deep ocean a suite of measurements for assimilation into large scale ocean circulation models (satellite altimetry, satellite SST, deep ocean glider temperature and salinity data and air deployed XCTDs).

In general, a set of nested circulation models for representing the deep ocean, coastal ocean and the coastal ocean, estuary interactions; wave models, and the evolution of ecological models are also needed. Ecological models, however, must explicitly include the fully three-dimensional ocean circulation because by uniting nutrients with light and distributing water properties the ocean circulation underpins ecology.

The above components are necessary in response to the present crisis and equally important for environment stewardship going forward. Additionally, for the present crisis, we still require information on hydrocarbon locations both at the surface and at depth and information on the rate of decay/consumption of oil by weathering and biological processes.

Ms. BORDALLO. Thank you, Dr. Weisberg, for your valuable input on the need for full implementation of an integrated ocean observation system. I would like now to recognize Ms. Lee. Please begin your testimony.

STATEMENT OF VALERIE ANN LEE, PRESIDENT, ENVIRONMENTAL INTERNATIONAL LTD., SEATTLE, WASHINGTON

Ms. LEE. Thank you, Madam Chairman, Mr. Cassidy, Acting Ranking Member of the Committee, and other members of the Committee. My name is Valerie Lee. I am the Senior Vice President of Environment International Government, Limited. EIGov is a service-disabled, veteran-owned small business. We specialize in environmental consulting, and the controlling service-disabled veterans are former Navy officers, one of whom is seated behind me to my right, Mr. Jack Burke. He served in Vietnam as a swift boat captain, and was decorated. He and the other owners of the firm support me in our testimony today.

Collectively, we share a deep respect for the oceans and the marine environment, and with members of the Subcommittee and the people of the Gulf Coast, we would like to assist in any way we can in terms of providing advice, not only to conduct research, but with a point, to actually achieve restoration and some measure of making the public whole. It is with great pleasure that I answer the Committee's questions as to data gaps and what we can do about them.

My background is law, science, and engineering. I have written a book along with others, The Natural Resource Damage Assessment Handbook, a legal and technical analysis. So, my perspective is a bit different from the others here seated with me today. I am practical. I have worked with teams of experts for many years, including well-regarded scientists like those seated to my right and to my left. Our speciality is working with inter-disciplinary teams in dealing with intractable problems that involve incredibly large data sets, like we have today.

With that as a backdrop, I would like to address the Committee's questions as to whether or not we have sufficient data, and what we can do about it, especially in the subsurface environment. The short answer is no, we don't have sufficient data. The needs are substantial. There are major gaps. The reason why we have substantial needs is not for lack of interest. In part, it is a reflection of us all and what we don't see and what we can't touch, what we can't feel immediately sometimes is not measured, or I should say, not given the kind of importance that we would like it to have.

In addition, there have been financial limitations. When we look at the current spill, we are looking at the size of an economic and environmental disaster that we have never seen before. We are talking about billions and billions of dollars of damages if we were to place an economic value on that which is priceless, the Gulf; priceless, the lives of the people who are lost. And we express our condolences to the families.

We are off the page. We are out of the book. We are learning on the job. We are building a fire truck in the middle of a fire. So, what can we do? Is there a lack of hope? The answer is, I believe, there is hope, and it is through science.

So, what would we do? First, marshal the science, as the folks beside me have mentioned, or will mention. And also, we need to spend some money. Whose money? That is for the Congress to decide. I would argue that there were environmental impact statements done by the oil industry all over the Gulf that could have

collected essential data to meaningful and reasonably understand potential technical impacts, and that was not done.

If I look at the size of the price tag for meaningful injury assessment, as it is called in the business, and the development of a restoration plan, which is really what this is about, we are looking at over a billion dollars, easily. We are looking at the kinds of things which are developing three-dimensional models. It is collecting water samples. Right now, we do not have the vessels in place and the real-time monitoring data to track plumes. We have to collect samples from the subsurface, bring them above, and then send them to the shore for analysis.

People sitting in a boat, the scientists, don't know where the plume is. They can't react in real time to really measure where it is. And, yes, I do believe there are subsurface plumes. The subsurface plumes were documented in a test spill that was done off of Norway in 1999. In addition to having real time information and vessels, the bottom line is that we need to do transects of the area, and we need to collect information in a way that we have never done before and with a thoroughness that we never have.

In short, my recommendation would be to activate the Navy and to get a group within the international community to bring to bear the vessels that we need, the technologies that we need, and we need to get at it quickly. And I have other recommendations, including studies related to toxicity, in my testimony, but I will submit that for the record, and happy to answer questions.

[The prepared statement of Ms. Lee follows:]

Statement of Valerie Ann Lee, Environment International Government Ltd.

Good morning Chairwoman Bordallo and Ranking Member, Mr. Brown, and members of the Committee. My name is Valerie Lee. I am the Sr. Vice President of Environment International Government Ltd (EIGov). EIGov is a service-disabled veteran-owned small business (SDVOSB) environmental consulting firm. The controlling service-disabled veterans are former Navy officers, one of whom is a decorated, combat-tested Vietnam Veteran Swift Boat Captain, Jack Burke, seated behind me. Mr. Burke and I first met professionally in 1986 many years ago working together as government attorneys on a very large oil spill in San Francisco Bay that resulted in one of the most successful injury assessments and restoration efforts still to this day. I am also the President of Environment International Ltd., a woman-owned sister company to EIGov.

Our focus at these companies is an interdisciplinary approach to science and law to address matters just like the Deep Water Horizon oil spill. We are group of cross-disciplinary trained experts – lawyers who are also scientists and engineers, economists who are also environmental engineers and the like.

We share a deep respect for the oceans and the marine environment with the members of this Subcommittee and the people of the Gulf Coast and we have a great love of science and law. The Principals of EIGov who have served our country and have a commitment to duty, honor and service are pleased to support me in my testimony today.

The Subcommittee has asked that I address:

1) The existing gaps in observation data needed to predict the extent and trajectory of the oil spill, including information about subsurface plumes;
2) The adequacy of pre- and post-impact spill data needed for conducting natural resource damages assessments;
3) Additional data required to understand the impact of the oil spill on the marine environment; and
4) Other information relevant to the Subcommittee's work and appropriate assessment of injury.

Before addressing these issues, I would like to provide the educational and experiential base that helps inform my answers to these questions.

I received my undergraduate degree in biology from Bates College in Maine, a masters in civil engineering from the Massachusetts Institute of Technology, where

my focus was on water resources and my law degree from the Yale Law School. I am the primary author of the only treatise in existence on natural resource damage assessment, *the Natural Resource Damage Assessment Handbook: A Legal and Technical Analysis,* published by the Environmental Law Institute in Washington, D.C. This treatise is used by the government agencies and others to train NOAA personnel, US Fish and Wildlife personnel in natural resource damage assessment.

I have worked on natural resource damage matters in all years since 1986. I have provided advice to private parties and also all levels of government on natural resource damage assessment matters. I have assembled teams of experts from multiple disciplines on cutting edge science issues to identify information that should be collected to assess injury, analyze the data, and frame approaches that will restore it and value injury. We have dealt with some of the largest data sets in the world to address consider natural resource injuries from pollution and have worked on more than one what is called "mega-site" where potential injuries are spread across hundreds and hundreds of square miles and injuries are hidden from view in the subsurface environment – such volumes are huge. These subsurface environments have not been the deep ocean; they have been groundwater plumes, because quite frankly the world has never dealt with a deep water spill and injuries beginning a mile beneath the ocean surface.

I have conducted neutral reviews of oil spill contingency planning and response after Exxon Valdez and provided advice in connection with improvements that could have been made to integrate natural resource injury assessment with oil spill response.

I am expert in the law associated with natural resource damage assessment. While at the Department of Justice, working with Jack Burke our CEO, I filed some of the first natural resource damage lawsuits on behalf of the United States. I am fully aware of the law under the Oil Pollution Act, the Clean Water Act and other statutes that are relevant to the Deepwater Horizon Oil Spill.

With that as a backdrop, I would like to address the Subcommittee's questions on data to consider subsurface potential impacts, the data gaps and needs to conduct natural resource damage assessments, and the data to understand the impact of the Deep Horizon Oil Spill on the marine environment. I would also like to contribute insights on the current structure and procedures that are in place to respond to oil spills and conduct natural resource damage assessment.

The short answers to the Subcommittee's questions are that the resource needs are substantial and immediate. The data gaps are large. The amount of resources that have been brought to bear to consider the impacts of the oil spill in the marine environment, especially the subsurface environment are inadequate to the task at hand. The reason for this is not for lack of interest on the part of the agencies, NOAA and U.S. Fish and Wildlife Service; it is for lack of technical and human resources. The paucity of data is created by financial constraints. It also derives from the human frailty of us all, whether we are members of the public, work for government, or are employed by the private sector. Humans are not well suited to understand the importance of what they cannot see and feel within their personal spheres, even if the threats are large and real. The world beneath the surface of the ocean is beyond our view. Its importance has not been recognized in the way that it should have been by *all of us.*

For these reasons, we are behind the curve in scientific knowledge of the ocean ecosystems and the species that live there and support our economy. The agencies tasked with studying natural resource injuries and restoring injuries when they happen do not have procedures and integrated approaches to address subsurface spills involving the deep-sea environment. We are playing catch-up. We are building a fire truck in the middle of the fire to respond. The civilian federal agencies responding don't have the resources they need to assess injury and mitigate and restore injuries to the Gulf.

The Deep Horizon Oil Incident – an explosion that caused substantial loss of life and we send our condolences to those families for their loss – an explosion that has resulting in an ongoing spill of a growing spatial and volumetric magnitude that is hard to fathom, causing injury to our marine ecosystem and to entire coastal economy of a major part of the United States. Measured by environmental injury and economic losses, that we in the trade call lost human uses, this is the largest natural resource damage case that this country has ever seen and I hope the world will not see one again. Damages are in the billions.

We are off-page and out of the book. With an ongoing spill of this size and severity, the law fails us as a mechanism for truly meaningful reparation for the sea, the marine ecosystem and the species that are a part of it, and the Gulf Coast economy supported by it. The law cannot achieve full compensation to make the public truly whole; a wise economist once said that in the free market system that which

is priceless cannot be provided. The fundamentals of science are the only real means to achieve an outcome for this spill and to ensure that others do not ever place our regional economies and ecosystems supported by them in danger.

As the Subcommittee has asked me to do, it is right to begin with data needs, data gaps, and how we fill them. Despite the spill's enormity and complexity, the fundamentals of science and logic guide us to an understanding necessary to build toward some type of restoration necessary for a healthy, vibrant Gulf Coast economy and a place where we and our children want to live, work and recreate.

To conduct an injury assessment for this spill and to develop information to help us restore at least some part of the natural resources on which the vibrant Gulf Coast economy depends, we need to assess the following.

- The transport and fate of the oil in the subsurface and surface regimes.
- The concentration of the contaminants in the subsurface from the oil being released over very large volumetric/spatial scales – currently one third of the gulf is closed to fishing.
- The toxicity of these contaminants delivered to organisms in the subsurface, e.g., fisheries, phyto- and zoo-plankton etc. and the toxicity at the surface to myriad species of the Gulf Coast ecosystem.
- An understanding of the physical effects of oil that can cause injury, such as breeding failure, or death.
- The location of species and whether or not they have been exposed to the contamination; the species of concern are not just the macro-charismatic ones, they are those at the bottom of the food chain that are not easily viewed, phyto-plankton, zoo-plankton and others. They are the ones that are exposed to toxicants at 3,000 feet and below as well as those higher in the water column.
- The consequences of ecosystem chaos precipitated by organisms "feeding" off the oil plumes and, thereby, likely to deplete oxygen in major regions of the subsurface.
- Information on injuries that have already occurred to mammals, birds and fish that are evidenced through bodies, not seen on the surface, but lying far below on the sea floor.

We have considered the cost to accomplish this work. Our estimate of the cost of an assessment to perform the foregoing might be surprising for some. It is *at least a billion dollars.* The reason why the number is so large is that it relates to the difficulty, expense, and time required to collect data with the current techniques in the deep-sea environment. Is it also driven by the enormity of the surface scale of known injury and the huge volumetric scale of the subsurface potential impacts that must be studied. We are limited in our ability to study such impacts. Among other things, there is:

- A rather rudimentary understanding of the deep sea and subsurface ecosystem as compared to the surface;
- A paucity of high resolution data on currents in the Gulf at different depths from 5,000 feet to the surface; this information is required to run numerical models that could offer mathematical predictions as to where the oil would go and also help us understand its transformation;
- A lack of a developed 3-dimensional (3–D) mathematical model that can be used to predict the transport and diffusion of oil spewing out of the deep, even with the collection of data above. Moreover, it may require the use of super computers to run such models;
- A lack of proven effective instruments for real-time measurement of contamination from oil in the subsurface, especially at depth;
- A lack of understanding of where the plumes are at depth and with what organisms the oil and dissolved phase toxic compounds from it are coming in contact;
- The effects of the oil and its constituents that have dissolved in water on organisms living in the subsurface;
- The cost of operating submersible vessels and surface vessels in sufficient numbers to allow collection of empirical data in sufficient quantity in subsurface space to be able to create information on currents, location of plumes, contaminant concentration, and exposures to organisms.

Given that we are behind on the knowledge and technology curve, this information base must be created for this spill to assess injury and to build toward at least a partial restoration of natural resource injuries. Many say that this is not possible; however, I believe with the right team of experts and appropriate amount of resources devoted to the issue we have hope for identification and restoration of injuries from this spill and we will create an information base for the next spill, if and when such an unfortunate event occurs. I explain in greater detail latter in my tes-

timony a practical approach to restoring injury to this vibrant ecosystem and the lives, businesses and economy supported by it. Restoration of the Gulf truly is a matter our economic health as a nation and in our interest in the defense of the nation. We have to begin planning for and implementing restoration now.

