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FIVE YEARS AFTER DEEPWATER HORIZON: IMPROVEMENTS AND CHALLENGES IN PREVENTION AND RESPONSE

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

APRIL 29, 2015

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

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FIVE YEARS AFTER DEEPWATER HORIZON: IMPROVEMENTS AND CHALLENGES IN PREVENTION AND RESPONSE

WEDNESDAY, APRIL 29, 2015

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 9:39 a.m. in room SR–253, Russell Senate Office Building, Hon. John Thune, Chairman of the Committee, presiding.

Present: Senators Thune [presiding], Wicker, Blunt, Rubio, Ayotte, Fischer, Sullivan, Gardner; Nelson, Klobuchar, Blumenthal, Markey, Booker, and Peters.

OPENING STATEMENT OF HON. JOHN THUNE, U.S. SENATOR FROM SOUTH DAKOTA

The CHAIRMAN. This hearing will come to order. If you all would come up, all the panelists, we will introduce you in just a minute. Thank you, and welcome, it is great to have you here.

Domestic energy production, whether it is in the form of crude oil in the Gulf of Mexico or North Dakota, hydropower in the Pacific Northwest or wind energy in South Dakota, is an important way of reducing America's dependence on foreign oil while creating jobs and decreasing energy costs.

This energy production, as vital as it is, must be accomplished in the safest way possible. A major failure in safety occurred on April 20, 2010 when 11 crewmen lost their lives in an explosion on the *Deepwater Horizon* drilling rig. The resulting oil spill was the largest ever recorded in U.S. waters with widespread environmental and economic damages across the Gulf.

In the past 5 years, we have attempted to learn from this tragedy and to find solutions that will improve the speed of clean up efforts, minimize the potential for future spills, and save lives.

In 2012, Congress passed the bipartisan RESTORE Act, which allocated funds to the Gulf states for restoration activities. In addition, Federal, state, industry, and academic scientists and engineers have been working together in unprecedented ways to find solutions to prevent and minimize oil spills in the future.

Today we are going to be hearing from some of these scientists. I look forward to learning about the progress they have made.

Senator Nelson will be here momentarily, I think. Until he arrives, we will get underway, and we will introduce our witnesses.

One of our panelists today is from the state of New Hampshire, and I will turn to our colleague from New Hampshire, Senator Ayotte, and allow her to introduce that witness.

STATEMENT OF HON. KELLY AYOTTE, U.S. SENATOR FROM NEW HAMPSHIRE

Senator AYOTTE. I want to thank the Chairman. I am really honored today to have with us Dr. Nancy Kinner. Dr. Kinner is a Professor of Civil and Environmental Engineering at the University of New Hampshire. She also is Co-Director of the Coastal Response Research Center and Director of the Center for Spills in the Environment at the University of New Hampshire.

I am very proud of the work that the Coastal Response Research Center and the Center for Spills is doing, not only on important scientific research on how to prevent spills, how to best address them. I just recently visited the Center. I think you will find the testimony today about the work being done at the University of New Hampshire as led by Dr. Kinner very important on how we work together to not only prevent future spills but also make sure we have the proper environmental response when we hope they do not occur, they do occur.

I am honored to have Dr. Kinner here, and so glad UNH is such an important part of this discussion.

The CHAIRMAN. Thank you, Senator Ayotte. Dr. Kinner, it is nice to have you here. We look forward to hearing about your research.

We also have with us Mr. Charlie Williams. He is the Executive Director for the Center for Offshore Safety. He will be discussing improvements in safety and prevention in the offshore oil and gas industry since the *Deepwater Horizon* oil spill.

Dr. Christopher Reddy is the Director of the Coastal Ocean Institute at the Woods Hole Oceanographic Institution. Dr. Reddy is one of the top cited and published scientists studying oil spill effects for mediation methods and petroleum microbiology.

Dr. Samantha Joye is a Professor of Marine Science at the University of Georgia. I look forward to learning about her multidisciplinary work in chemistry, microbiology, and geology.

It is a great panel. We are delighted to have you all here this morning. We will start on my left and your right with Mr. Williams. Please proceed with your opening remarks, and if you could confine them to as close to five minutes as possible, we will do our best to get our questions in. I think a number of members have to depart for an event that we have coming up a little later this morning.

Mr. Williams, please proceed.

STATEMENT OF CHARLES (CHARLIE) WILLIAMS II, EXECUTIVE DIRECTOR, CENTER FOR OFFSHORE SAFETY

Mr. WILLIAMS. Thank you, Mr. Chairman. Thanks to members of the Committee for this opportunity.

America's oil and natural gas industry is safer than ever before. Safety is a core value to the industry and an imperative. Our goal is and always will be zero spills and zero accidents.

What has changed? A renewed and sustained commitment to collaborating, learning, and delivering together through committing

the resources needed to do this. How this has come is with new industry standards, a new sub-sea containment system, increased clean up capability, and the Center for Offshore Safety.

The Center for Offshore Safety was created based on an industry study team recommendation but also on the Presidential Commission recommendation that there be a for the industry and by the industry organization totally focused on safety.

We are that organization and I am proud to lead the Center. We work every day, all day, on safety, using many teams of industry volunteers dedicated to our mission and the industry mission, which is one and the same.

We are also an important stakeholder in enabling all the work of the BSEE regulation that all the operators have a safety and environmental management system. An example of this is recommended Practice 75. The regulation and what we work on is not safety as most people know it. It is not about personal and personnel safety, such as hardhats and safety shoes, even though this is critically important. The industry has actually done a great job on personnel safety.

What we work on is safety and environmental management systems. What is SEMS and why is it so critical? SEMS is about having good procedures and standards, skills, a knowledgeable workforce, and good project design and execution processes including such things as hazard identification, planning, and very importantly, management of change.

SEMS is foundational to safety culture and must have a strong and clear leadership, and this strong and clear leadership develops SEMS into a sustained safety culture.

SEMS is a key barrier to major incidents, and in that way it is different from staff safety. How can this be? It is because SEMS is a sustainable and continuous learning process that manages safety with the same principles of planning and organization, implementation, and controls that you would expect from any other business function.

It fully embeds and integrates safety into the business. All planning and management of change are done in support of maintaining safety.

What else is different? SEMS is a performance-based system and not a rules-based system. People have to develop the system to best fit their business within the elements that are defined, and then it is measured through auditing that the performance of SEMS is effective and the performance is good.

The Center for Offshore Safety is making a difference in many ways. First, we are the place where the industry comes together and is totally focused on SEMS and how to make SEMS more effective. As a member, you commit yourself to high standards of safety.

An example of this is we committed to doing third-party audits before it was part of the regulation. We have also ensured good SEMS' audits through audit tools like audit procedures, auditor training, actually auditing in the accreditation of auditors. That is the primary way SEMS' audits and performance is assessed. This feedback is also used for learning and improvement purposes.

COS has established other measures that are continuous and forward looking and give us much more information about SEMS and how to improve its effectiveness as we go forward.

These tools include safety performance indicators and learning from incidents which help us learn about the safety and cultural elements of incidents and how those incidents will be prevented in the future, and it also has forward-looking measures like managing maintenance on your critical systems that helps you look and see that your safety and environmental management systems are effective going forward, and give you early indications.

A good example of what we do is we collect all this information and develop an annual report, and then develop a plan to have good standards and have good practices to help improve SEMS when we find places that need improvement.

A good example of what is our leadership site visit guideline, which helps leaders improve safety and safety culture by what they say when they are on the work site.

In closing, I want to leave you with two concepts that are key to SEMS. The first is barrier management. A key part of SEMS is identifying hazards and establishing barriers, maintaining those barriers, and ensuring those barriers stay in place to prevent major incidents, and using barriers to measure the effectiveness of the management systems.

The last one is skills and knowledge. We have to go beyond classroom training, and we have to have people that are knowledgeable, have experiences in all kinds of scenario's and are able to think about and respond to those.

Every incident is one too many and a powerful incentive for COS to redouble our efforts to learn and improve. Our thoughts will always be with those that lost their lives and their families. The industry is doing better, even the companies that had good SEMS are doing better through the Center for Offshore Safety in being able to share and work together.

Our strong culture of safety continues to grow along with advances in technology and standards. As long as there is room for improvement, COS' work is never complete. This is my livelihood and passion, and I will never stop improving safety management.

Thank you.

[The prepared statement of Mr. Williams follows:]

PREPARED STATEMENT OF CHARLES (CHARLIE) WILLIAMS II, EXECUTIVE DIRECTOR, CENTER FOR OFFSHORE SAFETY

America's offshore oil and natural gas industry is safer than before, but our goal will always be zero accidents and zero spills.

A significant enhancement in safety and environmental protection in the oil and natural gas industry post-Macondo was the creation and on-going work of the Center for Offshore Safety (COS). COS was created by the industry for the industry, and is devoted entirely to continually assessing, learning about, and improving the safety and environmental management systems (SEMS) implemented by operators in the OCS.

SEMS has the following benefits:

- Shifts execution and oversight strategy from a prescriptive rule-based approach to one that is proactive and performance-based
- Manages safety with the same principles of planning, organization, implementation, and controls that we expect from other business functions

- Drives both Process and Personal accountability up and down the organizational structure

SEMS requires mechanisms that:

1—Specify what is needed for safe operation

2—Check to see that these specifications are being followed

3—Build competency by developing individual knowledge and skill

COS is entirely focused on Safety and Environmental Management Systems (SEMS) and how their effectiveness can be continually evaluated and enhanced.

SEMS is intended as an active-learning safety and environmental management system that establishes and manages barriers, takes a systematic approach to all parts of offshore safety, has active monitoring via safety performance and other indicators, uses independent verification via third-party auditors, and focuses continually on operationalizing and enhancing safety and environmental management. Most significantly, SEMS focuses on the importance of leadership and the interaction of management with staff to deliver a positive safety culture.

The COS mission is promoting the highest level of safety for offshore operations through effective leadership, communication, teamwork, use of disciplined management systems and independent third-party auditing and certification. Sharing data and lessons learned throughout the industry is an essential part of the work COS does to continually enhance safety.