The Gulf is dotted with rigs, some operating at thousands of feet below the surface; it would seem that the Congress may want to consider the costs of these assessments as properly assigned to the companies operating in the Gulf. Indeed, much of this work should have been done to prepare realistic and technically sound environmental impact statements and it was not done. Instead, the government and the industry relied on the silver bullet of the "blowout preventer." In the case of the Deep Water Horizon, this silver bullet missed its mark.

The Nation now understands the importance of the Gulf; its importance to the organisms who support us and our economy; its importance to our children and their future. We now understand that we should have spent more financial resources on "inner space," the deep ocean, especially if we are to site hazardous activities like drilling that cannot be controlled and contained if the first line of defense goes awry. Appropriate risk management is to collect this information now, to ensure that we are prepared for a possible future failure. What follows are specifics of what we suggest as approaches to fill data gaps and meaningfully assess injuries. It also offers some possible improvements in government procedures in the aftermath of oil spills to ensure that we do not bring our economy to its knees as a result of spills.

1. Identification of subsurface plumes and contaminant concentrations; resource and data needs.

The only study we could find on consideration of a deep-sea spill was performed by the Minerals Management Service, ironically, in conjunction with BP and oil industry participants. I have attached these documents to my written testimony. With minuscule quantities of oil in that test release study by comparison to what we have with the Deep Horizon Oil Spill, the results suggested that we would find what we are seeing in the Deep Water Horizon spill. Plumes were created subsurface and the oil did not rise to the surface in a direct path. Napthalene, a constituent of oil that is highly toxic, was dissolved in water and delivered at depth to resources in the contaminant's path. This is but one of the toxic compounds in oil.

Existing current data in the Gulf is neither of the spatial resolution nor of the type that we need for accurate mathematical modeling plumes of the fate and transport of oil released at depths. Further, at depths below approximately 1500 feet there is no light, the environment is very cold, and the pressure is extremely high. Oil and gas at depth acts and is transformed in ways different from at the surface. We saw a dramatic illustration of this with the hydration problem that made the Top Hat solution to stop the spill of oil useless.

NOAA's numerical fate and transport models are excellent, but they were designed to predict fate and transport of plumes at the *surface.* Thus, using a model the existing numerical fate and transport models to predict where the plumes are from the Deep Horizon will go and in what concentration organisms will be dosed with toxicants is not as reliable as we would like. Given that people's lives and livelihoods in the Gulf Coast depends on science providing reliable guidance for the fate and transport and injury assessment, we must take a different approach than reliance on numeric fate and transport models.

The government must collect empirical data. The government must collect sufficient samples over large spatial scales (more than once) to be to able to rely on statistics to help us understand the magnitude and environmental severity of the plumes impact and the ecosystem chaos that they spawn by creating a food source for organisms that may deplete the oxygen in major areas of ocean. Vessels and equipment can be used to collect real time, physical information on currents, temperature and the like. Similarly, we need to collect water samples and determine whether oil contamination is present.

I would like to underscore that governments often give short shrift to statistics because they do not understand the discipline, but data collection and application of statistics to abstract conclusions for larger scale regimes and are our best hope for the identification of plumes and the assessment of injuries from the Deep Horizon spill.

We are challenged in two ways with the collection of empirical data, even with well-designed sampling studies and effective use of statistics.

First, based on an exhaustive review of research vessels (surface and subsurface), NOAA, which operates vessels frequently in partnership with universities, does not have enough marine assets/vessels to perform the kind of broad-scale, organized study required. NOAA has on the order of a total of a dozen surface and subsurface major vessels combined in the Gulf area at the present time, with three or four

large vessels having already collected some data. This size of the fleet in Gulf, even including vessels primarily operated by Universities is not big enough to collect data over the spatial and volumetric scale that encompass a third of the Gulf. Thus, Congress should work with the President, including units of the Navy, to consider how this fleet could be augmented quickly to collect data. The type of data collected should include high resolution, spatially targeted data on currents at various depths.

Second, assuming we augment the NOAA research/study fleet, we have additional technical challenges. Technologies that we should have for reliable real-time chemical concentration data collection at depth do not exist. The industry and the government is in the position of "making do" with technologies developed for other data objectives, such as, temperature and opacity (physical measurements) rather than chemical concentrations of the constituents of petroleum products to identify the existence of contamination in the subsurface that encompass enormous volumes (3–D spaces). Fluorimetry is a technique, that have received limited use for the detection of "oil" and it may not be effective. In addition, it cannot be used to provide information on contaminant concentrations, such as of naphthalene, in water. To consider contaminant concentrations gas chromatographs and mass spectrometers must be used. These are big instruments that are in the lab and not field measuring techniques.

As a result, NOAA has largely relied on using samplers lowered from a surface vessel to depth to collecting water samples. Such samples are raised to the surface on board ship. The ship needs to steam to port and then provide the samples to laboratories which will then take days to be analyzed. The net effect of this method is that *investigators do not know whether or not they are taking samples in the plume and, if so, do not have feedback to enable them to measure the vertical and horizontal extent of it while they are on location to sample.* They cannot find its boundaries. Thus, our ability to locate subsurface plumes and contamination is substantially compromised. The investigators are flying the plane without instruments and guessing which way they should go and whether they have found the airstrip on which to land, so to speak.

We would recommend that a significant effort be launched immediately to support surface vessels with the helicopter pickup and delivery of oil samples and set up shore-side laboratories to process samples as quickly as possible.

These are our principal recommendations for the identification of the plumes from the Deep Horizon that do exist at depth and to better understand the subsurface of the fate and transport of oil.

2. Data needs to assess injuries to natural resources: species and resources.

Scientists will usually say that there is not the kind of "baseline" data that they need to be confident in the assessment of natural resource injuries from oil spills. The Gulf Deep Horizon is this problem on steroids. By comparison to resources that we see on the surface, there is much less known about resources in the subsurface environment, especially resources of the deep-sea environment.

First, to assess injury we need to know species distribution and whether or not there has been exposure to oil. Second, we need to understand how species– fish, plankton, mammals, crustaceans etc. and their various life forms—living at various depths in a water column that is a mile deep are affected by petroleum products. If we are looking at injury from a population perspective, we need to know numbers.

When decisions were made to move ahead with deep drilling, we collectively did not do the job that we should have. Further, the reality is that there is *never* perfect data. So to assess injury, we need to fill this gap, not completely, but with *reasonable* information to allow us to make decisions that will help restore what we can from the spill and protect our fisheries and other resources that are the keystone of the Gulf's economy and way of life. Our recommendations are as follows.

First, gridded transects of the area of likely plume activity and underneath the surface contamination should be conducted. Transects should be accomplished with submersibles just like those conducted with planes in overflights to identify species composition and distribution. We recommend that real-time videography be used. Both remote submersibles and those manned by scientists can be used. Transects should be designed to systematically cover the area at various depths.

Second, just as we do a beached bird survey and walk a beach to identify dead birds and allow statistical analysis and estimation of the total number of birds killed, so to we should follow a similar protocol in the areas of the worst contamination. Such transects should follow the bottom and, obviously must use lights at depths below 1500 feet.

Third, we need to immediately synthesize available information on toxicity to a variety of species. As strange as this may seem, NOAA and the US FWS have never

collected a systematic and thorough compendium of known toxic effects for the various species. For years, this has been a data need for the entire natural resource damage programs of both agencies AND it is essential for this spill.

Fourth, after a quick review of existing information, the governments should launch shore-side toxicity studies for keystone species. It is without question that even with a scientific literature review, we have substantial data gaps. Illustrative of this is that the most information that I am aware of on the impacts of oil spills and petroleum products on fishery resources is on salmonids and there is by comparison very little information on other species. This also has been a data need for many years and its time has come with the potential collapse of the fishing industry in the Gulf.

3. Other recommendations to improve Natural Resource Damage Assessment in the marine environment and the Deep Water Horizon Spill

a. Applied Science and technology focused on restoration of the Gulf ecosystem, economy and way of life

The people of the Gulf Coast and the Nation and its economies have been supported by a vibrant Gulf ecosystem. The spill threatens this ecosystem. As I have described, the need for scientific and technical information is great in connection with the assessment of injury from the spill and NRDA. However, as we fill these gaps, our focus should be on *applied* science and technical development. Data collection, science and technology are merely the means to understand what action we must undertake to make the ecosystem and the people supported by it whole. It is the most important of applications.

Restoration planning and assessment must begin now even as we begin to assess the injury from the spill. One builds on the other. It is our hope for the Gulf and the lives that have been wracked by the Deep Horizon Well spill.

The United States must launch an effort of scientific integration and coordination of a scale that we have never seen before. We need to select and organize distinct subgroups of scientists in teams to quickly and efficiently assess critical habitat and species injuries. We must determine the critical habitat and injuries to species that are keystones of the Gulf Coast's biological environment and industries in the Gulf. These industries include commercial and recreational fishing, tourism, underwater diving, and bird and wildlife watching, amongst others. The government must combine science, policy and public input on an unprecedented scale.

We must move in the face of less than perfect information to begin to mitigate and injury to achieve environmental, economic, and social restoration. There should be an emphasis on using small businesses in restoration planning and implementation as small business to foster rapid economic restoration.

We are fighting to save the Gulf's ecosystem and our ways of life that depend on it. This should be our highest priority apart stopping the spill and this fight led by scientists will last for years to come.

b. Better integration of NRDA to oil spill response.

We have a long history of oil spill response in the United States. The Coast Guard and others have done an excellent job. If there was a failing on the PREP exercises, experts who participate in them indicate that they are not aware of any deep-sea drill scenarios. This should change if we intend to continue to have deep-sea rigs.

Second, human safety and stopping the spill are the primary objectives, especially in the early days of the spill. The Incident Command System is focused nearly exclusively on this. Moreover, the Coast Guard culture is properly one of working with the Responsible Parties. NRDA is seen by some in the Coast Guard as punitive.

The Deep Water Horizon necessitates a reconsideration of this practice and way of dealing. We suggest that the Administration consider revisiting the procedures and protocols because with the Deep Horizon we have learned that a spill of this magnitude can threaten the regional economy and dramatically affect peoples' lives. It is a dramatic illustration of how humans really are interconnected to the natural resources—the health of the natural resources is more than an "environmental issue," it is important to the economy and even our national security. Different policies probably would have meant that the resources required to investigate and mitigate impacts could have been activated sooner. Arguably, it might not have made a difference. But it is worthy of consideration by the Administration whether or not there should be a parallel emphasis in Incident Command System on NRDA.

c. NOAA and US FWS are not well equipped to deal with NRDA in the subsurface environment.

In over 20 years of working with oil spills, I am not aware of NOAA or US FWS focusing on the potential of a spill like this in the subsurface environment for

NRDA. Further, the resources of the two agencies are too limited to address a situation of this magnitude. They are using contractor support, but both agencies are focusing more on the resources that we see on the shore or on the sea surface. Moreover, in the case of the US FWS, the staff is exceedingly small. This is not to say that staffs should be increased because to truly be ready for all types of possible injury and associated assessment methods would require employing a significant percentage of the experienced biological scientists in the U.S. We recommend that NOAA and the US FWS develop an established network of experts identified within the United States to draw on for matters like these.

Thank you for your time. I look forward to any questions you might have.

Ms. BORDALLO. Thank you very much for your comments on the natural resource damage assessment process, Ms. Lee. And I would now like to recognize Dr. Reed to testify.

STATEMENT OF DENISE J. REED, PH.D., INTERIM DIRECTOR, PONTCHARTRAIN INSTITUTE FOR ENVIRONMENTAL SCIENCES, AND PROFESSOR, DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES, UNIVERSITY OF NEW ORLEANS, NEW ORLEANS, LOUISIANA

Dr. REED. Thank you, Madame Chair, distinguished members of the Committee. Thank you for the opportunity to discuss with you today how we are going to respond to the *Deepwater Horizon* oil spill and what role science and data collection can play. This crisis highlights the importance and vulnerability of coastal systems, and that is where I am going to focus my remarks today. In Louisiana, this is a coast which was already in trouble, a coast which I have studied for almost 25 years, a coast which we understand well, and which we think can be restored, even in the face of current events.

I would like to touch on five things this morning. One of the specific challenges for assessing the damages associated with the current oil spill will be separating out the effects of the oil spill from the long-term changes that were already going on at the coast. And for Louisiana, anyway, we will need to predict how the future of this coastal ecosystem has been changed by the oiling and by the dispersants, and by any other response efforts. We know that if some unsure response efforts are not conducted carefully, they can cause more damage than the oil on the surface.

I recommend specific investments in predicting the future of these impacted coastal ecosystems so that we can separate out the effects of the *Deepwater Horizon* from the ongoing ecosystem restoration. The system will be in worse shape in the future. The question is how much of that can be attributed to the oil.

My second point, the concept that oil is easier to clean up in sandy environments compared to muddy wetlands is well accepted. We have already heard that this morning. This premise, while accepted premise, has led to calls for action at the outer shoreline to reinforce the sandy perimeter of the Louisiana coast and to limit the tidal passes. Sand berms, rocks, barges have all been proposed. How well these measures will work remains to be seen. Hard structures like rocks are not a natural feature on the Louisiana shoreline, and our history has shown that rocks and breakwaters disrupt the natural sand movement and prevent natural healing, which can occur on our barrier islands after storm events.

We must be wary of causing long-term harm to the system with our emergency response measures, especially where the harm can

be avoided or where it likely outweighs the effects that it could have in terms of our ability to contain the oil, the tradeoff that has already been discussed.

I recommend increased efforts to specifically track the performance and effects of response measures in the coastal area to allow the implementation of additional measures, if necessary, if the ones that we have are failing, and to make sure that we assess the total impact of the event here. We must not be complacent. We must monitor, and we must try not to do more harm than the oil.

Oil will move into the estuary. All agree that containment and removal in open water is far preferable than letting the oil get into the wetlands. However, there are thousands of potential destinations that oil could get to. Those on the ground trying to respond can more effectively mobilize and deploy the booms and skimmers that they have if they have better information on the potential paths of oil movement within these complex and shallow bay systems. University researchers are already using their existing computer models to produce maps for local authorities of the surface and mid-depth currents within the estuary to aid the local people on the ground in preparing for where the oil might move.

The actual movement of the oil on any particular day is going to depend on local wind and tide conditions, but these kinds of tools have been very helpful to them in thinking about where it might go. I recommend increased utilization of predictive models of shallow water movement to inform the on-the-ground response on the coast. Water movement in shallow basins is rarely predicted by models, which focus on the entire Gulf of Mexico. It will answer only one part of the coastal ecosystem. In the open water areas, both in the bay bottoms and the water columns—and I am talking about the shallow water areas behind the barrier islands now, not the open Gulf. In those areas, oil, even in low concentrations, can be having an effect which is much less obvious than the coating of beaches or wildlife or marsh grass. What happens in the open water is crucial to the food web and to many of the species that we value as commercially and recreationally important.

A typical fish life cycle starts with eggs, goes to larvae, goes to juveniles, and eventually to adults. These different stages show major changes in their physiology, behavior, where they live, where they hang out, what they eat, and in their susceptibility to oil, with the early life stages being much more sensitive.

I recommend an increased emphasis on measuring and understanding the effects in open, inshore waters of low concentrations of oil, especially on lower parts of the food chain and the early life history stages of these commercially important species. We have to measure what we cannot easily see.

And last, the unprecedented extent of this event has led to a massive data collection effort using a variety of sensors and data collection techniques. Making these data available to interested scientists and stakeholders would increase understanding of the ever-changing effects and allow a wider range of experts, including university scientists like myself and the others assembled here, to communicate with the public on the effects of this oil.

I recommend increased access to agency-collected data through an easily accessible data management system. The new

GeoPlatform, which was released yesterday, is a good start. We can see the maps. We can see where the oil has been, where it isn't. But we need to see the actual data and work with that, too. It is going to take all of us to understand this thing.

I speak on behalf of many when I say that university researchers are ready to help and apply the tools and knowledge that we have to support this emergency. Thank you, Madame Chair and members of the Committee. This concludes my remarks. I will be happy to take questions.

[The prepared statement of Dr. Reed follows:]

Statement of Dr. Denise J. Reed, Professor, Department of Earth and Environmental Sciences, Interim Director, Pontchartrain Institute for Environmental Sciences, University of New Orleans

Madam Chair and Distinguished Members of the Committee:

Thank you for this opportunity to discuss with you the need to respond to the Deepwater Horizon oil spill and the role that science and data collection can play in that effort. This crisis highlights the importance and vulnerability of our coastal ecosystems. I will focus on the existing status of scientific understanding of coastal change, how that can be leveraged to respond to the spill and where gaps in data and understanding are currently limiting our ability to respond. I will also identify several areas where the extent and character of our coastal system make the long-term tracking of the impact of the spill more challenging that may be immediately apparent. More specifically I recommend:

- Investments in predicting change in the impacted coastal ecosystems to enable the impacts of Deepwater Horizon to be separated from ongoing ecosystem degradation.
- Specifically track the performance and effects of response measures on the coastal ecosystem to allow the implementation of additional measures if necessary, and to assess the total impact of the event.
- Utilization and refinement where necessary of predictive models of water movements within the estuary to inform mobilization of response techniques.
- Focus on measuring and understanding the effects in open inshore waters of low concentrations of oil, especially on lower trophic levels and early life stages of commercially important species.
- Increasing access to agency collected data through a data management system, thus allowing university researchers to better leverage existing funding sources and develop necessary understanding for assessment of impacts.

My expertise has been developed through my training as a coastal geomorphologist at the University of Cambridge, specializing in the dynamics of coastal wetlands, and almost twenty five years of research on coastal marshes and barrier islands in Louisiana. I have authored scholarly publications on coastal wetland response to sea-level rise, and the effects of hydrologic change on marsh sustainability. I have also worked actively in restoration planning in Louisiana since the early 1990's including 'Coast 2050' in 1998, the Louisiana Coastal Area Study of 2004, the State Master Plan for coastal protection and restoration of 2007, and now the 2012 update of that Master Plan where we must consider the effects of this crisis on our long term goals for the coast. In addition, in recent years I have conducted research on coastal wetland restoration and participated in restoration planning in the Sacramento-San Joaquin Delta, San Francisco Bay and Puget Sound. I live in Terrebonne Parish, Louisiana in the small town on Montegut.

As a Professor at the University of New Orleans my research on coastal ecosystems is currently funded by a number of federal agencies including the US Fish and Wildlife Service, NOAA and the US Army Corps of Engineers. The thoughts and opinions expressed here are my own and do not represent the views of the University or any of these agencies.

Putting the Effects of the Spill in Context of Current Change on the Louisiana Coast

Coastal wetland loss in Louisiana is occurring at a rapid pace and wetland sustainability has become an issue of paramount importance even before the Deepwater Horizon event. The processes involved with coastal land loss and their interactions operate on a range of spatial and temporal scales. Essentially, most agree that coastal land loss and the massive degradation of the coastal ecosystem can be attributed to two types of factors – natural and human induced. This is a very dynamic

landscape with riverine floods, sea-level rise, natural land subsidence, and storms from the Gulf leading to patterns of land building and decay on time scales from days to millennia. The constant adjustment among these natural factors produced a coastal ecosystem which sustained itself for thousands of years – constantly changing but productive. This balance has been disturbed by multiple human influences on the landscape, such as the construction of levees on the Mississippi River, the internal disruption of hydrology associated with the construction of canals for various purposes, and the introduction of an exotic herbivore, the nutria. Ecosystem degradation is the result of these and other factors interacting to produce complex patterns of stress to the ecosystem, ultimately resulting in land loss.

We understand these processes well and this science has been the foundation of our restoration plans for many years. The challenge for the assessment and restoration of the damages caused by the current oil spill will be separating out the effects of the spill from the long-term changes already going on. While the goal of the ultimate Deepwater Horizon restoration program will be to 'to speed the recovery of injured resources and compensate for their loss or impairment from the time of injury to recover', identifying this injury from the others to which this system is already being subjected will be challenging. It will require federal agencies to work in partnership with coastal scientists to develop and apply predictive models of ecosystem dynamics. We must identify how the trajectory of change of the coastal ecosystem has been influenced by the oil itself and by the response efforts, which if not conducted carefully in these sensitive environments may cause more damage than the oil. It is essential to put the effects of the oil spill in the context of existing coastal change.

Response at the Outer Shoreline

The concept that oil is easier to clean up in sandy environments compared to muddy wetlands is well accepted. This premise has led to calls for action at the outer shoreline to reinforce the sandy perimeter of the coast. The effectiveness of these measures, including a plan to build a long sand berm and close in tidal passes must be put in the context of how these systems have evolved and how they change.

The outer coast of Louisiana consists of low-lying sandy barrier with wide inlets, both deep and shallow. High rates of subsidence, coupled with sea-level rise, are compounded by the effects of tropical storms and hurricanes to produce a system of landward-migrating low sandy barriers which frequently are overtopped. The configuration of the islands and intervening inlets is not only controlled by waves and storms acting on the outer shoreline. Ongoing conversion of back barrier and interior wetlands to open water bays and lagoons increases tidal prisms (the amount of water that enters and leaves the estuary with every tidal cycle). Changes well behind the islands thus result in an increase in the flow of water moving through tidal inlets between the islands. Over time the continual increase in bay-tidal prism size together with the landward migration of the barrier systems results in an ever changing shoreline within which new tidal inlets are being formed and existing inlets are subject to changes in cross-sectional area (deepening and/or widening) and position.

Expectations of the performance of shoreline actions in containing the spill and providing clean up opportunities must take into account the potential for rapid changes at the barrier shoreline and the key role of inlets between islands in allowing tidal flows into and out of the estuary. Studies of just one area of the coast, Little Pass Timbalier, before and after the 2005 hurricane season at in showed that almost 13 million cubic yards of sediment was eroded from a 19 square mile area and this without a direct hit from a hurricane. Over four hundred yards of shoreface retreat was detected. While sand berms in the nearshore, as currently planned, may provide opportunities for cleanup in the near term, they may not last as long as the spill event. Even a minor tropical storm could erode them.

There is broad agreement that limiting the number of pathways for oil to enter the estuary would aid response. Currently the barrier islands are separated by large inlets, those which convey the majority of tidal flow and have formed over decades. In addition, there are many small cuts or 'low spots' on the islands which remain from the storms of 2005 and 2008. For the most part such cuts heal over time and natural sand transport fills them in. Accelerating this process to help spill response is certainly a reasonable approach. Using rocks or other unnatural structures for these closures may be necessary under these emergency circumstances but these measures should be considered temporary and be removed post-spill. Hard structures are not a natural feature of the Louisiana shoreline and our history has shown that rocks and breakwaters change patterns of sand movement disrupting the natural adjustments and the healing which can occur after storm events. We must be wary of causing long-term harm to the system with our emergency response meas-

ures especially where that harm can be avoided or likely outweighs the benefits of that aspect of the response.

As response measures are implemented at the shoreline it will be essential to understand their effects on shoreline dynamics. Changes in the coast resulting from the response itself could exacerbate ecosystem degradation and make long-term restoration more difficult. Changes in shoreline dynamics, the fate of any sand placed at the shoreline, and the effect on tidal exchange can and should be monitoring during and after the response effort.

Oil Movement into the Estuary

The barrier shoreline represents our outermost defense. But closing the shoreline completely is not an option. Tidal passes must remain open to allow for tidal exchange, the migration of organisms, and provide natural flushing. Rather than closing inlets or restricting their cross sections, efforts should be focused on how to contain the oil passing through the inlet. The amount of water which flows through the passes is not determined by the size of the pass. Rather it is related to the tidal prism and the amount of open water landward of the shoreline. Clearly the massive coastal land loss Louisiana has experienced has increased the tidal prism. That water must move in an out every day. If we make the tidal passes narrower in the hope of 'channeling' the oil and making containment easier the speed of water flow through the passes will simply increase. Containing oil in fast flowing waters is a challenge to our traditional clean up technologies and effective techniques must be incorporated into any plan which focuses on the outer shoreline.

Oil will move into the estuary. All agree that containment and removal in open water is far preferable to allowing oil to enter the wetlands. However, the complexity of the estuarine landscape means there are thousands of miles of potential destinations for the oil. To more effectively mobilize and deploy resources those on the ground require the best information available on the potential paths of oil movement.

Predictions of where the oil might go within the estuary require tools which appreciate the complex hydrodynamics of these shallow estuaries and the wetting and drying of wetlands each day with the tide. Oceanographic models often fail to incorporate these details, understandably so as they may not be important for understanding Gulf-wide circulation. But within the estuary researchers have developed tools which can support response. At the University of New Orleans researchers are using existing three dimensional computer models to estimate the trajectories of surface and subsurface tracers under various combinations of wind and tidal conditions. They can produce maps of the surface and mid-depth currents and directions for example events to aid local emergency planners is preparing for where the oil might move. The actual movement of oil on any day will depend upon local wind and tide conditions and oil may not move in exactly the same way as the water but these kinds of tools can help plan the response. Real time predictions would require model refinement and additional monitoring of tides and winds within the estuary. Such 'data assimilation' has been used in other estuaries to support emergency response as well as restoration planning and operations. Modeling approaches are available – investments in tool development, data collection and inshore observing systems are necessary for state of the art predictions of oil trajectories within shallow, complex estuarine systems.

Fate and Effects within the Estuary

The potential effects of oiling on coastal wetlands are well documented and the applicability of various clean up techniques, including natural remediation, in different situations is relatively well understood. The most important issue is to ensure that the clean up approach is tailored to the local conditions – what works in a wetland in one area may not be appropriate in others.

However, wetlands are only one part of the estuarine ecosystem. In the open water areas, both on the bay bottoms and in the water column, oil can be having an effect which is less obvious that the coating of larger wildlife or marsh grasses. Open waters are a huge component of the estuarine system and dominate the lower areas, adjacent to the tidal passes and inlets through which the oil enters. The effect on lower trophic levels, phytoplankton, algae and zooplankton, and how these are propagated to higher trophic levels, e.g., fish, must be evaluated not only through monitoring but by field studies of trophic interaction. For any specific organism a life cycle approach is important. This applies to all organisms, but is especially helpful with organisms such as fish because individuals often show very dramatic differences between their life stages. A typical fish life cycle is eggs, yolk-sac larvae, larvae, juveniles, and adults. The different stages can show major changes

in their physiology, behavior, diets, and habitats utilized – and in susceptibility to oil – with early life stages being more sensitive.

Existing sampling schemes for routine monitoring of the ecosystem, e.g., Louisiana Department of Wildlife and Fisheries need to be supplemented to ensure they identify these smaller animals and that they encompass the variety of habitats currently and potentially impacted by the oil. In addition, synthesis efforts which refine understanding of the resilience of these populations to effects of oil must be used to guide assessment and subsequent restoration.

Data Accessibility and Management

The unprecedented extent of this event and its impact on a variety of marine and coastal environments has resulted in a massive data collection effort using a variety of sensors and data collection techniques. Making these data available, where appropriate given their use in the official assessment, to interested scientists and stakeholders would increase understanding of the ever changing effects and allow a wider range of experts, including university scientists like myself, to communicate with the public on the effects of the spill. To make such a varied array of data accessible requires a focus on data management as well as collection.

Knowing what data is being collected already also allows researchers to leverage available funding sources to focus on additional sampling. The Natural Resource Damage Assessment process calls for 'reviewing scientific literature about the released substance and its impact on trust resources to determine the extent and severity of injury'. Establishing causality required understanding as well as data and many excellent scientists are willing and able to contribute and develop knowledge which can at least be used in future events.