Through the COS, industry members are committed to improving SEMS performance by subscribing to the following principles:

- Industry leaders demonstrate a visible commitment to safety
- Operators, contractors, and suppliers work together to create a culture of safety
- Decision making at all levels will not compromise safety. Safety processes, equipment, training and technology undergo continual examination and improvement
- Members share learnings and apply industry standards, good practices and promote continual improvement

COS broadly represents the oil and natural gas business on the U.S. Outer Continental Shelf with members from all aspects of the upstream offshore oil and natural gas industry including operators, drilling contractors, equipment manufacturers and service contractors. The COS has a full-time staff that works in conjunction with industry task groups to address specific SEMS issues. In addition, COS has a governing board made up of senior management of the industry member companies.

The COS is responsible for:

- Assuring that third-party Audit Service Providers and their auditors meet the goals, objectives and requirements for conducting SEMS audits
- Compiling and analyzing SEMS data and other safety metrics to find areas for enhancement
- Creating Good Practices to close gaps found through the safety data analysis
- Coordinating COS-sponsored functions designed to facilitate sharing and learning processes regarding SEMS and good practices
- Identifying and promoting opportunities for industry to continually improve SEMS and safety
- Developing outreach programs to facilitate communicating with government and external stakeholders regarding SEMS

COS has developed processes and documents in the following areas:

- COS SEMS Toolkit—SEMS Audit Protocols, Operator-Contractor interface documents, staff Knowledge & Skills worksheets, and other products for SEMS.
- SEMS Audit Service Provider (ASP) Documents, protocols, and guides
- COS Auditor Qualification and Training, SEMS Certification for Operators and Contractors, and ASP Accreditation Documents—Suite of documents that outline the qualification and training requirements for third-party auditors performing COS SEMS audits, COS SEMS certification requirements, accreditation requirements for ASP performing third-party audits and COS Standard Audit Report worksheets and template.
- Skills and Knowledge Management System Guideline (SKMS)—Tools and techniques to provide industry with a common process for the verification and development of employee and contractor skills and knowledge

- Leadership Site Engagement—Good practice guidance for senior managers and leaders to demonstrate visible safety and environmental commitment during visits to offshore operating sites, as well as enhancing accountability and safety culture

COS is actively working in the following areas:

- Audit Service Provider Accreditation—Develop an enhanced set of COS-endorsed standards for accrediting Audit Service Providers and their auditors to support the COS SEMS certification program
- SEMS Certification Program-Operator Certification—Certification of operator SEMS programs via accredited third-party audit.
- SEMS Certification Program-Contractor Certification—third-party SEMS Certification of drilling contractors and offshore service/supply companies in order to provide assurance to operators and regulators that a system is in place which meets applicable requirements and demonstrates contractor workers have skills and knowledge to follow safe work practices.
- Safety Performance Indicators (SPI) Program—Clearly defined indicators to evaluate safety performance and aid in identifying safety trends. This includes new leading indicators of SEMS effectiveness.
- Learning from Incidents (LFI) Program—A process and methodology to identify, assess and communicate high value learning incidents to promote cross-industry learning. This includes identifying SEMS elements that were ineffective and contributed to the incident and how the possibility of the incident will be minimized in the future.
- Information and Knowledge Management—An information and knowledge management framework to gather, manage and share information to enable the industry to continually improve SEMS performance.
- COS Safety Events—Plan, develop and coordinate annual COS Safety Forum, Offshore Technology Conference Technical Sessions, SEMS Audit Workshops, and other events to facilitate sharing knowledge and promoting opportunities to continually improve SEMS and safety.

COS has recently published its first Annual Performance Report detailing the initial round of data and lessons learned from the Safety Performance Indicator Program, Learning from Incidents Program and SEMS audits described above. This report is available via the COS website.

The oil and natural gas industry is committed to operating in a safe and responsible manner while minimizing our impact on the environment. Protecting the health and safety of our workers, our contractors and our neighbors is a moral imperative and core value of our industry.

No incident is acceptable. Our industry takes every incident seriously. Continued vigilance is essential in helping to prevent future incidents.

In the five years since the Macondo incident, the oil and natural gas industry has methodically examined every aspect of offshore safety measures and operations to identify potential improvements in safety management. COS was established by the industry to ensure that this continues and is effective, that there is a single group exclusively focused on SEMS, and that there is a group responsive to supporting a culture of safety.

We worked with the U.S. Department of Interior, the Presidential Oil Spill Commission, other Government Organizations, and industry experts as we developed the mission, programs, and tools of COS. But COS did not start from scratch. Offshore exploration and production has long been focused on safety and delivering remarkably safe and successful technology and operations. The industry is committed to ensuring that SEMS is continually enhanced and that the COS organization is in place to focus on this and share industry knowledge of SEMS and safety.

Despite industry's history of safety dedication and performance, it was understood that the balance between personnel safety and prevention of major incidents had to be enhanced and the focus on continual SEMS learning, as well as operationalizing those learnings, must be maintained. The oil and natural gas industry has dedicated the past five years to using the lessons learned from Macondo to enhance safety and operational practices.

Our strong culture of safety continues to grow along with advances in technology and industry standards. So long as there is any room for improvement, our work at COS will never be complete. This is our livelihood, and our work is critical to America's new energy renaissance.

Every incident is both one too many and a powerful incentive for COS and industry to improve SEMS, the learning process, skills and knowledge, operating proce-

dures and standards, and effectiveness measures and audits. Our thoughts will always remain with the families of all those who lost their lives in this tragic accident. And the industry, and the industry through COS, stands ready to continue to work with government and regulators to improve safety.

The CHAIRMAN. Thank you, Mr. Williams. Dr. Kinner?

STATEMENT OF NANCY E. KINNER, PH.D., CO-DIRECTOR, COASTAL RESPONSE RESEARCH CENTER; DIRECTOR, CENTER FOR SPILLS IN THE ENVIRONMENT; PROFESSOR, CIVIL AND ENVIRONMENTAL ENGINEERING, UNIVERSITY OF NEW HAMPSHIRE

Dr. KINNER. Chairman Thune, Ranking Member Nelson, and distinguished members of the Committee, thank you for giving me the opportunity to appear before you today.

I am a professor of civil and environmental engineering at the University of New Hampshire, and as Senator Ayotte mentioned, I am also the UNH Co-Director of the Coastal Response Research Center, a NOAA-funded partnership, and Director of the Center for Spills in the Environment, a center that expands the scope of interaction to other governmental agencies, the private sector, and NGOs.

The mission of the centers is to conduct and oversee response on spill response, assessment, and restoration, and make sure that research is transformed into practice. In addition, we serve as a hub for spill research and facilitate collaboration among all stakeholders in the response community, including those affiliated with industry, government, academia, and NGOs.

The centers were created in 2004 because many research and development needs existed with respect to spills. It may seem unusual that a spill response center is located in New Hampshire, but that makes sense when the goal is to have an independent and highly credible voice that can speak freely during a crisis and mediate difficult discussions among diverse stakeholders.

For example, we were asked to facilitate a discussion during the *Deepwater Horizon* spill among 50 renown scientists to evaluate whether dispersants should continue to be used.

After examining the available data and the science regarding the potential impact of dispersant use on the environment, the conclusion of those scientists was that use of dispersants and the effects of dispersing the oil were generally less harmful than allowing the oil to migrate into sensitive wetlands and near shore habitats, and therefore, dispersant use should continue at that time.

When oil is spilled, there is no single silver bullet response technology that provides an universal solution. As I like to tell my students, oil spills are bad and they cause very bad things to happen. The goal of response is to minimize as much as possible the damage. Hence, the challenge is to translate the results of the oil spill research into better response.

In the wake of the *Deepwater Horizon,* there has been a large influx of money into research, and there are many oil spill related papers being published each month as a direct result of this funding.

The question is how much of this research will result in improvements in oil spill response. Unfortunately, the answer might be not very much. Why not?

First, the research that needs to be done to improve response is often not conducted because researchers rarely interact with responders. They do not go to the same parties. Second, it is difficult for scientists to simulate the real environment.

For example, to answer questions as to whether chemical dispersants should be added to a blowout, scientists need to simulate the mixing that occurs at a deep wellhead where many, many gallons of oil and gas are billowing out rapidly at very high pressure. That is to say the least a very challenging environment to simulate in the laboratory, small test tank, or with mathematical modeling.

Third, scientific journals rarely publish papers where experiments do not show any measurable changes. Yet, research that shows no effects can be very useful.

For example, if we added oil to very cold seawater that contained naturally occurring microorganisms and that oil concentration did not change over time, the results would probably be difficult to publish. Yet, responders fighting a spill in the Arctic Ocean would want to know that the oil might not be degraded as rapidly as in warmer water.

How can we address these challenges? We can bring responders and scientists together in a partnership to develop research needs and design and conduct experiments to address those needs.

Even if we started that process today, the results of the research would not be available for several years. In the interim, we can sort through the large amount of research published to determine if and how it can improve response.

Here is one example of how our centers in partnership with NOAA and EPA are doing this. We have convened 70 scientists, two of whom are sitting to my left, to review the literature and determine what is known and what is uncertain about the state of the science of dispersants and dispersed oil in spill response, especially as it applies to the Arctic.

My job is to facilitate those discussions, which as you might imagine can be quite interesting. What never ceases to amaze me is how a diverse group of researchers and response scientists can come to consensus when the focus is on the details of the science. I see this approach as a path forward on many thorny issues.

In summary, there are many questions that must be addressed to improve response when oil is spilled, especially as we consider drilling in outer continental shelf regions and face the energy renaissance in the U.S. We must take advantage of the current and future investments in research, translating them into better response.

I believe we can accomplish this by bringing responders and scientists together in a partnership to determine what is known and what is uncertain with respect to response science.

Once identified, those uncertainties can be used to define research needs and design experiences whose results can be translated into improved response decisionmaking, and that does mean a better job of minimizing the damage spills cause.

Thank you very much.