Thank you Madam Chair and members of the Committee. This concludes my testimony.

Ms. BORDALLO. I thank you very much, Dr. Reed. And, Dr. D'Elia, we will hear from you now.

STATEMENT OF CHRISTOPHER D'ELIA, PH.D., PROFESSOR AND DEAN, SCHOOL OF THE COAST AND ENVIRONMENT, LOUISIANA STATE UNIVERSITY, BATON ROUGE, LOUISIANA

Dr. D'ELIA. Madame Chair, Ranking Member Cassidy, and members of the Subcommittee, my name is Chris D'Elia, and I am a Professor and the Dean of the School of the Coast and Environment at Louisiana State University. I welcome this opportunity to be here with you today.

Federal research and monitoring assets are critically important at this time of national crisis. The academic community and private sector want to contribute more also. Universities like LSU depend heavily on Federal funding to undertake their research. Unfortunately, significant Federal funding has been slow to materialize as this crisis evolves. Here are some concerns.

Serious existing gaps exist in observational data needed to predict the extent and trajectory of the oil spill. The Integrated Ocean Observing System, IOOS, a Federal, regional, and private sector partnership for collecting, delivering, and using such information, needs more Federal funding. The Gulf of Mexico has, until recently, had very poor coverage by high frequency or HF radars that provide real-time data on the direction and strength of surface currents. The NOAA IOOS Office helped relocate three HF radar units to provide coverage of a portion of the Mississippi, Alabama, and Florida continental shelf, but the Louisiana coast, including the Mississippi Delta region, still has no HF radar coverage. This is unacceptable.

Large scale regional models are critical to understanding Gulf circulation, but they are not particularly useful for near-shore pre-

dictions of the fate of oil. LSU scientists have excellent fine-scale, near-shore, and estuarine models that need to be adapted and interfaced with regional scale circulation models of the Gulf. This, of course, takes funding.

I would also like to comment briefly on the adequacy of pre- and post-impact spill data needed for conducting natural resource damage assessments. For many years, LSU has occupied many research sites in the wetlands, coastal embayments and estuaries along the Louisiana coast. Pre-impact data obtained at these sites will be extremely useful for spill impact assessment. We await being informed of a mechanism by which we can apply for significant Federal funding for continued data collection. It is nearly two months now since the spill began.

Our assessments are important for recovery of damages from the spill. However, many scientists believe that important information must also be obtained outside of this process. One senior faculty member in my school expressed it as follows: I haven't much time left in my career, and I would prefer not to spend it in court. Others have told me that the legal burden added by the process actually impedes good science and means that state-of-the-art scientific approaches are not used. And I think Dr. Reddy was implying that.

Most present research seems to be focused on offshore concerns pertaining to the fate and effects of oil and dispersants. These are important concerns, but we must not forget that the Louisiana coastal environment is particularly vulnerable and threatened. Louisiana's extensive wetlands constitute approximately 40 percent of the national total, and the state is second only to Alaska in terms of seafood production. We must accelerate our efforts to understand the impact of this dreadful spill on these living resources.

Louisiana is the focal point of the fertile fisheries crescent that extends east and west into all or parts of Mississippi and Texas. We do not know what the effect of oil and dispersals will be on this food chain, as my colleague sitting to the right mentioned.

I would offer the following recommendations. We need a comprehensive spill science plan that includes the academic community. We do not have one now. Federal agencies need better ways to get emergency funding to researchers. As someone mentioned, the National Science Foundation has rapid awards, which have been extremely valuable, and NOAA also has a sea grant program, which has program development awards.

Such emergency programs need more resources. As of June 11, a search on www.grants.gov did not return any results for oil spill. This seems remarkable to me. Communication with and within the academic community should be enhanced. EPA Administrator Jackson did come down to meet with us early on, which we appreciated greatly. I recommend that more such contact occurs with more communiques from agency leaders to university leaders and scientists.

Ship time is difficult to find, schedule, and pay for. Better coordination mechanisms would be very helpful. Human impacts have received inadequate attention at the Federal level. More attention needs to be paid to those. Finally, we need new ways to finance sustained research and observation on the inevitable conflicts between energy and environment. A Federal Gulf oil trust should be

established. Senator Landrieu has recently introduced legislation to allow Gulf Coast states to share the revenue from offshore oil and natural gas drilling. I think that and other mechanisms should be considered.

Thank you for your attention. I would be pleased to answer any questions you have.

[The prepared statement of Dr. D'Elia follows:]

Statement of Dr. Christopher F. D'Elia, Ph.D., Professor and Dean, School of the Coast and Environment, Louisiana State University

Chairwoman Bordallo and members of the Subcommittee, my name is Christopher F. D'Elia, and I am a Professor and the Dean of the School of the Coast and Environment at Louisiana State University. I welcome this opportunity to be with you today to testify about the gaps and limits in our understanding of the complex estuarine, coastal, and marine environments of the Gulf, and especially, how limited investments in coastal ocean science programs and ocean observation systems affect capabilities for NOAA and other Federal agencies to provide timely and accurate scientific information to target response activities and to assess damages to natural resources.

You have asked me to provide my perspectives on the existing gaps in observation data needed to predict the extent and trajectory of the oil spill, including information about subsurface plumes; the adequacy of pre- and post-impact spill data needed for conducting natural resource damage assessments; and additional data required to understand the impact of the oil spill on the marine environment.

Federal personnel and their research and monitoring assets are critically important at this time of national crisis, and agencies like the Coast Guard, NOAA, USGS, and EPA have been challenged by the complexity and magnitude of this spill. Moreover, the Federal Government plays a critical role in funding extramural research and monitoring.

The academic community and private sector's potential contributions to understanding an event as complex as this are enormous. Non-Federal partners such as universities like LSU depend heavily on federal funding to undertake their research and monitoring efforts. Unfortunately, for a variety of reasons that funding, regardless of source, has been slow to materialize as this crisis evolves. Before I elaborate further on that, let me address the issues that you asked me to comment on.

Existing Gaps in Observation Data Needed to Predict the Extent and Trajectory of the Oil Spill

One of the greatest challenges faced is predicting the extent and trajectory of the oil leaking from the seabed. Doing so requires synoptic and real-time physical oceanographic and meteorological information, in tandem with robust satellite observations and simulation modeling. The Integrated Ocean Observing System (IOOS) is a federal, regional, and private-sector partnership for collecting, delivering, and using such information. IOOS provides essential data and information needed for predicting the extent and trajectory of the spill. IOOS is a prime example of the value added by academic and private sector entities that receive support from Federal agencies. The IOOS community, like many others, has been rallying to aid the response effort. Despite the best efforts of all involved, there is still a critical lack of actual data for the surface and subsurface conditions in the Gulf that dictate the fate of the oil. A well-designed network of sustained observations in real-time is critical to providing the data needed for forecasts that guide the work of responders. Later, these same data will provide critical baseline information that will be an essential component during the restoration process.

Unfortunately, the Gulf of Mexico has, until recently, had very poor coverage for measurements of currents and meteorological conditions. For example, high frequency (HF) radars, which provide real time data on the direction and strength of surface currents, are unavailable in Louisiana coastal waters. In response to the spill disaster, the University of Mississippi, with assistance from the NOAA IOOS Office and Scripps Institution of Oceanography, recently re-deployed 3 high-frequency radar (HF radar) units. However, these systems provide coverage of only a portion of the Mississippi/Alabama/Florida continental shelf. The Louisiana coast, including the Mississippi Delta region, still has no HF radar coverage! This data gap needs to be filled as soon as possible. The lack of this information is jeopardizing the Louisiana oil containment efforts. Considering that the port of South Louisiana (New Orleans/Baton Rouge) is the largest bulk cargo port in the world and the Louisiana coast is the location of the majority of drilling for oil and gas in the

U.S., this expenditure by the federal government is well justified and long overdue. With the onset of hurricane season, a robust suite of HF radar systems is needed especially in the region around the Mississippi delta. In addition, the redeployed HR radar units along the Miss/Al/Fla coast should be made permanent. There are also other technologies for measuring and monitoring ocean conditions critical to understand the fate of the oil that can and should be deployed.

At the request of the NOAA IOOS Office, SECOORA and GCOOS have been working with their numerous partners in academia and industry on a strategy for mapping and monitoring the subsurface plume and for providing observations for the initialization, validation and assimilation of the available circulation models. This provides the Incident Command Center with one high-level strategy that represents the input from multiple institutions and players.

Regional ocean circulation models operated by researchers at Texas A&M and the University of South Florida are now accessed daily by the Federal Incident Command Center. NRL and NOAA operate similar models but as the experience of the National Weather Service in predicting hurricanes has shown, ensemble modeling improves forecasts and predictions. I understand that such ensemble models are in development. Circulation models provide enhanced understanding of how currents, such as the Loop Current and its eddies, winds, river plumes, and other salinity patterns and temperature regimes will influence the fate of the oil. More alternative models by different teams of investigators would increase the robustness of plume forecasts.

While large-scale regional models are critical to understanding the circulation of the Gulf, in deep water, these models are not particularly useful for near-shore predictions of the fate of oil, such as in Barataria Bay, Breton Sound or the numerous other estuaries along the northern Gulf of Mexico coastline. Here, LSU scientists are able to provide considerable expertise based on their long-term observations of coastal processes and as well as their experience with near-shore and estuarine models in these areas.

The northern Gulf communities deserve the best possible real-time satellite images showing the location of oil especially in near-shore regions. The satellite data are useful for indicating the presence of oil. However, aerial overflights are also essential to resolve adequately the details of oil thickness and identify coastal areas at greatest risk. This information is currently not being provided to local responders in a timely manner. According to BP, such coverage by aerial surveys is too much of an expense! The government should demand this information with daily updates. These data are essential in tandem with real-time currents from the HF radar systems for predicting inner shelf trajectories of oil that are currently and will continue to impact our barrier islands and enter through tidal channels to adversely affect Louisiana's environmentally sensitive shallow bays and marshlands.

The Earth Scan Laboratory (ESL), the WAVCIS Program, and the Coastal Studies Institute Field Support Group, all in the School of the Coast and Environment at LSU, currently provide some of the data essential to the real-time tracking of the oil from the BP–Deepwater Horizon drilling accident allowing short-term predictions as to trajectories of the oil in various sectors of our coast. The Earth Scan Lab has three antennas which give it access to real-time satellite coverage many times each day of the Gulf of Mexico using several sensors (MODIS, GOES–East, AVHRR). These data have been used to reveal the spatial extent of the oil, its motion, and the motion of the Loop Current and its eddies. They are provided on the ESL web site in near real-time (www.esl.lsu.edu) and archived at the ESL for time-series studies. In addition, the ESL staff has been using radar (SAR) data obtained daily from the University of Miami CSTARS lab, augmenting capabilities for detecting oil across the Gulf. The satellite coverage has been an essential component of the response to this spill. However, the satellite data could be more useful with validation, which has been almost impossible for LSU researchers to obtain.

The WAVCIS system provides real-time met-ocean data at eight stations along the Louisiana coast. Coupling of remote sensing and physical data into numerical coastal models could improve the prediction of the path and fate of the oil. Each WAVCIS station collects data on wind speed and direction, wave height and period, and current speed and direction among other parameters. These data are telemetered by satellite link back to a central processing station at LSU and the data are made available in a web-based format in near real-time. In addition, the WAVCIS program boasts a highly sophisticated suite of hydrodynamic models that have proven very useful in tracking and predicting future migration of the oil slick. In addition, WAVCIS models are used to provide a series of predictions including an 84-hour wave forecast and a 120-hour surface current forecast (see: http://wavcis.csi.lsu.edu/forecasts/forecasts.asp?modelspec=currents).

With such sophisticated data-collection systems it is absolutely essential to have high quality technical support during the current oil spill period. Sustained Federal funding is necessary for us to continue to provide essential services such as ESL and WAVCIS. Current Federal appropriations do not provide sufficient resources for us to meet our needs, and we are unaware of any Federal program that can provide necessary support.

The Adequacy of Pre- and Post-Impact Spill Data Needed for Conducting Natural Resource Damage Assessments (NRDA)

For many years, LSU has occupied numerous research sites in wetlands, estuaries and embayments all along the Louisiana coast. For example, the Shell/LSU Breton Sound Ecosystem Project of the Northern Gulf Institute includes data collection from a variety of platforms and sensors. The pre-impact data obtained at those sites will undoubtedly be extremely useful for spill impact assessment for NRDA and to understand the unexpected consequences, and for other purposes. We emphasize that it is critical that our research at these sites continue and be adapted to monitor conditions as the spill progresses, as clean up efforts are undertaken, and throughout the ensuing recovery phase. It is essential to understand the resilience of Louisiana's coastal ecosystems to an event like the BP 2010 oil spill, because of the critical role these ecosystems have in sustaining seafood harvests and in providing essential habitat for wildlife. We are waiting to be informed of a mechanism by which we can apply for significant Federal funding to support our work, although we are told to expect opportunities shortly. It is nearly two months now since the spill began.

The NRDA assessments are obviously an important focus of the Administration for the recovery of damages from the spill. However, many scientists I have talked to express concern that important information must also be obtained outside of the NRDA process. One senior faculty member in my School expressed it as follows: "I haven't that much time left in my career, and I would prefer not to spend it in court. I would rather be working in the field doing my research on behalf of future generations."

The baseline to measure change and impacts is slipping away with each day and week that supplemental funds are absent, or that adaptive and focused new initiatives are stalled. The environmental, social and economic insults have come quickly (months), but the results will be here for decades. If we are to truly learn from this disaster, then we need to know much more about the pre-existing conditions and the transition as the spill progresses. We cannot start this in December – it needs to begin immediately.