[The prepared statement of Dr. Kinner follows:]

PREPARED STATEMENT OF NANCY E. KINNER, PH.D., CO-DIRECTOR, COASTAL RESPONSE RESEARCH CENTER; DIRECTOR, CENTER FOR SPILLS IN THE ENVIRONMENT; PROFESSOR, CIVIL AND ENVIRONMENTAL ENGINEERING, UNIVERSITY OF NEW HAMPSHIRE

Chairman Thune, Ranking Member Nelson and distinguished members of the Committee, thank you for giving me the opportunity to appear before you today. My name is Nancy E. Kinner and I am a professor of Civil and Environmental Engineering at the University of New Hampshire. I am the UNH Co-Director of the Coastal Response Research Center (CRRC), a NOAA-funded center, and the Director of the Center for Spills in the Environment (CSE), a center that expands the scope of interaction to other governmental agencies, the private sector and NGOs.

1.0 The Coastal Response Research Center and The Center for Spills in the Environment

The mission of the two UNH Centers, CRRC and CSE, is to conduct and oversee research on spill response, assessment and restoration and make sure that research is transformed into practice. In addition, we serve as a hub for spill research and development (R&D), and facilitate collaboration among all stakeholders in the spill community including governmental agencies, NGOs, academia, and industry, both in the U.S. and globally. Since the Centers' inceptions in 2004, we have overseen 34 funded research projects, conducted 48 workshops, and currently manage five working groups on topics such as dispersants and dispersed oil, data management during environmental disasters, modeling and submerged oil response.

The Centers were started because NOAA and UNH, which is known for its strong programs in marine science and ocean and environmental engineering, knew that many R&D needs existed with respect to oil spill preparedness, response and restoration. Further, we realized that oil and chemical spills are always occurring and, that despite popular belief, there would continue to be major oil spills in the U.S. It may seem unusual that an oil spill center would be located in New Hampshire, a state that lacks any petroleum-based resources, but that fact makes sense when the goal is to have an independent and highly credible voice that can speak freely during a crisis and mediate difficult discussions among the diversity of stakeholders. The Centers have focused on R&D in a few key areas: dispersants and dispersed oil, toxic and sublethal effects of oil on organisms, Arctic spill response and restoration, human dimensions of spills, and environmental data management. As one example, the CRRC was asked to convene a meeting in May 2010, during the DWH, of a diverse group of renowned scientists to evaluate whether dispersants should continue to be used. Fifty scientists, some of whom were diametrically opposed to dispersant use, met for two days to examine the data and state-of-the-science, regarding the potential impact of dispersant use on the environment. The overwhelming consensus of the group was that, while removing the oil from the environment using mechanical recovery is preferred, it was not always effective because of environmental conditions such as the wind and waves in the Gulf. Further, the scientists concluded that up to that point, use of dispersants and effects of dispersing oil into the water column had been generally less environmentally harmful than allowing that oil to migrate on the surface into the sensitive wetlands and nearshore coastal habitats.

In 2014, CRRC conducted a unique *Forum on the campus of the University of New Hampshire* on the 25th anniversary of the Exxon Valdez Oil Spill (EVOS) in Alaska and the 5th anniversary of the DWH. This forum brought together academicians, oil spill practitioners, industry representatives and Federal and state agency personnel to discuss the lessons learned from EVOS and DWH that could help improve future oil spill response (*e.g.,* the Arctic, pipelines and rail transport). Several initiatives came from the Forum which has set some new directions for CRRC/CSE.

- Expand the role of academic science in improving spill and environmental disaster response, assessment and restoration;
- Identify strategies and actions to improve governmental communication with the public and ensure journalists the information they need prior and during spills;
- Improve outreach to Congress on spill and environmental disaster science and response.

CRRC/CSE has begun to move forward with some of these new initiatives. CSE provided an initial briefing on oil spill response since the DWH for Senate staffers on April 21, 2015, sponsored by New Hampshire Senators Shaheen and Ayotte. In addition, in conjunction with Capitol Hill Ocean's Week 2015, we will host a forum with responders and journalists to discuss how to improve communication and provide information more effectively to the public.

2.0 Research Response Since DWH

Since the DWH, there has been a large influx of funds into oil spill R&D: most notably BP's $500 million over 10 years to the Gulf of Mexico Research Initiative (GoMRI), and the $500 million over 30 years given to the National Academy of Sciences for Gulf of Mexico and other Outer Continental Shelf R&D. Industry through the American Petroleum Institute (API), and other international petroleum associations (*e.g.,* IOGP/IPIECA), has also funded a significant amount of new research. There are also some Federal (*e.g.,* BSEE) and state (*e.g.,* Texas, California) R&D programs, though these tend to be funded at lower levels. This influx of funding for research has focused on a number of issues important to future oil spill response including:

- Short and Long Term Spill Impacts in the Gulf of Mexico as a Result of DWH;
- Studies of the Chemical and Physical Behavior of Oil Released in the Environment;
- Efficacy and Effectiveness of Various Response Actions;
- Public Health Impacts; and
- Social and Economic Impacts of Spills.

Gulf of Mexico Research Initiative

The Gulf of Mexico Research Initiative (GoMRI), one of the major new oil spill research institutions, was formed to investigate the impacts of the oil, dispersed oil, and dispersant on the ecosystems of the Gulf of Mexico and affected coastal states in a broad context of improving fundamental understanding of the dynamics of such events and their environmental stresses and public health implications. Another focus of GoMRI is developing improved spill mitigation, oil and gas detection, characterization and remediation technologies.

The ultimate goal of GoMRI will be to improve society's ability to understand, respond to and mitigate the impacts of petroleum pollution and related stressors of the marine and coastal ecosystems, with an emphasis on conditions found in the Gulf of Mexico. Knowledge accrued will be applied to restoration and to improving the long-term environmental health of the Gulf of Mexico. GoMRI has issued numerous RFPs for consortia and individual investigators.

National Academy of Sciences

As part of legal settlements associated with the DWH, the National Academy of Sciences (NAS) established a Gulf Research Program to fund and conduct activities to enhance oil system safety, human health, and environmental resources in the Gulf of Mexico and other U.S. outer continental shelf regions that support oil and gas production. The Program will work to enhance oil system safety and the protection of human health and the environment in the Gulf of Mexico and other U.S. outer continental shelf areas by seeking to improve understanding of the region's interconnecting human, environmental, and energy systems and fostering application of these insights to benefit Gulf communities, ecosystems, and the nation, safety, human health, and environmental resources. Given this context, the Program will address three interconnected goals:

- *Goal 1:* Foster innovative improvements to safety technologies, safety culture, and environmental protection systems associated with offshore oil and gas development;
- *Goal 2:* Improve understanding of the connections between human health and the environment to support the development of healthy and resilient Gulf communities; and
- *Goal 3:* Advance understanding of the Gulf of Mexico region as a dynamic system with complex, interconnecting human and environmental systems, functions, and processes to inform the protection and restoration of ecosystem services.

The Program will fund studies, projects, and other activities using three broad approaches specified in the legal settlements: research and development, education and training, and environmental monitoring.

ICCOPR

The *Interagency Coordinating Committee on Oil Spill Research (ICCOPR)* was created by Congress in the Oil Pollution Act of 1990 (OPA 90). ICCOPR is charged with two general responsibilities to: (1) prepare a comprehensive, coordinated Federal oil pollution research and development plan; and (2) promote cooperation with industry, universities, research institutions, state governments, and other nations through information sharing, coordinated planning, and joint funding of projects. ICCOPR reports on its activities to Congress every two years. It is comprised of 15 Federal independent agencies, departments, and department components. The USCG chairs ICCOPR with NOAA, BSEE, and EPA rotating assignments as the vice-chair every two years.

ICCOPR is currently preparing, with the assistance of CRRC/CSE, an Oil Spill Research and Technology Plan (OSRTP) that will set the priorities for oil spill research for the next six years. The OSRTP will be completed in 2015.

Industry

In the wake of the DWH spill, the petroleum industry, API and IOGP/IPIECA, launched four Joint Industry Task Forces (JITFs) to critically assess capabilities and performance. Each JITF brought forth subject matter experts to identify best practices in offshore drilling operations and oil spill response and to share that knowledge across industry. The goal is to ensure environmental protection through enhanced safety.

The Oil Spill Preparedness and Response JITF is examining industry's ability to respond to a "Spill of National Significance (SONS)" or other large spills.

The program is developing guidance and planning documents, recommended practices, training and exercise guidelines, technology evaluations, and developing a database for research activities. As part of the overall research program, industry is developing communications/outreach and decision making tools. Topics include:

- Spill response planning;
- Oil sensing and tracking;
- Dispersants;
- In situ burning;
- Mechanical recovery
- Shoreline protection and
- Alternate response technologies.

3.0 Impediments to Transforming Research into Improved Response

The combined effort of all these programs has resulted in a significant body of information. It is difficult to remain current on all the papers being published related to oil spills. Each month, several new papers appear in journals and there are two to three major conferences each year solely dedicated to oil spill research. The question is, how much of this research will result in improvements to oil spill response? Unfortunately, the answer might be, not very much. There are several reasons for this.

A primary reason is that researchers and responders do not have much opportunity to interact and coordinate research. They usually do not attend the same meetings. Most researchers are not familiar with what occurs during a response: the pace at which decisions must be made and the types of trade-offs considered during a spill. Conversely, responders are often not familiar with the latest experimental techniques which scientists have at their disposal to assist in response decision-making.

Another significant problem is that it is very difficult to simulate the environment in a laboratory or small test tank or with mathematical modeling. For example, even though a solution of 200 ppm of dispersants can be created in water to test its toxicity on organisms, the findings may not be translated into what would happen in the field where concentrations of dispersants are likely to be at least 10 times lower. In addition, it is incredibly difficult to simulate the mixing that occurs at a deep well blowout where many gallons of oil and gas are billowing out of a pipe rapidly at very high pressure. Yet this is exactly what must be done to determine whether dispersants prevented oil from reaching the surface of the GOM during the DWH.

Finally scientific journals almost always publish papers that show effects: where the research shows that the experimental conditions resulted in a measurable change in some parameter. If no change is observed, a so-called "null" result, the paper will rarely be published even if that null result occurs many times. For example, if an experiment was conducted where oil was added to very cold seawater that

contained naturally occurring microbes and the oil concentration did not change over time, the results would probably not be published. However, responders fighting an oil spill in the Arctic would want to know this information. You can see the implicit bias that might result when examining the scientific literature for possible response options that might improve spill response.

4.0 A Path Forward

So how can we effectively sort through the research that has been published since the DWH and the older, relevant research? First, we can bring responders and scientists together to develop research needs and design and conduct experiments to address those needs. One way we have done this at the Centers is to have responders and response scientists act as liaisons during the development of request for proposals (RFPs), selection of projects, design of experiments, and translation of results into practice. This approach was used very effectively in developing the Environmental Response Management Application (ERMA®) which was used as the Common Operating Picture (COP) during the DWH and provided the public easy access to information about the spill.

However, even if we start bringing responders and scientists together in this manner today, the results of the research would not be available for years. In the interim, we need to sort through the large amount of research published to determine if, and how, it can improve response. One example of how this might be done is a partnership between our Centers, NOAA and EPA. We have convened more than 70 scientists, representing a diversity of perspectives and expertise in the research and response communities, to read all of the applicable literature and determine the state-of-the-science of dispersants and dispersed oil in spill response especially as it applies to the Arctic. The scientists are asked to determine: (1) what is known; and (2) what is uncertain. Over 500 peer-reviewed papers and reports have been amassed in a database covering the period June 2008 to the present and this is been combined with an existing database of dispersant research from 1962 to 2008. The scientists have read the articles within their area of expertise and have been discussing whether each paper simulates the environment, has the necessary controls, and is statistically sound. What we have observed through our facilitated discussions is that a group of scientists can come to consensus when they focus on the details of the science. The results of the state-of-the-science discussions on dispersants and dispersed oil should be available later this year. I see this process as a way forward on many of the thorny issues of applying oil spill R&D to practice.

5.0 Summary

When oil is spilled, there is no single "silver bullet" response technology that provides a universal solution. Oil spills are bad, and cause very bad things to happen. The goal of response is to minimize, as much as possible, the damage. Hence, the challenge is to translate the results of oil spill research and development into better response.

In summary, there are many questions that must be addressed to improve response when oil is spilled, especially as we consider drilling in other outer-continental shelf regions and in the face of the energy renaissance in the U.S. We must take advantage of current and future investments in research, translating them into better response. I believe we can accomplish this by bringing responders and scientists together to determine what is known and what is uncertain with respect to response science. Those uncertainties can be used to identify research needs and design experiments whose results can be translated into improved response decision-making before, during and after spills.

The CHAIRMAN. Thank you, Dr. Kinner. Dr. Reddy?

STATEMENT OF CHRISTOPHER M. REDDY, Ph.D., SENIOR SCIENTIST, DEPARTMENT OF MARINE CHEMISTRY AND GEOCHEMISTRY, WOODS HOLE OCEANOGRAPHIC INSTITUTION (WHOI)

Dr. REDDY. Chairman Thune and Ranking Member Nelson, members of the Committee, thank you for the invitation to participate in this hearing, and I have three points to make.

For the record, I am a senior scientist in the Department of Marine Chemistry and Geochemistry at Woods Hole Oceanographic Institution. I have extensive experience studying oil spills, which

are detailed in my written testimony, including the *Deepwater Horizon,* as well as the *Exxon Valdez,* and in the last year, I have responded to three oil spills, one in Bangladesh, Galveston Bay, Texas, and Yellowstone River.

In September 2010, I was asked to join the Unified Command, essentially the oil spill headquarters to the *Deepwater Horizon* in New Orleans, to serve as a liaison between Federal officials, industry, and the academic community.

At that time, there was a disconnect and some unsettling tensions. I can tell you very happily that things have changed for the better, that the unprecedented *Deepwater Horizon* disaster created an unprecedented intersection of stakeholders, and the silver lining to the *Deepwater Horizon* disaster is it compelled previously disparate cultures, scientists and responders, much like Dr. Kinner just mentioned, to introduce themselves and join forces.

I would be remiss without giving great credit to my Senator from Massachusetts, Senator Markey, who ran as United States Congressman in 2010, demanded the increased transparency and availability of information from the responders so academia could contribute.

I believe this has led to the silver lining that I just discussed, and I also just wrote about this in the *Huffington Post* last week.

My second point is I got asked a lot of questions about the *Deepwater Horizon* in the last month or so, coming up to the fifth anniversary. The one that is asked often is how bad is the Gulf today.

There were many studies that have been done, documenting damages, simulating them in the lab, and you likely heard about many of these results, but I would advise you to read the fine print. I would advise you to think about where these studies were, what time they were done after the spill, where they were in the broader context, and even follow up and say how certain are you with these results.

Let me give you an example from some work I have done. I published a paper in November 2014 examining the evidence of contamination on the sea floor near a damaged well. It was a massive effort. Our upper end estimate was that 16 percent of the total oil discharged during the accident fell within a 1,250 square mile patch on the deep floor.

What was not often mentioned was our lower end estimate, that we might only think there is 2 percent on the bottom of the sea floor. That is a pretty big range, and that is the fine print, and that is the uncertainty that we have to ask and push for.

Moreover, that research that got a lot of press was based on studies that ended in 2012. Today, I cannot say how much oil is still on the Gulf of Mexico floor. I cannot say how toxic it is, and I cannot say whether or not it is negatively affecting the Gulf.

How is the Gulf today? It is far from the graveyard predicted by some experts in the throes of the spill, but it is not a picture of health. What we hear most about are damages that are compartmentalized and localized, and the story is not complete, as studies are still underway.

It is probably frustrating to you that you are not going to get all the answers you want, and the rub is we cannot put the Gulf of Mexico in an MRI. It would have been great if we had some

physicals on the Gulf of Mexico and MRI scans in 2008, 2009, 2010, and as of yesterday. It would be a much easier presentation today to show those MRI scans of the Gulf. We do not have that.

My advice right now is to let science take its course and allow for all the pieces to be placed together, and then we can provide a full accounting.

My last point is the one I am most passionate about, about dispersants. I think the media coverage of dispersants has been lopsided, and we regularly hear that dispersants amplified damage in the *Deepwater Horizon* and are continuing to harm marine life.

These are the negatives, and there is certainly no doubt there are negatives with the use of dispersants, but they are benefits, which is precisely why dispersants were authorized and part of that discussion that Dr. Kinner mentioned.

When sprayed on an oil slick, the resulting micro size droplets freely mix into water effectively breaking apart the coating and diluting oil over a greater volume. Both effects can be beneficial.

Dilution and also a chance that we are going to reduce oiling on the coast line. What is also lost, and unfortunately, is not available, is anecdotal evidence that the air quality of responders near the well was better when the dispersants were used subsurface. That means if we did not use dispersants, there is a chance that it might have taken more than 87 days to shut it down.

What we hear about in the media are only the negatives. What is not discussed are the benefits. I think the question that really needs to be asked is what if we did not use dispersants? By weighing this question, we can weigh the negatives against the benefits to know if dispersant use caused more harm than good.

If I can leave you with just one take away this morning, it is the pressing need to perform an objective, thorough, and comprehensive post-*Deepwater Horizon* analysis on the net usage, was it good or was it bad.

This is a non-trivial exercise. It will take a lot of time, but it is worthy of the attention. It touches upon several of the recommendations of the President's Commission, it will settle many of the concerns about the *Deepwater Horizon,* and it will be critical to how spills are tackled in the future.

To me, the absence of a study that looks at the overall net benefit analysis, which is a huge study, is the elephant in the room. It is so big that we cannot ignore it, and I would recommend Congress endorse such a study by the National Academy of Science.

Thank you for your attention.

[The prepared statement of Dr. Reddy follows:]

PREPARED STATEMENT OF CHRISTOPHER M. REDDY, PH.D., SENIOR SCIENTIST, DEPARTMENT OF MARINE CHEMISTRY AND GEOCHEMISTRY, WOODS HOLE OCEANOGRAPHIC INSTITUTION (WHOI)

Chairman Thune and Ranking Member Nelson and Members of the Committee:

Thank you for the invitation to participate in the hearing, "Five Years After the Deepwater Horizon: Improvements and Challenges in Prevention and Response." It's an honor to provide my observations and recommendations on future oil spill response, in particularly from "lessons learned" in the aftermath of the *Deepwater Horizon* (DWH) disaster. This statement reflects my personal professional views and does not represent those of my institution, the Woods Hole Oceanographic Institution.

For the record, I am a Senior Scientist in the Department of Marine Chemistry and Geochemistry at the Woods Hole Oceanographic Institution (WHOI) in Woods Hole, Mass., principally investigating marine pollution. I have published more than140 peer-reviewed scientific journal articles and several book chapters on the chemistry of oil, 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, two in 2007, and also the 1989 *Exxon Valdez* spill. More recently, I have been involved the Galveston Bay, Texas, spill in March 2014, the Bangladesh spill in December 2014, and the Yellowstone River oil spill in January 2015.

For the past five years, I have focused considerable efforts on the *Deepwater Horizon* oil spill. I have visited the Gulf of Mexico more than twenty times, participated or led four open-water trips near the Macondo well and three overflights of the region, collected hundreds of oiled beach samples, published 16 peer-reviewed papers on DWH, consulted with government and response officials, provided countless interviews to the media and written several opinion pieces on the topic, including ones on the role of academic scientists in disaster response. In September 2010, I was a scientist working at the Unified Command in New Orleans, the official operating center responding to the DWH oil spill.

In my experience, the disaster's impact was enormously exacerbated because the Macondo well pipe ruptured 5000 feet deep—a depth never encountered before. There was little or no experience in getting a such a rupture under control or tracking its consequences at those depths. This was aqua incognita to most industry and oil response officials.

But it was a familiar neighborhood for scientists at my institution, who had long conducted basic research in the deep sea and mustered their deep-submergence technology and expertise to help. In the heat of the disaster, I worked with WHOI scientists and engineers who had developed an instrument, an Isobaric Gas-tight Sampler (IGT) to sample and preserve fluids spewing from seafloor hydrothermal vents. We used an IGT to get a definitive sample of oil spewing right from the Macondo well. On the same mission, I worked with Sentry, a deep-diving autonomous underwater vehicle—used to find plumes from hydrothermal vents—to map a trail of hydrocarbons from the well flowing at depth through the Gulf of Mexico, something that had theorized but never seen before.