Additional Data Required to Understand the Impact of the Oil Spill on the Marine Environment

Most of the research, monitoring and modeling that is now being conducted seems to be focused on offshore concerns pertaining to the fate and effects of oil and dispersant. Considerable attention has been paid to determining the location and magnitude of deep-sea plumes of oil and dispersant. While these are important concerns, particularly since dispersants have been used in unprecedented ways and amounts, we must not forget that the Louisiana coastal environment is particularly vulnerable and threatened. Since Louisiana's extensive wetlands constitute approximately 40% of the national total, and the State is second only to Alaska in terms of seafood production, we need to accelerate our efforts to understand the impacts of this dreadful spill on living resources from the continental shelf to coastal wetlands.

Louisiana is the focal point of the "Fertile Fisheries Crescent" that extends east and west into all or parts of Mississippi and Texas. Important fishery species include: oysters, brown and white shrimp, Gulf menhaden, blue crabs, king mackerel (offshore), red snapper, amberjack, cobia, dolphin fish, grouper, tuna/swordfish (offshore), spotted seatrout, and red drum. These species support economically important commercial and recreational fisheries as well as the human communities that depend on them in many ways – for employment, tourism, marinas, charter boats, seafood industries, etc.

Additionally, the above species depend on the "forage fishes" near the base of food webs such as Gulf menhaden and bay anchovy. Loss of these species would have serious implications for the entire food web. At present, we have little firm information on the status of these fish stocks vis-à-vis the oil spill.

Habitat concerns are also important and growing. Louisiana estuaries provide spawning, nursery and rearing (grow out) habitat for a huge array of estuarine-dependent species that migrate and spread to populate coastal systems across the northern Gulf of Mexico.

Louisiana's most important fishery habitat asset is its expansive coastal wetland system with an extensive marsh-edge shoreline that provides foraging (feeding) and

refuge (shelter) sites for the early life history stages of commercial and sport fisheries and forage species. The marsh edge is highly vulnerable to oiling and resulting damage to its nursery function will form a bottleneck for the recruitment of virtually all of our most important species into adult populations. Up to 90% of our important species use our marshes and estuaries at some point in their life cycles.

The open waters of the Gulf of Mexico are also important for many estuarine-dependent species and for offshore species. Offshore food webs are potentially affected by Deepwater Horizon plumes, but this has yet to be studied. The Gulf of Mexico is the only spawning area for the heavily depleted Western Atlantic Bluefin Tuna and the Gulf is an area of concentration of swordfish and marlin. While the densities of organisms may be lower in open waters than in other habitats, this translates into many numbers of organisms because of the volume of the open water habitat.

Life histories of species found in affected waters must also be considered. The longevity of a species relates to how risky its reproduction is. Short-lived species can complete their life cycles in 1 to 3 years. Because they are dependent on good and bad spawning years, their population sizes are quite variable from year to year. These species are highly productive but the fisheries associated with them are volatile as well, tracking good and bad years of spawning. Thus, additional mortality from external sources could accentuate the volatility.

Longer-lived species may not mature for five years or more and may live for 20–50 years. When unexploited, they can withstand a run of poor years of reproduction until conditions are right. However, long-lived species are also vulnerable to fishery impacts and in the Gulf of Mexico red snapper and a number of other long-lived species have been depleted and are under heavy management regimes. Accordingly, additional sources of mortality will dissipate the management benefits. For these long-lived species, the effects of high mortality years or low recruitment (due to oil) will leave a gap in the age structure of their populations. So if we lose the next 3–5 or more years of reproduction due to oil, there will be a long period of lowered egg production as these impacted year-classes make their way through the age-structure.

In extremis, large-scale recruitment failures could lead to long-term and serious changes in coastal ecosystems. It is possible for a "state change" to occur, for example. What is now a highly productive system in terms of fisheries and wildlife could become one dominated by microbial processes that are less capable of sustaining fish and shellfish species that coastal residents depend on in so many ways. I can only speculate here about this prospect, but it must be considered.

Habitat damage in Louisiana is likely to have severe effects on the reproductive success of both short- and long-lived species, but short-lived species like brown, white shrimp, blue crabs, seatrout and forage fishes (including bay anchovy and Gulf menhaden) are likely to suffer immediate population declines that will affect fisheries and the entire food web until estuaries and marshes recover from smothering and toxic effects of the Deepwater Horizon event. I have heard several fisheries scientists comment that herring have still not recovered in Prince William Sound more than 20 years after the Exxon Valdez spill. Will similar situations develop in the Fertile Fisheries Crescent?

We know that there are a number of possible exposure pathways that must be researched and quantified. Direct exposure may occur when fish swim through any concentration of dissolved or suspended petroleum constituents. Gill breathing animals like fish exchange gases and solutes with their environment across gill surface areas that appear small but are actually large compared the entire surface area of their bodies. Gill damage imperils respiration and gill uptake results in a body load that may have lethal or sub-lethal effects. Sub-lethal effects could seriously reduce a fish's viability or probability of reproductive success. The mix of individual contaminants may be at low concentrations and have only minor impacts, but the combined effects of different petroleum constituents, dispersants, and other contaminants may be more than additive (i.e., synergistic). The Deepwater Horizon Event is clearly adding many kinds of contaminants to the environment. Many scientists have urged that there be full disclosure of the composition of chemical compounds and mixtures used in dispersing spills such as Corexit 9500.

Fishes may suffer from indirect exposure that may also result from ingestion of contaminant-exposed prey. Fishes feeding on contaminated prey can accumulate an additional body load to that acquired from direct exposure. Contamination of food webs is likely to change the species composition of open water and estuarine fish communities. Sensitive species will diminish in population size and reduce prey availability to higher trophic levels. Thus, indirect effects of the Deepwater Horizon event could be spreading though the food web in unforeseen ways.

The timing of this event is troubling. Had it occurred during the winter, one would have expected less potential impact. Unfortunately, it has occurred during a season when many species are reproducing or migrating, and during which primary productivity (photosynthesis) is high. We do not know what if any, effects this spill will have on fundamental ecosystem processes such as energy flow and nutrient cycling. Fortunately, ongoing studies on these processes have been conducted in this region for years, but sampling frequency and geographic coverage should be increased markedly in spill-affected areas.

Because oil is a mixture of organic compounds that are subject to microbial processes such as respiration that consumes oxygen, there are other implications as well. Susceptibility of shelf waters to hypoxia is well known. Whether the added burden of the metabolism of the extra organic material represented by oil and dispersants is going to exacerbate hypoxia is unknown.

Other Considerations

Sitting on the sidelines and taking potshots at BP and Federal agencies is now accepted practice by many. One can easily understand why a mounting feeling of hopelessness has developed that leads to this happening. I prefer instead to make some constructive suggestions here about what might be done to improve our knowledge about the spill, its fate, its effects, and the ability of the environment to assimilate hydrocarbons and recover.

1. My foremost concern is that the academic research community has the potential of making considerable contributions beyond what it is now making. The biggest obstacle to this happening is funding. One Federal agency we approached told us that BP had funds for research, and we should check there first. In Louisiana, tight State finances have left LSU with frozen budgets and little flexibility to support research internally. I have heard anecdotally from several faculty members that they are taking a chance and charging some of their research expenses to their own personal credit card accounts, hoping to be eventually reimbursed. Federal agencies need to have better mechanisms to get emergency funding to researchers. Only the National Science Foundation seems to do this effectively via RAPID awards, but even NSF's hands are tied because of budgetary constraints as the end of the fiscal year approaches. NOAA's Sea Grant program does have funding available for "program development" awards, but the amount of funding available is woefully inadequate for the tasks at hand. As of June 11, a search on www.grants.gov did not return any results for "oil spill." This seems remarkable to me.
2. Communication with the academic community should be enhanced. EPA Administrator Jackson did come meet with LSU faculty early on, which we greatly appreciated. It took nearly a month after the spill before other Federal agency leaders made a concerted joint effort to engage academic scientists and engineers in the Gulf. On June 3, NOAA, NSF and USGS sent high-level officials to participate in a meeting organized by the Consortium for Ocean Leadership at the LSU Lod Cook Center. This meeting was highly successful, very informative, and helped the academic community understand better the challenges faced by Federal agencies as they continue to confront the spill and its impacts. I hope that other such meetings follow, and that more frequent communiqués with university research leaders ensue. President Obama has appointed a team of extremely talented scientists to lead many Federal agencies, and they need all the support that can be provided from the White House and us in academe.
3. Ship time is difficult to find. This is quite understandable. Virtually all Federally supported research vessels are presently being fully utilized. Ships are expensive, and the only alternative to using Federally supported ships would be to charter ships from the private sector or abroad. It is not clear where the funding to do that would come from. In any case, again better communication mechanisms would help in making sure that if ships do become available, or berths on scheduled cruises are open, the appropriate opportunities can be conveyed to prospective users.
4. In my opinion, human health impacts (both in terms of exposure from sea food, air quality from the "controlled" burns, as well as the health of the response workers) have received inadequate attention at the Federal level. Again, I have heard rumors that major announcements are on the way, but with every day that passes, important baseline health data are not collected.
5. In my view, it is time to consider new ways in which sustained funding can be brought to bear with respect to researching and monitoring the inevitable conflicts between energy and environment. It appears that offshore drilling

will need to resume fairly soon, or the U.S. will be in an ever-worsening economic crisis due to a shortage of liquid fuel and an increasingly large balance of trade problem – something noted very clearly by the U.S. Military's "Joint Operating Environment 2010" report. In my view, there should be a Federal Gulf Oil Trust established using federal oil and gas royalties from the Gulf, and perhaps fuel taxes as well. Sen. Mary Landrieu, D–La., has recently introduced legislation to allow Gulf Coast states to share 37.5 percent of the revenue from offshore oil and natural gas drilling. This is one possible approach. Some of this revenue could be directed to enhance research on oil drilling and production safety issues, on the environmental effects of this drilling and production, and on gaining a better understanding of Gulf of Mexico environment. There are other possibilities as well. The Land and Water Conservation Fund receives about $900 million from revenues from offshore oil and gas development. However, those funds are subject to Congressional Appropriation, which has ranged from zero funding (FY00–02) to as high as $369 million in 1979. This year's appropriation is just $38 million. The LWCF program provides matching grants to States and local governments for the acquisition and development of public outdoor recreation areas and facilities, which is very important. It would be great if the Land and Water Conservation Fund Act could be amended so that some of those funds could also be appropriated for coastal observing systems.

6. Directed federal funding should be provided to follow up on the emergency funding, such as NOAA's Cooperative Institutes, which many regard as highly successful models. Centers of collaboration that bring together academic, government and even industry scientists and engineers would foster better communication and lead to better synthesis and integration of our interdisciplinary knowledge.

Thank you for your attention. I would be pleased to answer your questions.

Response to questions submitted for the record by Christopher D'Elia, Professor and Dean, School of the Coast and Environment, Louisiana State University

Questions from Chairwoman Madeline Z. Bordallo (D–GU)

1. How has the Federal government engaged with independent scientists to enhance modeling of the oil spill and to improve pre-spill and post-spill ecosystem assessments?

We are unaware if Federal scientists have engaged academic scientists, but they have clearly engaged consulting companies to get field and logistical support for data collection and analysis. We do not know of any modeler affiliated with a university that was supported by the Federal government outside the NRDA process to help with the oil spill modeling. We have worked with NOAA/NGI to develop some research questions related to oil spill modeling, although funding has yet to be identified.

The focus has also been on fate of the oil and dispersants, and now is moving towards ecosystem issues. However, there is no clearly articulated Federal science plan that includes academic researchers and takes advantage of their modeling expertise.

The academic community has the capability to make great contributions to modeling the spill both in computational power and understanding of oceanographic processes. The northern Gulf of Mexico is graced with highly acclaimed academicians capable of hydrodynamic, biological and ecological modeling, and this resource should be used extensively.

Ms. BORDALLO. Thank you very much, Dr. D'Elia, for your comments and your recommendations. And I will now recognize members, beginning with myself, for any questions that we may wish to ask.

First, I would like to begin with you. And I do want to say this of this panel. I appreciate your honesty. It has been very refreshing. We know the problems. We have heard the problems, and you admit to them. And so we will take it from there.

Dr. Reddy, following up with my question to Dr. McNutt earlier, after the containment dome failed, did BP recontact scientists from Woods Hole to take flow measurements, yes or no?

Dr. REDDY. From my knowledge, no.

Ms. BORDALLO. Thank you. Also, Dr. Reddy, do flow measurement technologies exist that can be used to estimate the total spill volume from this oil spill?

Dr. REDDY. The technologies that have been used so far have been modified from other previous knowledge, I believe. I do not believe there is a known set-in-place technology that is used for such questions. But that is a little bit outside my expertise.

Ms. BORDALLO. I see. Well, how quickly can these measurements be made, and do you think these measurements could have been made without interfering with response and recovery activities?

Dr. REDDY. I believe the numbers that Dr. McNutt has put together as part of her working group are pretty robust. They include—what is particularly interesting from them is that they have come from a variety of different angles, and they seem to be all in the same ballpark. And the values that my colleagues collected more recently on a vessel, on a BP vessel, I think are particularly strong.

I would like to make one comment on these estimates. We are never going to get a number that is 53.5 or anything like that. My personal opinion is if we can nail down an estimate in the ballpark of within a factor of two or a factor of three, considering all of the other uncertainties that are in play with this very large event, I think that would be a sound number.

Ms. BORDALLO. Why is it important to have an estimate of the total volume of oil released into the environment?

Dr. REDDY. From a scientific perspective, we want to have a mass balance. To take that out of scientific jargon, that is essentially we want to balance our checkbook. We want to know where all the oil went. We want to know what got biodegraded, what evaporated, what may have gone into the sediments, what have gone into the marshes. So, in a couple of years, when we start to look at all of this data comprehensively with a team of interdisciplinary scientists, we will want to start looking closely where everything is, kind of have our own little, for lack of a better term, boxes of where oil was, and we will hopefully try to balance this checkbook. If we don't know how much came out, then we may be missing something.

Ms. BORDALLO. Dr. Weisberg, it is clear that the worst case scenario for an oil spill is now much worse than previously imagined. Can you suggest how the Federal Government and scientists could better respond to events of this scale and complexity?

Dr. WEISBERG. Thank you. I will try to respond to that. There was a comment made earlier that had we had enough resources in place based on previous experience, then perhaps we wouldn't be in the position we are in right now. And so I think we have to respond with that in mind. There is an immediate crisis right now that obviously requires being dealt with. But we have to lay down for the future resources so that we can deal with crises like this better into the future.

Ms. BORDALLO. Ms. Lee, do we have enough economic and social data to adequately assess the impacts of lost use and access to natural resources?

Ms. LEE. We have sufficient—well, let me say this. We have a substantial body of data. In terms of lost uses, the kinds of things that you would be looking at is you would be looking at bookings and what has been canceled. And what is different about this spill, this is an area where we probably have more information than we did in other spills, so it is one bright light in terms of the assessment. Because people have booked more on the Internet, it is easier to see a change from baseline, if you will.

So, in terms of lost use, as far as things like recreation, yes, we have better data than we have in prior spills. With respect to things like lost uses for fishery resources and so on, no, we don't because we need to know changes in populations and have a sense of how it is going to affect the industries over the longer term. And there it gets back to the scientific data that people have been talking about, the experts here at this table, which is to try to collect information so that we can see a change.

A lot has been said about baseline. I take a slightly different perspective on baseline. I believe you can show injury without knowing exactly what was there before, and you do that by virtue of showing where the oil is, what has been exposed to the oil, and then considering toxicity. Now, we definitely need more toxicity studies, but we also can collect information that is out there in the literature and bring it together. And that is where the scientific community is incredibly important.

So, with respect to those lost human uses, we have a lot of work to do.

Ms. BORDALLO. I also have another question for you. You state in your testimony, and I quote, "The law cannot achieve a compensation to make the public truly whole." Can you please elaborate on this statement?

Ms. LEE. I believe that the damages are so huge on this, were we to truly evaluate it, that there is probably not enough money to actually pay for it. And also, there are certain fundamentals that really can't be compensated with money. Fundamentally, the question is can we restore the environment and bring it back so that the fishermen can fish and lives can be put back together. And the answer is the jury is still out on that, no pun intended.

So, when I look at the law, I see that the most important thing that we all could do, at least among us here at this table, is to focus on the fundamentals of science, the focus on the fundamentals of technical analysis, and put our energy in tasks toward trying to get it better. The Justice Department can attempt to address the injury in terms of economic value, but I have been told by an economist once before that which is priceless is valueless. And unfortunately, we are almost in that situation.

I truly am worried about the Gulf. I am less worried about how much money the government might collect. I am more worried about can we direct our resources to the place it needs to be to put back the lives of the people on the Gulf Coast, the industry, and the ecosystem.

Ms. BORDALLO. Thank you. We have a panel of scientists here, all experts in their field. When they talk about it, and you read about this oil spill, they say, well, the recovery will be a decade, several decades, many decades. Can anybody answer? I know we can't put a firm number on this, but will it be many, many decades before all is at least partially normal?

Dr. REDDY. May I respond?

Ms. BORDALLO. Yes.

Dr. REDDY. I believe, and I heard this morning somebody say that recovery would be a very, very long time. It is my opinion that any estimate at this point beyond what we see on the short term and perhaps some estimates in terms of what we are seeing, any type of quantifier is scientifically imprudent, and it frustrates me to hear them do so. We will have a much better perspective about the long-term impacts of this spill as data comes along and where experts get to sit down from a variety of different disciplines to get an idea and a perspective.

This is by no means giving BP a free pass at all. And then we also have to put this in the context of scale. We often hear people talk very, very long, long time, and they put it in the context of the whole Gulf of Mexico. It is quite possible that there will be impacts for a long time, but they may be in small aspects of the ecosystem.

So, I would say at this time, let us slow down, let us collect the data, let us be prudent, and in the pipeline we will be able to have much more robust estimates.

Ms. BORDALLO. Thank you. Thank you very much.

Dr. REDDY. Thank you.

Ms. BORDALLO. And now I would like to turn it over to the Ranking Member, Mr. Cassidy.

Mr. CASSIDY. Thank you all for your testimony. I just whispered to staff that we are going to go on a bipartisan basis to try and have some of that BP money that we are going to put in escrow, fund proactive research that will be put out on an NSF rapid response, et cetera, et cetera, et cetera. So, thank you. You have informed me. And I am so confident. I mention it here because I am so confident that Chairwoman Bordallo will support that.

Also, Dr. Weisberg, I promise you that Dr. D'Elia also believes in earmarks, and has also assured me that they can be really good things, and so I have heard from my own constituents.

I am a doctor. I am actually on faculty with LSU Medical School. I am an academic. I know that oftentimes we as researchers hold our data. We don't release it because we want to make the big splash at the meeting. One thing Michael J. Fox did, which I thought was very wise in health care, is when he started his foundation to promote research into Parkinson's disease, he demanded that it be released real time. It may be a little dirty, it may not be quite where it should be, but it is not going to be encumbered for three years while it is kind of polished and goes to a meeting.

Now let me ask you, in your field, in your academia, is data typically impounded? I have learned from Dr. D'Elia, from his colleagues, that some of them have data on the *Exxon Valdez* which has still not been released because of threat of court order. Let me ask you, what solutions do we have so there can be real-time re-

lease? If we are successful at getting money for proactive research, credit yourself for putting the idea there. But second, let me ask the whole panel, what do we do that we know that that research has the maximal impact upon the ability of the Gulf to heal itself. One, is it a problem in your area of academia? And two, how do we address it? Dr. Weisberg?

Dr. WEISBERG. Well, you know, I mentioned IOOS on several occasions, and one of the hallmarks of IOOS is that the data be open access.

Mr. CASSIDY. And IOOS, what is an IOOS? I am sorry.

Dr. WEISBERG. The Integrated Ocean Observing System that was originally promoted by Ocean.US and endorsed by the U.S. Commission on Ocean Policy. And so, yes, we share your concern, and that was a part of the IOOS concept, open-access data. My experience so far with the *Deepwater Horizon* oil spill has been whatever I have produced has gone out on the Internet, and has gone in briefing Power Points to anybody that I thought could use this, but my information flow has been a one-way street. I have not gotten information back that I think is critical.

Mr. CASSIDY. Back from whom?

Dr. WEISBERG. From any of the agencies.

Mr. CASSIDY. Now I heard earlier one of our speakers—I think it was one of the women—mentioned that NOAA has been putting stuff out, or maybe you, Dr. Reddy—that NOAA has been putting out stuff real time. Let me ask you in the context of that, continue, Dr. Weisberg.

Dr. WEISBERG. Yes. So, one of the things that I have been doing specifically is providing spill trajectories at the surface and also attempting to do subsurface tracking, not knowing where the oil may be. We use satellite imagery interpretations of where the oil is to reinitialize on a daily basis the location of the oil, without which these forecasts are useless.

On a cloudy day, we have no satellite imagery. The unified command, they have overflights; they have a lot of other access to information on where the oil is, and yet there is not any provision to provide that information to people like me. And so one of my immediate suggestions in my written testimony is that be provided immediately so that we, any of us, that are engaged in spill trajectory forecasts can provide more accurate products. That is one example.

Mr. CASSIDY. Dr. Reed, you spoke of—I think it was you that spoke of the GEO. Again, I am learning. So, I am not asking you questions to challenge you. I am asking you questions to learn. The GEO doesn't have this data in adequate amount? Help me out here.

Dr. REED. Yesterday, NOAA announced a website called geoplatform.gov, where you can go and see a variety of data related to this event. It includes images from NASA. It includes the surveys on the ground from the SCAT teams about where they have seen oil and where they haven't seen oil. It includes information that is being put together in terms of supporting the response. It is a geospatial platform. You go in and you see maps, and you use different layers.

You can't actually access the data, though. You can see it, but you can't actually have it and take it and put it in your computer and analyze it in a different way, which is what would—that would be a database that would——

Mr. CASSIDY. Michael J. Fox would say put the data out there so you can download the database and you can play with it.

Dr. REED. Yeah. And I understand that that is in process at the moment. I had some discussions with NOAA on this, and I do believe that is in process. But that really needs to be moved out as quickly as possible so that we can do analysis. We can assist with understanding what is going on. There is so much going on that we can't just rely on the government scientists to do everything. We have to be able to play our role, too. And so making that data accessible is going to be important.

I do recognize, though, that some of the data that is being collected is going to be kept aside as part of the official assessment, and that may not be available. But there is a huge amount of data collection out there that is guiding response, as opposed to really establishing this legal baseline that we could really use.

Mr. CASSIDY. Are we going to have a second round? We are going to have a second round of questions. I will yield back and come back to a couple more.

Ms. BORDALLO. I thank the gentleman, and now I would like to ask for unanimous consent that the gentleman from Florida, Congressman Gus Bilirakis, be allowed to join us on the dais for this hearing. And hearing no objections, so ordered. And I would like to now recognize the gentleman from Florida.

Mr. BILIRAKIS. Thank you so much, Madame Chair. I really appreciate it, and I apologize for being late. Some of these questions may have been asked, but I feel that they are important. So, I would like to begin by again thanking the panelists for your excellent, informative testimony, and a special welcome to Dr. Weisberg from the University of South Florida. While not directly from my district, Dr. Weisberg, in conjunction with USF, an institution that I have long admired and endeavored to assist, has been very helpful to me, in particular, by coming to my office and personally briefing me, as well as taking the time to consistently brief members of my staff. Thank you, Doctor.

I thank you for sharing your knowledge and your expertise. And really, this is the crux of my question, the sharing of information. It is irrefutable that you alone at USF were the first person, hours after the tragic explosion of the *Deepwater Horizon* rig, to engage instruments you already had placed out in the field. These are the same instruments that you had deployed as far back as 1993 to help set up your numerical calculation models. As I understand it, you have been prodding NOAA and other government agencies for years to be better prepared for scenarios just like the one we are facing today.

Since April 21st, 2010, you have shared your information with government agencies. Has the government reciprocated by sharing information that they have gathered? In your testimony, you say that data gaps abound. You suggested that satellite data could be supplemented by other means. And again, a quote, "ground truth."

But again, that information has not been shared with me, with you, as I understand. That is disconcerting to me.

Who is not sharing the data that can better assist you to help fight this environmental and economic nightmare? What can Congress do to compel the sharing of information and to make sure that the new data exists? If you can answer that question, I would appreciate it very much.

Dr. WEISBERG. Thank you. That is a tough one to answer, but I will, and I will try to be very candid, and we will see where this goes. First of all, I was involved from day one. However, I am sure I was not the only one, so let me just make it very clear there have been a lot of people involved, and I am one of them. And I happen to have an excellent staff and some resources in place that allowed me to do that, and I am very thankful for that.

However, my group has received absolutely no resources from day one. So, we are doing this out of professional responsibility. And I feel that if I am privileged enough to be a professor at a university and to be engaged in what I do, then I have a responsibility to respond as best I can. So, that is what I did.

I have been frustrated from the beginning that the flow of information has not been as good as I would like it to be. And in particular, the reinitialization of these trajectory models with actual oil locations. As I said, all I have available to me are the analyses that my gifted colleagues can do at USF in identifying in satellite images where oil may be. It is not an easy task.

Nobody has asked my recommendations on where overflights should go. There has been no discussion whatsoever between anyone in my group as to how maybe we can assist better. And therefore, I am frustrated that I think I can do a better job of what I am doing if there was some information flow to me, and that has not occurred 57 days into this tragedy. That is a pretty strong statement, but I think it is important to make.

As far as other observations go, we have heard today about high frequency radar. And I have made a point in my testimony to say that there is no single instrument system that is adequate. There is no single model that is adequate. This is a complex problem. This is very broad. This is not a problem for NOAA, not a problem for the EPA, not a problem for the MMS. This is a universal problem, and we have to begin approaching it in a more comprehensive manner. Otherwise, we are just not going to understand how our systems work. And if we don't understand how our systems work, we cannot project well into the future as to what the results of this crisis might be.

So, we have to reevaluate how we do our science in the coastal ocean for the betterment of society. I hope that at least begins to answer your question.

Mr. BILIRAKIS. What if I help facilitate that information flow with the united command in St. Petersburg. Would that be helpful?

Dr. WEISBERG. Yes, it would.

Mr. BILIRAKIS. Very good. Thank you. A couple more questions, if I may, Madame Chair. In your testimony, Dr. Weisberg, you say, and I quote, "Scoping out the nature of a potential subsurface threat as quickly as possible is necessary for contingency planning and possible mitigation." Tell me why that is important. We have

heard all along that the unified command, which includes BP, Coast Guard, NOAA, EPA, and Interior, say that the flow rate of the oil coming out of the wellhead is irrelevant because they are treating this as a worst case scenario. Does the oil flow matter at this juncture, and how should we be responding to the disaster? And other members of the panel are welcome to join in as well. But first you, Doctor.

Dr. WEISBERG. Well, let me treat the last question first. I think the flow rate does matter, if for no other reason than to have been prepared with a surface vessel that can capture more than 15,000 barrels per day. If they know it was 25,000 barrels per day, then why didn't they have a surface vessel brought in that could handle 25,000 barrels per day?

But getting back to subsurface oil, the ocean circulation and the whole organization of ecology is a fully three-dimensional problem. For example, as oil is now approaching Florida, and it has started to hit northwest Florida beaches, we know that the region of the continental shelf break where the depth all of a sudden drops off into the abyss—we know that that is a very sensitive region for all of our reef fish. In fact, that is where the gag grouper live as adults, and that is where they spawn. And so if there are contaminants in levels high enough, with toxicity large enough to impact those communities—and I don't know, but if there is, we need to know about that because the worst thing we can do then is wipe out the fundamental habitat of our reef fishes. And so just because we don't see it, just because it is below the surface and we don't see it, does not mean it is not a threat. It may even be a worse threat than what we can see.