In this story lies two lessons learned from *Deepwater Horizon:* This nation's community of academic scientists represents an insufficiently tapped reservoir of expertise and assets that can be of great service—both *during* and *before* a disaster.

(1) We should seize the opportunity to build on the DWH experience to improve the integration of academic scientific expertise in disaster planning and response.

(2) Basic research paid off—in this case, in unanticipated ways. We should invest in baseline research to understand all facets of environments we want to drill in—before we drill, rather than after an oil spill. This increased knowledge will give us the capacity to recognize opportunities to prevent future damages and to know quickly, under crisis conditions, where and how to allocate assets to limit damage.

Integration of the academic science community

I flashback to the spring and summer of 2010 while oil was flowing unstoppably from the seafloor 5,000 feet deep in the Gulf. U.S. officials and industry had an impressive track record responding to the hundreds of oil spills that occurred every year. But those spills, unlike *Deepwater Horizon,* were in shallow waters. Government officials had little need to keep abreast of such things as oceanographic robots equipped to operate at great depths or biological communities living on the deep seafloor. They were generally unaware of singular and valuable assets and technology that academia had available.

Academic scientists, on the other hand, had little incentive and few avenues to add their expertise. These were two cultures that infrequently met and were unaware of one another's perspectives.

In September 2010, I was asked to join the Unified Command to serve as a liaison between Federal officials and the academic community. I saw that some Federal officials were bitter toward my colleagues and me, and much of it was justified. They thought we did not appreciate their efforts and successes and that we were naïve about their shorter-term responsibilities to control the disaster. They remarked that academics did not understand that occasionally our highhanded comments to the press forced the officials to respond and took precious time away from them performing their urgent mission.

The unprecedented *Deepwater Horizon* disaster created an unprecedented intersection of stakeholders. A silver lining to the DWH disaster is that it compelled previously disparate cultures to introduce themselves and join forces.

One piece of evidence for this came just a few weeks ago in a single e-mail. It was sent by one of the lead Federal officials responsible for responding to oil spills after an inquiry from one of my academic colleagues. It was sent the day after the April 1 explosion of a Mexican oil-processing rig in the Gulf of Mexico that killed four people and created a slick, informing the recipients what happened, what was known, and the chances of oil reaching U.S. waters.

It was the recipient list that made it a milestone event. The e-mail was sent not only to .govs and .mils, but .edus. So not just to employees in government agencies, but also to several scientists from academic institutions who have been conducting research in the Gulf of Mexico. I would wager that the Federal official who sent the recent e-mail and her predecessors had written similar e-mails, faxes, and teletypes about past oil spills, small or large, without including academic researchers. Now the government official is sending the same information she gives to her own people to a host of academic scientists—not a watered-down version, or even worse, a carefully worded message to "stay away."

Before *Deepwater Horizon,* there were few meetings for much interaction among the federal, academic, and industry stakeholders and media to cover the results. The annual meeting of the new Gulf of Mexico Research Initiative (GoMRI), funded after DWH, has now provided a forum for them to meet, exchange ideas, share data, and begin collaborations.

I have participating in another project that is forging key relationships between agency responders and academic experts: the "Science Partnerships Enabling Rapid Response" (SPERR) project, coordinated by the Center for Ocean Solutions and ChangeLabs at Stanford University. Academic scientists and government decision-makers from agencies such as NOAA, EPA, Coast Guard and USGS involved in this project have a common goal: to understand the obstacles to effective scientist-responder collaborations that emerged during *Deepwater Horizon* and codesign a solution to bridge the cultural divide and build trust across those communities.

Over the last year, the SPERR project has explored the tensions that arose around motivations and incentives within academic research institutions and government response agencies, and their inability to collaborate before and during large oil spills. The project team and partners have since crafted a solution that we believe will powerfully address these tensions and catalyze the agency and academic partnerships and resource sharing pathways that are imperative for improving oil spill response in the future.

The proposed solution, called the Science Action Network, will be a network of academic and professional scientists that are linked to regional government planning and response bodies—such as Regional Response Teams—to coordinate and streamline scientific input for decisionmaking. In the proposed Network, Regional Academic Liaisons in each of the ten response regions would ensure academic expertise is leveraged from universities, and government bodies such as NOAA and the Coast Guard have streamlined access to relevant science before and during disasters.

As we glean lessons learned from *Deepwater Horizon,* there is strong consensus among agencies and academia alike: improved integration of science and scientific expertise into disaster planning and response is essential. In order for a scaled, national solution like the Science Action Network to be implemented, funding is needed for formalized coordinator positions, such as the Regional Academic Liaisons, and Network operation. We must institutionalize the communication and collaboration demonstrated by the e-mail I cited, so that the next time a spill occurs, we can effectively leverage our unparalleled scientific expertise to improve decisionmaking and, ultimately, minimize spill impacts on human and ecological communities. The challenge of integrating scientific expertise into decision-making is not unique to oil spills and the investment in formalized solutions like the Science Action Network will pay off in the short term across all types of large disasters.

I've already seen beneficial changes:

- When I was researching some mysterious oil sheens near the DWH site in 2012, BP provided me with satellite overflight data and other information. With BP's help, we were able to grab invaluable samples that eventually showed that the oil was not from a leak at the repaired Macondo well, but a trickle of oil that leaking from the wreckage of the toppled rig.
- In March 2014, the *Kirby* barge released 168,000 gallons of fuel oil in Galveston Bay, Texas. I immediately dispatched a team from my lab to collect samples. After several exchanges with NOAA officials, my team was granted badges and

easy access to study this location. This contrasts starkly with an experience I had in 2007 when I was trying to collect samples in San Francisco Bay following the *Cosco Busan* oil spill. Gaining access to field samples was challenging, and often I was not permitted access to oiled locations, limiting my capacity to provide valuable insights into that spill.

- In December 2014, I heard that there was a devastating release of a very heavy, viscous oil along the coast of Bangladesh. With a keen interest in the behavior of these types of oils, I offered my services and willingness to help NOAA personnel who was sent to assist. I was sent a sample of the oil and was able to prepare a report on the behavior of the spilled oil, which was forwarded to the Bangladeshis.
- In January 2015, there was a pipeline break in the Yellowstone River in Montana that released Bakken crude oil. The use and transport of Bakken crude oils continues to increase, but little is know about how they biodegrade, so I e-mailed NOAA personnel on how I could access samples. Thru a NOAA intermediate, I was introduced to the lead EPA on-scene coordinator. With assistance and guidance, he introduced me to the spiller who shared samples with me. I was then able to provide a report on the fate of the oil to the spiller within two months.

Last Thursday, I was a guest lecturer in Commander Gregory Hall's marine pollution class at the United States Coast Guard Academy in New London, Conn. I could have presented some new scientific results on DWH on how sunlight broke down the oil, how much oil is on the seafloor, or that some oiled samples we find on the beaches of the Gulf are not from the *Deepwater Horizon,* but my lesson for these future Coast Guard officers—who will be on the frontline of lines of future oil spills—is that they will have to interact with numerous stakeholders who have different interests. What I have learned, and others have observed, is that the best outcomes occurred when members of academia and the oil spill response community had pre-existing relationships. I encouraged these future officers to get to know those they may work with during a crisis. It may sound trite, but a cup of coffee and an exchange of e-mails may save miles of coastlines from oiling.

Wise pre-emptive research

I could give you numerous examples—from Woods Hole Oceanographic Institution alone—where investments in basic research paid unanticipated dividends in assessing the DWH disaster. WHOI and other academic institutions were "preadapted" to respond to the spill. "Preadaptation" is a term borrowed from evolutionary biology. It refers to natural selection turning an existing structure to a novel use when the right conditions develop. In an analogous manner, our culture of scientific inquiry meant that knowledge applicable to the oil spill response already existed and could be applied to a new use.

But my suggestion is not a blanket call for more investment in research because it often turns out to be useful and applicable. More specifically, I recommend more investment in collecting baseline information about environments we intend to drill in.

The DWH disaster exposed how little we knew about fundamental physical, chemical, and biological conditions and processes that exist in the Gulf of Mexico. In an area full of oil rigs, where a spill was a good bet (if not inevitable), we had not conducted extensive, long-term research that would have captured what the Gulf was like before it was dosed with oil. We lacked baseline knowledge about preexisting conditions, making it extremely hard to assess damages afterward.

And although after-the-fact assessment studies will teach us lessons, in some ways it is like providing knowledge to firefighters and insurance adjusters after the fire. Another approach is to focus research on learning what we can about how individual ecosystems operate—because they all operate differently—*before* we invest in constructing oil rigs in them.

Let us learn from the Gulf before we look to drilling in the Arctic. The Arctic is a unique ecosystem that we know very little about. It is also far more unpredictable, remote, harsh than the Gulf, with far less infrastructure nearby to combat spills.

With knowledge and predictability about their operating environment, oil spill responders will have the ability to plan more effective responses and be prepared with necessary equipment. In other words, what to do and what is needed and where—in much the way, for example, that firefighters have surveyed how tall the buildings are in their city are and have mapped their city's streets, so that they can take the fastest routes, bringing trucks with ladders of sufficient heights.

Oil spills are inevitable. This is a pay-me-now-or-pay-me-later situation in which up-front investments now can save lives, property, and money later.

I appreciate the opportunity to testify and am prepared to respond to any questions from Members of the Committee.

The CHAIRMAN. Thank you, Dr. Reddy. Dr. Joye?

STATEMENT OF SAMANTHA B. JOYE, Ph.D., ATHLETIC ASSOCIATION DISTINGUISHED PROFESSOR OF ARTS AND SCIENCES, PROFESSOR OF MARINE SCIENCES, UNIVERSITY OF GEORGIA

Dr. JOYE. Good morning, Chairman Thune, Ranking Member Nelson, and members of the Committee. Thank you for the opportunity to provide testimony today regarding the lessons learned from the *Deepwater Horizon.*

My name is Samantha Joye. I am a Distinguished Professor at the University of Georgia. My research examines naturally occurring microbial processes that mediate oil and gas cycling in the Gulf of Mexico and elsewhere.