Mr. BILIRAKIS. Thank you. Other members of the panel, would you like to address it? Does the flow matter?

Ms. LEE. Yes, I think it does. I mean, certainly the mass matters, what is out there. And maybe the answer was in relation to what they would do to clean it up, and there are limited assets so that you can only clean up so much. But it very much matters with respect to injury assessments. And I would like to remind the Committee again about restoration. I would like to submit that all is not completely lost, that it isn't just about preparing for the next spill and having research to count the organisms that have died.

I would like to suggest that if we are smart about collecting the information—and let us not even call it research. Let us call it appropriate technical response to the spill. Let us analyze what is happening. Let us make some reasonable conclusions, maybe not to the 95 percent degree of certainty that scientists love, but to the degree of certainty that we need as policymakers and people who are trying desperately to make sure that we have a Gulf and a vibrant economy in the near-term rather than decades out. So, I think it does matter, and it matters for restoration.

Mr. BILIRAKIS. Thank you, thank you.

Dr. D'ELIA. Yeah. I would also like to comment. I think flow absolutely does matter. We should understand it. It is going to be important to know how much is out there because the effects will be determined by how much is there. But it also important to know how it is partitioned, where it goes. The fate of the oil is extremely critical. If they are using dispersants, it may send it in one direc-

tion. If they don't use dispersants, it may send it in another direction.

So, all of these things are important. I think as Marcia McNutt indicated in the previous panel, doing the mass balances is an extremely critical activity that we need to undertake.

Mr. BILIRAKIS. Thank you. Madame Chair, thank you. I yield back. There is another round. Is that correct?

Ms. BORDALLO. Yes, there is.

Mr. BILIRAKIS. OK. Thank you.

Ms. BORDALLO. Dr. Reed, in collecting data about the inventory and condition of natural resources as part of the natural resources damage assessment, is it helpful to involve local programs that may have extensive data and local knowledge about impacted resources? And how do you involve these local or state entities?

Dr. REED. I think it is absolutely crucial, ma'am. One of the points I wanted to make about the Louisiana coast and the issue of a baseline is that it is constantly changing anyway. If we were to go out and collect a large amount of data in 2010, that would really not give us a good idea about what it was like in 2008 or what it would be like in 2012 because it is constantly changing. And that is exactly why we need to not just go out and look at what it is like now, but we need to engage folks who have been tracking it over the last few decades to show what path it was currently taking, where were areas eroding already, how was the grass growing to begin with. You know, was this a bad year; was this a good year?

And so really engaging those folks that have had studies on the ground, particularly in the wetlands, in the barrier systems, and the open bays, these complex environments where we are not going to be able to go out and measure every little piece of it. We need to bring those of us together who have studied it for awhile and lay their data on the table. And I think most people are willing to do that.

Ms. BORDALLO. Thank you. And I agree with you. The experience that these folks bring with them would be very, very helpful. What kind of monitoring is needed to understand the oil and dispersant impacts on important fish populations in the Gulf of Mexico, and what would be needed to implement this kind of monitoring?

Dr. D'ELIA. I think it is both a research and monitoring question. And we obviously want to do the fundamental toxicity studies that one always does and take into account the different life stages that fish are involved with, as Dr. Reed suggested. So, that will be very, very important. But we also need to understand, whenever you work with a pollutant, you have to understand dose and exposure. And so trying to understand what the dose is, referring to Mr. Bilirakis's previous question, is going to be very, very important, and how long that dose stays resident, how long the various life stages of organisms are going to be affected.

We want to understand the ecosystem. We want to understand trophic relationships. If we do something that causes a catastrophic failure of the trophic dynamics, if you will, of the coastal shelf, it could have a devastating effect that could last for years. If we destroy the ability of fishes and shellfish to recruit future generations, then we are going to have a serious problem.

These questions are all up for grab. We need to be studying them now. We need to be planning our studies now. We cannot wait and hope that later on we can begin these things.

Ms. BORDALLO. And, Dr. D'Elia, do you think that NOAA should establish an emergency funding program similar to the National Science Foundation's rapid awards for immediate collection of ocean observation and environmental baseline data in the event of an oil spill?

Dr. D'ELIA. Absolutely, or in the event of another catastrophic environmental concern that they might have. There isn't a mechanism right now. As a former Sea Grant director, I am always proud of what the Sea Grant program does. They have a small pot of money, called program development money, that is used for that purpose. But it is a very small pot of money. It is limited to I think about $10,000 a shot. That is simply not enough to do a substantial, credible amount of work.

The NSF rapid program goes up to $250,000, and is really a much better approach. So, frankly, Sea Grant has been underfunded for as long as I can remember, and it is an extraordinarily important program.

Ms. BORDALLO. Thank you very much. And I would like now to call on the Ranking Member.

Mr. CASSIDY. Drs. D'Elia and Reddy, BP has said they are going to make everybody whole insofar as they can make people whole. Let me ask the two of you, is it possible that BP could do so if we don't have prospective, ongoing research as to the, again, ongoing effects of this spill? Dr. Reddy?

Dr. REDDY. No.

Mr. CASSIDY. Yes. I doesn't right, huh? I just want to get that for the record because——

Dr. REDDY. Sorry. I am not being fresh. No.

Mr. CASSIDY. Yes. Dr. D'Elia?

Dr. D'ELIA. I would agree completely.

Mr. CASSIDY. OK. Let me go on to the next one. Let me ask the two of you to rate NOAA's response or any Federal agency's involvement right now of academia, because you are obviously doing some work with them, but in general, rate—we have already heard from Weisberg. It is an F. Please rate what you think, the Federal Government's response has been so far in engaging you in these kind of prospective or——

Dr. REDDY. Engaging me directly? I have had the luxury to speak to NOAA frequently. In fact, I am planning for this cruise that I am leaving in a few hours for. I have looked at the data that has been released quite quickly, and we have used that to make our cruise plans upcoming. So, I consider the fact that there has been a lot of transparent data recently. There is a website for us to see where every vessel that is in the theater is out there, and every research vessel now that is in the theater has to update the data that has been out there in terms of collection of data and some other raw data that we are using as we speak.

Mr. CASSIDY. So, Woods Hole has had a good experience.

Dr. REDDY. Myself, in interacting with NOAA and the EPA as well in terms of recently planning our data, our cruise.

Dr. D'ELIA. I would say that for both NOAA and the EPA, the experiences are mixed, and that is because both agencies have regulatory and operational responsibilities, and we tend in the academic world to be much more oriented to research. And it is always the case that if you have to regulate or do something operational, like forecast the weather, you are going to make those your highest priorities. So, as a result, NOAA and EPA both tend to be agency-centric to a certain degree, and that is partially the complexity of their mission.

It would be nice if we could have a way of partitioning out the research that each agency does so that it is better protected. Years ago in Congress, there was a proposal to establish a National Institutes of the Environment to do exactly that. But it went nowhere. So, that is a fundamental challenge for NOAA, for EPA, and for the academic community.

Mr. CASSIDY. Ms. Lee, again—Dr. Weisberg?

Dr. WEISBERG. Yes. I would just like to just clarify one point. I have not received any direct flow of information or support from NOAA for this. However, I have interacted with a limited number of NOAA scientists, and NOAA does acknowledge the work that we are providing on their daily forecast. So, it is not as if there has been no, you know, linkages. I just wanted to clarify that, for the record. Thank you.

Mr. CASSIDY. Ms. Lee——

Dr. D'ELIA. I would agree with that also, Congressman.

Mr. CASSIDY. Ms. Lee, again, I have been so struck by somebody who worked on *Exxon Valdez* who says that his research is still encumbered, however many years later, because of litigation issues and subpoenaed, et cetera. When I spoke to some of the researchers, they said when they went to the marshes, they were confronted by somebody, they said from BP—I have learned in this job to say what I have been told, not what I know—that took kind of their name, where you are from; if you have published anything, we are going to subpoena you sort of thing, which is an intimidation for academic who just wants to get along with their life.

So, that said, as the lawyer on the panel, what can we do to allow folks like you to do your research without fear of being intimidated by the legal process?

Ms. LEE. Well, that is a challenging question, and I think the bottom line is that in some ways there needs to be a parallel process. So, to the extent that one wants to get compensation—and I believe there is clearly a case here that is substantial—then one does need to recognize the limitations of the law. The limitation that we are presented is it is an adversarial process, and information can be used in ways—I think it is inappropriate for somebody to be threatening subpoenas.

Mr. CASSIDY. And it may just have been that it was taken as a threat and wasn't intended to be——

Ms. LEE. Correct.

Mr. CASSIDY. But still.

Ms. LEE. However, I will share with you, I was working on a matter in the State of Maine and had occasion to speak with someone from the agencies, and the damage assessment team from that agency actually was given the same story. They ignored it. And I

certainly have read within interest the statements made by members of the press. Obviously, the beaches are public, and people have access to beaches. There is a legitimate concern to the extent that there is a hazardous situation, but at this point we can't declare the entire Gulf Coast a hazardous waste site.

Mr. CASSIDY. I think I heard a kind of presentation of a problem by you, but not a real solution. And I am a physician. I typically don't like attorneys. But that said, is there a solution to this?

Ms. LEE. Well, there is a solution. One is there needs to be a transparent and public process; two, that there is a role for the Department of Justice working on behalf of the United States to prepare a case. Third, I do believe that the data that was collected in *Exxon Valdez*, we should revisit that issue. I am aware of actually, when I was at the Department of Justice, which I was, experts who were working on *Exxon Valdez* were actually literally to get rid of their notes by the Criminal Division.

So, that is the kind of thing that there may be a basis for it in law, but the bottom line is that that is not very helpful for the larger public interest. And I am a different kind of lawyer. I don't go out and sue folks. What I try to do is I try to work with interdisciplinary teams. So, I don't fit neatly in a box. I love science. I love law. I love interdisciplinary approaches.

Mr. CASSIDY. So, if you have a way—because sometimes the Chair won't—Madame Chair is being very lenient with us. If you have something to suggest working with these academics that would allow Dr. Reed to do research without fear of being in court when she should be teaching classes, that would be wonderful if you could suggest that.

Ms. LEE. Well, I think that we need to have interdisciplinary teams. I think we need to have transparent information. And the bottom line is the data are the data. I mean, one of the problems that you have with more junior lawyers and less seasoned lawyers who don't understand technical information is they are petrified that a scientist is going to say something to hurt their case.

We have a larger public interest here. The truth is the truth. The data are the data. And those working on behalf of the Department of Justice and others need to take that into account. And so were it up to me, I think greater transparency is the watch word.

Mr. CASSIDY. Dr. D'Elia.

Dr. D'ELIA. Yeah, I would just comment. I think that the Administration's strategy has very much been to favor the legal adversarial process here. And I can understand the motivation to do that, to try to recover as much damage money as possible. But I think that the downside of that is that it slows down and impedes the science that really should be done. And I think sooner or later, the Federal Government is going to have to make some investments in doing further research without regard to whether they are going to be able to recover those damages.

Mr. CASSIDY. Thank you. I yield back.

Ms. BORDALLO. I thank the gentleman, and now I would like to recognize the gentleman from Florida, Mr. Bilirakis.

Mr. BILIRAKIS. Thanks so much, Madame Chair. I really appreciate it. Dr. Weisberg, I would like to learn more about the Loop Current. I hate to be particularly regional, but I am from the

Tampa Bay area, and I am especially concerned about the oil spill, how it is going to affect us. Does the Loop Current appear to be a natural barrier for the Tampa Bay area as it relates to us being directly impacted by oil slicks, sheen, or tar balls?

Dr. WEISBERG. The Loop Current stays in deep water. And on the west coast of Florida, the continental shelf is, let us say, about 100 miles wide or wider. And so the west coast of Florida is actually buffered by the extent of the continental shelf. If oil gets entrained into the Loop Current, and it has been, then it flows south. And presently, the Loop Current has shed what we call an eddy, so the oil is actually staying in that eddy—as opposed to continuing into the Florida straits and up the East Coast. Under other situations, the oil could go up the east coast of Florida, where the continental shelf is very narrow, at least off of Miami, and that oil can come in proximity to land.

So, the Loop Current is extremely important. Monitoring how it evolves between now and several months from now, as long as there is oil out there, is critical because that could be a game changer. It can determine—the Loop Current could conceivably go all the way to the wellhead. And if it does that, then a lot of the oil that is up there is going to be transported out of that region. And unfortunately, we can't predict exactly how the Loop Current will behave.

Mr. BILIRAKIS. How will the weather affect—maybe a hurricane, God forbid—how would that affect or alter your trajectories regarding the Tampa Bay area, or for the Gulf Coast, for that matter?

Dr. WEISBERG. It is difficult to say exactly what a hurricane will do because it depends from what direction that hurricane may approach. So, for example, if a hurricane came ashore somewhere in Georgia, the region of the oil spill would have very strong winds blowing from west to east. That could drive oil along the coast of Florida. If, on the other hand, a hurricane came into the Gulf of Mexico from the south and progressed westward, those winds would be blowing from east to west. So, it is really impossible to state what the impact of a hurricane would be without knowing about the actual properties of that hurricane. But there certainly would be an impact. We just can't really predict in advance.

Mr. BILIRAKIS. Other members of the panel, would you like to respond to that question, or any question that I asked? Yes, please.

Dr. REED. Thank you. I would like to make some observations about the wetland side of the equation. In Louisiana and in Mississippi and Alabama, thus far, we have been very lucky, I think, in that most of the oil is still out in the Gulf of Mexico. I mean, it is not good that it is there, but it could be a lot worse in the wetlands. And what you see when you see these images on television is the oil is largely around the edge of the marsh, and the marsh kind of catches it as it comes in. And this is exactly what we saw in the Lake Barre spill a number of years ago in Louisiana.