I am going to limit my testimony today given that my colleagues here have covered many of the points that I wanted to touch on, but I hope to impress upon you the need for developing an academic response network, complete with necessary infrastructure, tools and technology, for academic scientists to be out on the water working closely with the National Incident Command within days of a disaster.

Such a collaboration would reduce response time to an offshore spill, potentially limiting long term damage to offshore and nearshore ecosystems. A shortened response time would save resources and could save lives. It will also reduce hydrocarbon exposure, acute ecological impacts, and economic impacts regarding tourism and fisheries.

The cost benefit of investing in effective oil spill response mitigation technologies and infrastructure is almost assuredly positive, given the high density of oil production platforms in the Gulf and the increasing number of drilling endeavors undertaken in ultradeep water and in extremely gas rich reservoirs.

One of the big issues that we faced when the *Deepwater Horizon* occurred was a lack of communication. This scientific action network, which is being developed by scientists and individuals at Stanford University, and both Dr. Reddy and Dr. Kinner are involved in this effort, I provided Senator Nelson's staff with some copies and information about this network.

I think this network would move us forward in terms of bringing together Federal responders and academic scientists.

In terms of the oil spill, I want to talk about a couple of critical things. The most important is the issue of environmental baselines. Dr. Reddy just touched on this briefly, that it would be nice if we had a pre-*Deepwater Horizon* MRI of the Gulf of Mexico. The fact is the Minerals Management Service funded many, many studies of the Gulf of Mexico prior to the oil spill. The problem was that none of those studies had a microbiological component involving oil and gas degradation.

There are many studies of deepwater chemosynthetic communities. There are many studies of deepwater invertebrate communities, many studies of physical oceanography of the Gulf of Mexico, those physical oceanographic studies were really insufficient to

help us do what we needed to do in terms of the *Deepwater Horizon,* but you cannot really quantify an impact when you do not know what the original condition was.

That means you have to make guesses, and I think that hinders the natural resource damage assessment process that is going on today because we are making guesses as to what those original baselines were.

Few long-term baseline datasets exist in the Gulf of Mexico regarding microbiology. One of the few was funded by the NOAA National Institute of Undersea Science and Technology at Mississippi Canyon Block 118, which lies about 20 miles northwest of the *Deepwater Horizon* wellhead.

The baseline microbiological data from this site was integral in providing the background information that we needed to see how the microbial community was evolving in the water column after the *Deepwater Horizon* blew out.

Environmental baselines are also lacking on the natural distributions of hydrocarbons in the Gulf and their geochemical fingerprint. You have heard many people say, I am sure, that you cannot really trace the oil that you might find on the sea floor to the Macondo wellhead because there is a lot of oil seeping out of the seabed in the Gulf and it is all the same.

It is not all the same. We do not really know how different all those reservoirs are, but we need to know how different those reservoirs are. We need to be able to go in there and do some CSI geochemistry and resolve the actual fingerprints of those individual reservoirs.

Finally, to be prepared for the next incident, the research community needs well validated models of deep circulation and the ability to deploy tens if not hundreds robotic floats with appropriate instrumentation. The benefit of providing robotic floats or underwater vehicles to do plume tracking and oil and gas tracking for us is that it limits the requirements for ship times out on the water.

I would like to conclude for a plea for environmental baselines again. Environmental baselines are absolutely important for the Gulf of Mexico ecosystem and for the Arctic ecosystem in light of the drilling that is going to be probably undertaken there in the future.

Environmental baselines, obtaining necessary environmental baselines, are a goal that could be achieved as part of the Department of Interior Bureau of Ocean Energy Management's mission since they are mandated to provide funding to support documentation of environmental baselines through the environmental studies program.

However, BOEM's budget for the environmental studies program is $35 million a year. This may sound like a lot but it is not a lot when you consider the area over which this money must be spread.

Obtaining proper baselines for the Gulf and Arctic alone would cost substantially more than $35 million a year, and I personally believe that these costs could and should be shared by industry.

Sufficient environmental baselines are the best instruments of industry and the trustees, thus, I encourage Congress and the Administration to increase BOEM's funding and give them the au-

thority to require industry to obtain baselines and ongoing environmental monitoring data at all locations impacted by oil and gas development and production.

These requisite data collected by proper standardized protocols and sampling intervals should be determined by a panel of experts selected and convened by either BOEM or the National Academy of Science, potentially in collaboration with NOAA's Emergency Response Division.

Industry should shoulder some of the cost of this monitoring program, and I believe the funds would be best administered competitively through BOEM.

With that, I conclude my testimony, and answer any questions you might have.

[The prepared statement of Dr. Joye follows:]

PREPARED STATEMENT OF SAMANTHA B. JOYE, PH.D., ATHLETIC ASSOCIATION DISTINGUISHED PROFESSOR OF ARTS AND SCIENCES, PROFESSOR OF MARINE SCIENCES, UNIVERSITY OF GEORGIA

Good morning Chairman Thune, Ranking Member Nelson, and members of Committee. Thank you for giving me the opportunity to provide testimony regarding the lessons learned and long term environmental impacts of the Deepwater Horizon (DWH)/Macondo oil well blowout (hereafter Macondo Blowout), which devastated the Gulf of

Mexico ecosystem beginning in April 2010. My name is Samantha Joye and I am a Distinguished Professor at the University of Georgia. My research examines the naturally-occurring microbial processes that mediate oil and gas cycling in the Gulf of Mexico and Arctic Ocean, two areas where natural seepage of hydrocarbons is widespread. I have published over 120 peer-reviewed papers on these and related subjects. I have worked in the Gulf of Mexico ecosystem for 20 years and continue to do so.

For this hearing, I was asked to discuss what the scientific community has learned in the past five years in the wake of the Macondo Blowout, the lingering environmental impacts, as well as my thoughts on how to move forward so that we are better prepared as a research community and as a response community for the next incident. My comments represent the not only my opinions, but those of my colleagues within the consortium that I direct, and of the broader scientific community working in the Gulf system, of which I am an active participant. The topic of this hearing could not be more timely. Recently, John Amos summarized the number and location of hazardous material spills in the Gulf since the 2010 DWH disaster: 10,000 spills of various sizes have occurred in the past five years. Clearly, it is not a matter of if, but rather when, the next large accidental offshore marine oil discharge occurs in the Gulf of Mexico.

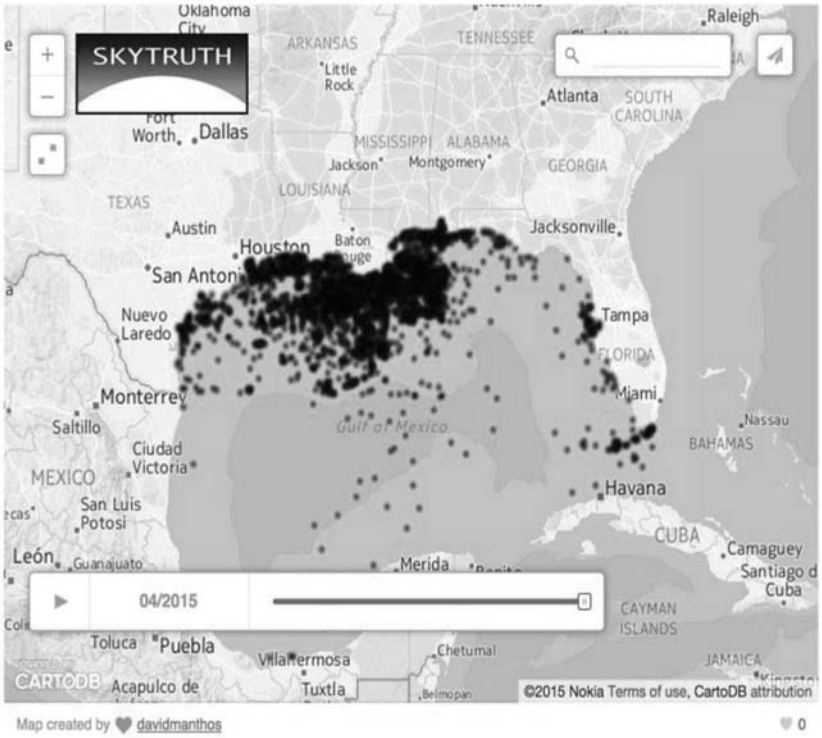

Figure showing the locations of hazardous material spills in the Gulf since 2010. This is time 5-yr aggregate map; the time series is available at the SKYTRUTH® website: (*http://bit.ly/1aLX5UF*).

On April 20, 2010, a chain of events that ultimately resulted in the most significant offshore oil release in U.S. history began. The *Deepwater Horizon,* a dynamically positioned offshore mobile drilling unit, was drilling a production well in the Macondo Prospect, located in Mississippi Canyon lease block 252, about 40 miles offshore if the southeast coast of Louisiana. The night of April 20, 2010, rig operators experienced a loss of well control, resulting in an uncontrolled blowout. The explosion and subsequent fire on the platform killed eleven men and injured sixteen others. The blowout preventer, which should have cut the riser pipe at the seafloor and sealed the blown out well, failed and the fire on the platform raged for two days. On April 22nd, the *Deepwater Horizon* sank, initiating an uncontrolled release of oil and gas from the seafloor that lasted for 87 days and introduced some 5 million barrels of oil (210 million gallons) and 500,000 metric tons of methane into the Gulf of Mexico ecosystem.

I am qualified to provide testimony on the impacts of the Macondo blowout based on my detailed knowledge of the Gulf ecosystem and through my role as Director of a large research consortium that is tracking long-term impacts and recovery from the Macondo blowout. I was among the first academic responders to the DWH oil spill, serving as chief scientist on the second academic response cruise on board the *R/V Walton Smith* in May/June 2010. Being out on the water in May/June 2010, August/September 2010, and November/December 2010, I witnessed, first hand, the devastating environmental consequences of this deep-water oil well blowout. I was part of the scientific team that discovered the "underwater oil plumes" and led the effort that discovered freshly deposited sedimentary layers containing weathered oil that extended over a large parts Gulf seabed in late August 2010.

Since 2010, we have continued and expanded our work in the Gulf with the aim of conducting long term monitoring studies and directed laboratory experiments to elucidate the impacts of oil, chemical dispersant, and dispersed oil on Gulf microbial communities, in both the water column and in deep sea sediments. I am the Direc-

tor of the "Ecosystem Impacts of Oil and Gas Inputs to the Gulf" (ECOGIG) research consortium (*www.ecogig.org*), a group of 29 scientists conducting DWH-related research. Our consortium is funded on a competitive basis by the Gulf of Mexico Research Initiative (GoMRI), which was created to administer the $500M research fund BP provided to support DWH-related research over a 10-year period. The ECOGIG mission is to understand the environmental signatures and impacts of natural hydrocarbon seepage versus that of abrupt, large hydrocarbon discharges on coupled benthic and pelagic processes in deepwater ecosystems in the Gulf of Mexico, and to chart the long-term effects and mechanisms of ecosystem recovery from the 2010 Macondo blowout.

My testimony today is limited to issues relevant to offshore, deepwater environments and I will describe the major lessons learned and long impacts of the Macondo Blowout. I also hope to impress upon you the need for developing an academic response network, complete with necessary infrastructure—tools and technology—to be on the water within days of disaster. This network of academic responders would work closely and collaboratively with National Incident Command. Such a collaboration would reduce response time to an offshore spill, potentially limiting long term damage to offshore and nearshore ecosystems. A shortened response time saves resources and could save lives, and will also reduce hydrocarbon exposure, acute ecological impacts, and economic impacts (fisheries, tourism). The cost-benefit of investing in effective oil spill response and mitigation technologies and infrastructure is almost assuredly positive, given the high density of oil production platforms in the Gulf and the increasing number of drilling endeavors undertaken in ultra-deep water and in extremely gas-rich (*e.g.,* Tertiary) reservoirs.

Preface

The Gulf of Mexico ecosystem is representative of a highly stressed oceanic environment—multiple stressors affect the system from almost every direction and this was the case before the Deepwater Horizon/Macondo oil well blowout. Nutrient over-enrichment, seasonal hypoxia, fishery stress, pollution, intense industry activity, warming waters, and ocean acidification have collectively pushed the Gulf ecosystem to the point of collapse. The Macondo Blowout was yet another anthropogenic impact and it has had a tremendous affect on this ecosystem.

Lessons Learned from the Deepwater Horizon Disaster

Assessing impacts of an offshore, open ocean oil discharge represents a formidable challenge.

At the peak of the DWH incident, oil covered 29,000 square miles of the Gulf's surface, an area comparable in size to the state of South Carolina (32,020 square miles). An oceanographic research vessel travels at about 10 miles an hour. Imagine attempting to characterize the vegetation and soil all across South Carolina by driving in a car at 10 miles an hour across the state. Given the large area, you could only take a sample every few hours, perhaps 8 samples a day if you and your partner shared the driving. And if taking a single sample required 3 hours (~this is the amount of time required to collect a depth profile of water samples at a depth of 1500m), it would take a very long time to characterize the entire state.

This example provides insight to the situation faced by scientists attempting to characterize Gulf offshore environments in the wake of the DWH discharge. The sheer size of the open ocean area impacted by the DWH discharge and the fact that the ocean is extremely dynamic—the water moves and chemical signatures can change on time scales of minutes to hours—underscores the daunting challenge this incident posed to oceanographers. The spatial and temporal complexity of the arena and the presence of oil complicated collection of basic geochemical and biological data. Characterize the distribution of oil and gas, aiming to discover novel features, and quantify impacts, made this task Herculean. The regular sea-going gear we use to collect samples is not made for oily water; extraordinary effort was required to clean bottles, sensors, etc. between sample collections. And, choices had to made: one could characterize smaller areas at greater resolution or characterize larger areas at more coarse resolution—one could not do both on a short cruise.

The infusion of oil and gas to the system meant that the biological system was rapidly evolving. This meant that time series data were critical, so that we could track the response of various parts of the system to perturbation. Though insufficient data of this type were collected for offshore water column and sediment habitats, the one published suite of time-series measurements made over a 10-month period (March–December 2010) underscores the clear importance of time-series data, as opposed to "snap-shot" sampling (*i.e.,* a single week or two sampling campaign) (Crespo-Medina *et al.,* 2014). An enormous amount of time and multiple ships con-

ducting comparable operations would have been required to properly sample and characterize the entire area impacted by the discharge.

Possessing prior system knowledge, *i.e.,* experience working in the area and familiarity with the bathymetry of the seabed, was integral for our group's discovery of the deepwater plumes. We discovered the plumes because we had a good idea of the direction the deep currents was moving and we knew the bathymetry of the area because many of us had been involved in the only long-term Gulf benthic observatory (at Mississippi Canyon lease block 118) which lies to the N/NW of the Macondo wellhead, so had seabed maps of the area. In depth system knowledge provided us with instincts—and the willingness to trust our instincts—and this led to our discovery of the plumes (Diercks *et al.,* 2010, Joye *et al.,* 2011). We shared the locations of the plumes with Federal responders and with other scientists, which led to additional discoveries (Camilli *et al.,* 2010, Valentine *et al.,* 2010, Kessler *et al.,* 2011).

To facilitate and improve the efficacy of future open-ocean oil spill response, a foundation of strong coordination, communication and trust is needed between academic responders and Federal incident command officials. Ideally, this foundation should be in place and vetted before the next incident occurs. As described in the testimony below, academic scientists have a great deal of expertise to offer the Federal responders and this expertise should be brought to bear immediately in future response scenarios. Furthermore, in hindsight, significant investments in infrastructure and technology and basic research are required to be prepared for the next deepwater discharge. Such bold moves will increase the ability of responders to identify the multitude of system-scale impacts and assure collection of the proper samples to quantify those impacts.

Environmental baselines are necessary and must be obtained.

How do you quantify whether and to what extent something has changed (i.e., an impact) when you do not know the original condition (*i.e.,* the baseline)? The answer is that it is difficult and it requires that you essentially make an educated guess as to what the original condition was. Environmental baselines are sorely lacking across the Gulf of Mexico ecosystem. Despite numerous Minerals Management Service (now the Bureau of Ocean and Energy Management) funded studies to describe Gulf physical oceanography (*e.g.,* MMS 204–022, "Cross-shelf exchange processes and the deepwater circulation . . .) and deepsea chemosynthetic and hard bottom communities (*e.g.,* MMS 2009–046, "Investigations of chemosynthetic communities on the lower continental slope . . ."; MMS 2009–039, "Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study"; and MMS 2007–004, "Characterization of Northern Gulf of Mexico Deepwater hard-bottom communities with emphasis on *Lophelia* coral"), the basic microbiology of the Gulf system and the ability of microorganisms to oxidize oil and gas were essentially unconstrained at the baseline level in 2010. There was no data available on water column oil degradation rates and very little available on water column methane oxidation rates (Wankel *et al.,* 2010). Prior to the DWH, someone once described my work on oil and gas microbiology in the Gulf as esoteric. In the post-DWH world, that word would never be used because we now know that microbiological research is absolutely critical.

Few long-term baseline data sets that include basic microbiology are available for the Gulf (Joye *et al.,* 2014). The NOAA/National Institute for Undersea Science and Technology Mississippi Canyon block 118 (MC118) Gas Hydrate Microbial Observatory and a NSF funded 5-year, though only 2 research cruises, Hypersaline Ecosystems Microbial Observatory programs are notable exceptions. The MC118 site is less than 20km from the site of the Macondo blowout and data from this program provided critical baseline data that was used to assess microbial community changes in the water column and sediments following the DWH incident (Crespo-Medina *et al.,* 2014, Yang *et al.,* 2014). Without such critical baseline data, it would have been impossible to quantify changes in pelagic microbial oil and gas degrading communities in response to the blowout. Still, other parts of the pelagic "microbial" community such as phytoplankton and small zooplankton, are unknown because we do not know much about them in the first place. Thankfully, baseline data were available for some cold water coral communities and that has facilitated research aimed at quantifying Macondo-related impacts to those communities (White *et al.,* 2012, Fisher *et al.,* 2014a, 2014b).

Environmental baselines are also lacking on the natural distributions of hydrocarbons and their geochemical "fingerprint" for the Gulf. Fingerprinting oil to a specific reservoir requires ultra-clean sampling protocols in the field and sophisticated instrumentation in the laboratory. We need to know how the natural distribution of oil (dissolved hydrocarbons) and gas (methane) vary across the Gulf system and we need to be able to identify and isolate specific sources (reservoirs). We need to

understand variability in concentration and fingerprint at the scale of an individual seep field, in a lease block, and between regions (*e.g.,* Mississippi Canyon, Green Canyon, Alaminos Canyon, etc.). Furthermore, we must obtain basic information on oil and gas degradation rates in the environment, how they vary over space and time, and we have to know what constrains these activities. One cannot conclude that "microbes ate all the oil" based on the observation that oil is no longer measurable in a water sample; the fact is that the oil may have instead moved to another location (*e.g.,* the seafloor) where you were not looking.

Finally, to be prepared for the next incident, the research community needs well-validated models of deep circulation and the ability to deploy 10s–100s of robotic floats with the appropriate instruments (fluorometers) to detect oil. We have much better models of the Macondo area now (Goni *et al.,* 2015) and of some of the unique physics that led to development of the deepwater plumes, for example (Zachary *et al.,* 2015), but we need comparable models for the entire Gulf ecosystem. This is a goal that can be achieved, with proper research funding. In fact, one could argue that such floats with CDOM fluorometers should be deployed now, to start obtaining the desperately needed environmental baselines. The research community must push the envelope to develop other instruments specific to hydrocarbons that can be deployed on autonomous vehicles.

This will permit characterization of large areas with minimal demands for ship time.