I think one of the things that I worry about is not a big hurricane, but perhaps a small tropical storm that just lifts the water level a couple of feet, and so that instead of the grasses sticking out of the water at high tide, when the storm comes in, the whole marsh is covered. Not a big enough storm that we evacuate New Orleans or something like that, but the kind of minor tropical

storm that we get a lot in the Gulf of Mexico that could just actually spread this oil much further into the wetland environment.

We have oil in some of our wetlands already. We have been lucky. It is mostly around the edge. But, you know, we are getting into the season where we have events that just could carry it a lot further. And that could make it a much more widespread problem in the wetland environment than it is at the moment.

Mr. BILIRAKIS. Anyone else? Yes, please.

Dr. D'ELIA. Yeah. I would just like to comment. I think Florida has been very fortunate by and large that the currents have done what they have done and that the oil has stayed offshore. I also own property in St. Petersburg, and I am a courtesy professor at USF. And so I have a strong interest in what goes on there as well. I think that the tourism industry has been really dealt a hard blow by media reports that suggest the situation is worse. And I would encourage people to get the word out that Florida is still open for business, and there are only certain areas of it that are under siege right now from the oil.

Mr. BILIRAKIS. I promise I will do my best to get the word out.

Mr. CASSIDY. Will the gentleman yield for just——

Mr. BILIRAKIS. Yes, please. Of course.

Mr. CASSIDY. You must own a hotel.

[Laughter.]

Dr. D'ELIA. No, no. I wish I did.

Mr. BILIRAKIS. I have one more question, if I may, Madame Chair. Thank you. Dr. Weisberg, could you tell me a little bit more about the Integrated Ocean Observing System? Has it been useful in the past? Can it be useful in the future?

Dr. WEISBERG. The answer is yes, it has been useful in the past. It is actually useful right now. It could be much more useful if we really begin to implement it. And so there is a concept advanced in 2002 for this Integrated Ocean Observing System that would be a full partnership between the agencies and the academics and the private sector. And there was an original ramp-up to $500 million that had been suggested in 2002. The President's Commission on Ocean Policy increased that to $750 million. I have been using numbers more like a billion myself.

Whether or not these dollars are adequate depends upon how they are distributed. And so when I say partnership, I mean a true partnership. The academics have an extremely important role to play, as does the private sector and the agencies, obviously. But R&D, research and development, is really a purview of the academic community. Operations obviously is a purview of the agencies. But we can't improve upon our operations unless we have adequate R&D. And we can't improve upon our environmental stewardship unless we really understand how these systems work.

So, if you want to fix your car, you have to open a book and see how the thing works, otherwise you can't fix your car. We don't know well enough how our coastal oceans work. And so that is going to be what IOOS can provide for us, that set of observations and models and enough people thinking about this massive problem that we can really start bringing closure to our understanding of the workings of the deep ocean to coastal ocean to estuaries.

Mr. BILIRAKIS. Thank you. Anyone else want to comment on that?

Dr. D'ELIA. Yeah. I just wanted to emphasize what Bob said. I think he is absolutely right about distinguishing the operational side from the need for R&D. We really can't make progress until we do the necessary R&D, and that is going to be continuing as circumstances change. We live in an environment that has constant new challenges, and accordingly, we need to always be up on our research. You never get to the stage where you know enough to deal with everything. And I think that is one real lesson that is going to emerge from this event.

Mr. BILIRAKIS. Thank you. Thank you, Madame Chair. Thank you for allowing me to sit on the panel, and I yield back.

Ms. BORDALLO. I thank the gentleman from Florida. I guess I am going to ask the final question here before we close the Subcommittee hearing. On behalf of my colleagues, I am sure they are very anxious to hear the answer to this question. Can anyone on the panel speak to the safety of seafood from the Gulf, given what we do not know about the dose and the toxicity of the oil and the dispersant? How will we know when our seafood is or is not safe to eat? We are all anxious to know. Can anybody answer that?

Dr. REED. We have certainly in Louisiana very good programs in place even before this event came through about seafood safety. We have extensive monitoring of oyster beds. The state Department of Health and Hospitals, in conjunction with the state Department of Wildlife and Fisheries—this is the kind of thing that is vital to us in Louisiana. We don't want a bad reputation about our seafood, that we regularly close oyster leases if there is a problem with any kind of microorganism or anything like that. I think the approach in Louisiana is that seafood safety, good seafood, tasty seafood, healthy seafood that is not going to get you sick, that is our brand, if you like. And so the state has very good programs in place at the moment, and I am confident that they are only going to be allowing to market seafood which is safe.

Ms. BORDALLO. Thank you. That is a very good answer. Now we can have our seafood lunch and dinners.

Dr. D'ELIA. I can also comment on that. I would like to just echo very strongly what Denise just said. And as a former Sea Grant director, I know something about seafood and the attention that is paid to having quality seafood. I was also in this area as a Maryland Sea Grant director back when the Pfiesteria crisis hit in the '90s, and I can tell you that the worries about seafood in one very small geographic area caused people to shun seafood in a much wider area, even when there were no effects going on from Pfiesteria. And I am worried about the same thing going on here. It is almost like the tourism thing. If the oil doesn't reach the seafood, it is not going to be a contamination problem. And the oil has not reached a lot of the fisheries that we are now using to produce seafood.

Obviously, the state agencies in all the states will be monitoring this closely, as will FDA and NOAA and others who are involved with this, and I am confident that they will be very cautious.

Ms. BORDALLO. Well, thank you. And that is good news. I want to thank the second panel and all of the witnesses for their

participation in the hearing today. And I would like to remind the members of the Subcommittee that they may have additional questions for the witnesses, and we will ask you to respond to these in writing. In addition, the hearing record will be held open for 10 days for anyone who would like to submit additional information for the record.

So, if there is no further business before the Subcommittee, the Chairwoman thanks the members for their participation here this morning. And the Subcommittee now stands adjourned.

[Whereupon, at 12:57 p.m., the Subcommittee was adjourned.]

[Additional material submitted for the record follows:]

[A letter submitted for the record by William Y. Brown, President, Natural Science Collections Alliance, follows:]

June 18, 2010

The Honorable Madeleine Bordallo
Subcommittee on Insular Affairs, Oceans and Wildlife
United States House of Representatives
1324 Longworth House Office Building
Washington, DC 20515

Re: Hearing on "Ocean Science and Data Limits in a Time of Crisis"

Dear Ms. Chairwoman:

As President of the Natural Science Collections Alliance (NSC Alliance), I thank you for recognizing the importance of biological collections during the Subcommittee's recent hearing about science and its role in understanding and responding to the problems associated with the Deepwater Horizon oil spill.

The NSC Alliance is a nonprofit association that supports natural science collections, their human resources, the institutions that house them, and their research activities for the benefit of science and society. Our 100 institutional members are part of an international community of museums, botanical gardens, herbariums, universities, and other institutions that house natural science collections and utilize them in research, exhibitions, academic and informal science education, and outreach activities.

As you know, Dr. Jonathan Coddington, associate director of research and collections at the National Museum of Natural History, testified before your subcommittee about the importance of natural history collections. As Dr. Coddington noted, the Smithsonian's collections of marine biological specimens represent a unique and now irreplaceable resource to describe quantitatively the pre-spill Gulf of Mexico ecosystem. These collections document the biological diversity of the region prior to the oil spill, and will contribute to assessments of the spill's environmental impacts and will help to guide ecological restoration efforts.

Scientific collections held by other institutions will also contribute valuable scientific knowledge to the oil spill response. As Dr. Coddington noted, an estimated 42 percent of publically available biological specimens from the Gulf of Mexico are held by entities other than the Smithsonian Institution. Numerous universities, museums, and non-profit research centers hold biological specimens collected from the region. These collections serve as vital sources of biological information about the Gulf of Mexico and the southeastern United States.

Our nation's natural history collections, whether held at a national museum or in a university science department, contain genetic, tissue, organism, and environmental samples that constitute a library of Earth history. These specimens and associated data drive cutting edge research on the significant challenges facing modern society. Beyond informing oil spill response and restoration, these specimens enable researchers to answer questions about the effects of climate change, the spread of invasive species and pathogens, and the loss of biological diversity and its effects on ecosystem function. In short, natural history collection specimens and associated data enable scientists and natural resource managers to develop the knowledge required to inform environmental management.

Unfortunately, for too many years, the federal government has failed to make an adequate or coordinated investment in natural science collections. Thus, we often hear from curators about backlogs of specimens that have yet to be identified or properly curated. There is also a need to digitally capture and make available infor-

mation about key holdings. For these and other reasons, the NSC Alliance has requested that the President promulgate an Executive Order establishing a formalized interagency process for the preservation and use of the nation's science collections, both federal and non-federal. Information about the NSC Alliance proposed order is available on our Web site at http://nscalliance.org/?p=139.

Once again, thank you for focusing attention on the importance of science collections to responding to environmental and public health crises. I would welcome an opportunity to discuss with you the importance of a sustained and coordinated federal investment in the nation's scientific collections. Please do not hesitate to contact me at 215–299–1016 or wbrown@ansp.org, or Dr. Robert Gropp, Director of Public Policy, at 202–628–1500 x 250 or rgropp@aibs.org.

Sincerely,

William Y. Brown
President
Natural Science Collections Alliance

[A letter submitted for the record by Ronald S. Tjeerdema, Ph.D., Professor and Chair, Diplomate, American Board of Toxicology, follows:]

June 23, 2010

The Honorable Madeleine Z. Bordallo
Subcommittee of Insular Affairs, Oceans and Wildlife
Committee on Natural Resources
US House of Representatives
Washington, DC 20515

The Honorable Henry E. Brown, Jr.
Subcommittee of Insular Affairs, Oceans and Wildlife
Committee on Natural Resources
US House of Representatives
Washington, DC 20515

Re: Data gaps in oil spill research

Dear Chairwoman Bordallo and Ranking Member Brown,

Thank you for the opportunity to contribute input regarding the existing data gaps that may hinder the ability of Regional Response Teams to respond to marine oil spills in the future (the subject of the recent hearing on June 15, 2010). As a professor of environmental toxicology, I have directed research on the environmental fate and toxic actions of crude oil, dispersants and dispersed oil for almost 25 years (resulting in nearly 150 peer-reviewed publications and proceedings abstracts). In light of the recent Deepwater Horizon blowout, it has become apparent that there are a number of data gaps that need to be addressed prior to the next spill event.

Following the Exxon Valdez oil spill in 1989, interest in the fate and effects of crude oil, dispersants and dispersed oil increased dramatically – with a concurrent rise in research funding made available by numerous federal and state agencies, as well as the oil industry. However, over the past decade both interest in oil spills, and research funding, dramatically declined; today there are few active sources. Thus, many important areas have not been addressed, leading to the data gaps that have become so apparent with the current Gulf of Mexico oil spill.

In general, once an oil spill has occurred responders first determine whether a formal response is necessary. If the spill is limited in scale, and moving away from important shorelines and/or resources, it may be sufficient to allow it to degrade naturally. However, once the decision is made to formally respond, the means then need to be identified. Common methods include removal (via booms/skimming), burning, chemical dispersal and bioremediation. Often small spills can be adequately dealt with via removal techniques, but for larger spills usually a combination of methods is necessary. However, technology has advanced little over the past decade, and for the most part both short- and long-term environmental consequences remain largely unknown.

Obviously, numerous data gaps exist. General research areas requiring attention include:

1. Development of improved collection techniques. The current generation of skimmers collects much more water than oil, making them highly inefficient.

2. Design of more effective corralling systems. Booms currently in use are only effective in calm seas, and without efficient booms the effectiveness of skimming declines dramatically.
3. Evaluation of currently available dispersants for effectiveness using a wide variety of oil types, weathered states and environmental conditions. Every oil spill is unique, and the best decisions involving dispersant selection and use depend on data specific for the oils and conditions unique to each spill.
4. Short- and long-term fate of both naturally-dispersed and chemically-dispersed oils under varying environmental conditions should be characterized to determine the influence of droplet size, persistence and potential formation of more toxic products.
5. Both acute and chronic toxic effects should be characterized for both naturally-dispersed and chemically-dispersed oils using the sensitive life stages of marine, estuarine and freshwater organisms likely to be impacted in the future.
6. Development of more effective microbial systems for bioremediation that are optimized for a variety of fresh and weathered oils, their chemically-dispersed forms and various environmental conditions. Ultimately nature degrades petroleum, primarily through microbial degradation. However, advanced bioremediation techniques possess the potential to enhance degradation rates, leading to decreased environmental impacts.
7. The potential for development of "dead zones" from the localized release of massive amounts of organic carbon, which would potentially elevate biological oxygen demand (BOD), should be assessed. Hydrocarbon degradation by microbes has the potential to produce anoxic conditions, leading to toxic impacts.

These are some of the main areas of need from my vantage point of nearly a quarter century investigating the fate and impacts of oil and dispersed oil. During that time, and with support from the California Office of Spill Prevention & Response, my research team developed a state-of-the-art oil spill research facility which provided much of the data on both oil dispersant and dispersed oil toxicology that is currently guiding responders in the Gulf of Mexico. However, research funding has declined by over 90% during the past decade, which has dramatically slowed our progress.

The good news is that our program and others are poised to address the current data gaps if sufficient research funding can again be made available. I would suggest support in the area of $25 million per year be dedicated to the areas listed above, and recommend that it be administered by agencies such as the National Science Foundation and the US Environmental Protection Agency, as they are well equipped to solicit targeted research proposals and organize the peer review necessary to identify projects of the highest quality.

I hope I have been helpful, and please do not hesitate to contact me if I can be of further assistance.

Best regards,

Ronald S. Tjeerdema, Ph.D.
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