Obtaining proper environmental baselines for the Gulf system is something that every environmental scientists conducting post Macondo research realizes. This necessary goal can be achieved as part of DOI/BOEM's mission, since they are mandated to provide funding to support documentation of environmental baselines through the Environmental Studies Program. BOEM's budget for the ESP is a $35M a year and those funds must cover all areas impacted by oil and gas development. Obtaining proper baselines for the Gulf and elsewhere (*e.g.,* The Arctic) will cost substantially more than $35M per year and I believe these cost could and should be shared by industry. Sufficient environmental baselines are in the best interest of the industry and the Trustees. Thus, I encourage Congress and the Administration to increase BOEM's funding and to give them increased authority to require industry to obtain baseline and ongoing (annual) environmental monitoring data at all locations impacted by oil and gas development. The requisite data collected, proper protocols, and sampling intervals should be determined by a Panel of Experts selected and convened by BOEM officials, potentially in collaboration with NOAA's Emergency Response Division. Industry should shoulder the costs of this monitoring program and the funds should be administered competitively by BOEM.

Knowing the flow rate is a critical to closing the "oil budget".

Knowing the discharge rate is essential for selecting and employing the most appropriate method of intervention to seal a discharging well. Quantification of the discharge rate over time—and knowing and whether, and if so how much, it varies over time, is also essential for determining the total hydrocarbon discharge, a value of obvious importance in the NRDA process. I have heard many people say there was no technology available to quantify the flow rate when the Macondo blowout began. This statement simply is not true. Scientists had determined the flow rate of discharging vents in deepsea hydrothermal systems using particle imaging velocimetry (PIV, Westerweel 1993), optical plume velocimetry (OPV; Crone *et al.,* 2008) or acoustic scintillation (Di Iorio *et al.,* 2005, 2012) before the Macondo Blowout. The first evidence that the discharge rate was well above the stated rate of 1000 or 5000 barrels of oil per day (BOPD) came from satellite imagery: the satellite-derived estimate of 26,500 barrels a day was called the "MacDonald Minimum" by the *New York Times* (the number was generated by Prof. Ian MacDonald at Florida State University). The first estimate of the Macondo well discharge rate based on (very poor quality) digital video footage of the discharging wellhead was obtained by PIV and the value was 57,000 ± 10,000 BOPD (Crone and Tolstoy 2010). It is noteworthy that release of this video footage required three congressional subpoenas. Later in the discharge, Camilli *et al.,* (2011) reported a flow rate of 52,700 BOPD. There is no reasonable explanation for why the flow rate was not quantified early on and continuously. However, because it was not, we will never truly know how much oil was discharged from the Macondo wellhead. And not knowing the absolute discharge rate makes generating and closing the oil budget impossible.

In the future, immediate and continuous assessment of the discharge rate should be an absolute requirement of the responsible party.

Patching other holes in the oil budget.

—Deepwater plumes and sedimented, weathered oil

The discovery of deepwater plumes enriched in oil and gas was not an accident. The literature was rich with papers describing the formation of underwater oil-rich plumes in the event of a deepwater blowout and field experiments verified model results. On the first academic response cruise on board the R/V Pelican in early May 2010, Vernon Asper and Arne Diercks discovered the deepwater plumes (Diercks *et al.,* 2010) and on the second academic response cruise, we characterized the chemistry and microbiology of those plumes in great detail (Joye *et al.,* 2011, Crespo-Medina *et al.,* 2014). *How much of the discharged oil was in the deepwater plume?* That value is not well constrained but the number that is most commonly stated is 30 percent. All of the discharged gas, namely methane, some 500,000 metric tonnes of it, was trapped within the deepwater plumes (Joye *et al.,* 2011). Notably, discharged gas is not included in the "oil budget".

A significant fraction, some 5 to 15 percent of the discharged oil, was deposited to the seafloor as "marine 'oil' snow" (Chanton *et al.,* 2014, Valentine *et al.,* 2014), covering an area of over 8,000 square kilometers. Our research team collected cores from many sites at various distances from the wellhead in May 2010. We re-sampled some of those areas in August 2010 and discovered layers of recently deposited oil-containing material that were absent in May 2010. These layers were observed many 10s of miles from the wellhead, showing that "oil snow" deposition was a widespread phenomenon. The freshly deposited layer exhibited a dark coloration; these cores smelled strongly of hydrocarbons and the water overlying the cores contained a visible rainbow sheen of oil. These cores were not from known hydrocarbon seep; this oil had not seeped into the sediments from below, it had rained down onto the sediments from above. The depth of the layer was up to several cm thick in some places; layers that thick would take hundreds of years to accumulate under natural sedimentation regimes. The animals, worms and such, living in the sediment had been suffocated. These cores were like nothing any of us had ever seen.

We now know that this oil-containing material reached the seafloor through the mechanism of marine oil snow sedimentation, a process that was unrecognized and unappreciated prior to the DWH disaster. Marine oil snow forms by several different mechanisms, abiotically through oil-mineral aggregation, and biologically through the activity of bacteria and phytoplankton (Passow 2014, Joye *et al.,* 2014). Environmental conditions determine which type of marine snow is most important for the transfer of oil to depth and the primary mode of oil snow formation can vary by location and time. Mobilization and redistribution of this sedimented, weathered presents a long-term, persistent impact of the oil on benthic ecosystems that are exposed, possibly multiple times, to oil components that sank to the seabed.

Marine oil snow could also serve as an important food source for many planktonic species as well, making oil contaminated snow a mechanism to move oil into the food web. Macondo-derived hydrocarbons were found in floating particulate matter in the Gulf as far as 190 km southwest of the wellhead in 2010, and the ancient hydrocarbon isotopic signal persisted into 2011 and 2012. This particulate phase appears to have been ingested by zooplankton and it entered the food web. There is also evidence consistent with the hypothesis that Macondo hydrocarbons entered the food web of coastal organisms to the north of the spill site.

Sedimentation of oil was not included in the original Federal oil budget. We now know that the formation of marine oil snow particles is an important fate of oil. This fate must be considered in future response plans and its importance quantified, through direct measurements of sedimentation and trophic transfer, relative to other potential fates and impacts of oil.

—The failure to constrain rates of microbial oil degradation

Despite the fact that oil was present in the deepwater plume and on the sea surface, no actual rates of oil degradation were carried out. By "actual rates" I mean that oil degradation rates were not determined using highly sensitive radiotracer techniques. The one degradation rate that was published was from a lab bottle experiment and it represented a potential rate of one group of compounds, alkanes (Hazen *et al.,* 2010). The "turnover constant" for this one, very labile, group of compounds, the alkanes, was then applied to all the various components of oil, from benzene to polycyclic aromatic hydrocarbons, by some other scientists and the media, leading to the highly inappropriate conclusion that microorganisms magically degraded the Macondo "oil" on a ~10 day time scale. Another journal in Science (Camilli *et al.,* 2010) published much slower oil degradation rate, but that value was largely overlooked.

There is no evidence that 'magic microbes' consumed all the Macondo oil. The reasons why we do not how much of the Macondo oil the microbes did, in fact, consume are as follows: The reasons microbial degradation rates were not determined include: (1) making these rate measurements is extremely difficult and time-consuming, (2) the radiotracers are very expensive, and (3) the measurements requires specialized shipboard accommodations (*e.g.,* radioisotope-usage isolation vans). The scientific community is better prepared now to make these measurements—robust methods are now available—but the bottleneck may be expertise as few people make these laborious measurements.

In contrast to oil, methane consumption rates were well constrained and it is clear that microbial processes were unable to completely consume the methane discharged from the Macondo wellhead (Crespo-Medina *et al.,* 2014). Though there remains some debate about the fate of methane (*e.g.,* Kessler *et al.,* 2011 and Crespo-Medina *et al.,* 2014), the differing conclusions are largely a function of the timing of sampling and the time-scale sampled (the former lacked samples from early in the discharge when activity was maximal while the latter presented a comprehensive data set representing a 10-month time series).

Because no direct measurements of oil (component) degradation rate exist, we are left to make assumptions about the potential for the microbial community to degrade oil and that results in very large error bars and an unconstrained oil budget. The Federal oil budget released in August 2010 stipulated that approximately 50 percent of the discharged oil was not accounted for in a quantitative sense. Some fraction of this now lies along the seabed. Another portion was certainly consumed by microbial processes. However, we cannot know, in an absolute sense, how much of this oil remains in the system in some (weathered) form or where this oil ended up.

In the future, we must constrain the quantity and fate of oil and gas in deepwater plumes; we must constrain the formation and fate (sedimentation vs. trophic transfer) of marine oil snow; and, we must quantify rates of oxidation of model oil compounds, *e.g.,* hexadecane as a model alkane, naphthalene as a model PAH, etc.

Dispersants

Chemical dispersants break down surface oil slicks, creating a spectrum of sizes of dissolved oil particles. The general principle behind application of dispersants is that they reduce the amount of oil that reaches the shoreline and that they increase rates of microbial oil degradation by increasing the available surface area of oil that is subject to microbial attack. Importantly, these chemicals are also assumed to be inert, doing no harm to the environment.

The decision to apply dispersants during the DWH response was not taken lightly and ultimately, I believe it came down to minimizing coastal impacts with a true belief that offshore impacts of dispersants would be minimal. As it turns out, the evidence that dispersants increase oil biodegradation rates is contradictory (Kleindienst *et al.,* 2015). There is no scientific consensus that chemical dispersants increase rates of microbial oil degradation. In fact, since the DWH incident many papers have been published documenting that dispersed oil, and in some cases dispersant alone, are more toxic and harmful than oil alone. Negative impacts of dispersants have been documented in marine phytoplankton (Ozhan and Bargu 2014), ciliates (Ortmann *et al.,* 2012, Almeda *et al.* 2014), rotifers (Rico-Martinez *et al.,* 2013), fish (Ramachandran *et al.,* 2014, Brette *et al.,* 2014), corals (DeLeo *et al.,* 2015) and coral larvae (Goodbody-Gringley *et al.,* 2012).

Clearly, the assumption that dispersants are inert and impart no negative ecosystem consequences was wrong. Much more research is required to quantify the impacts of dispersants and dispersed oil on the biological components of the Gulf system before they are again used as a primary mode of oil spill response. Notably, today, blowout preventors are being instrumented with automated dispersant applicators. Available science suggests this is a bad idea and argues that this practice should be halted until either a truly biologically inert dispersant is developed or concrete evidence is produced to contradict and invalidate the available work that underscores the inherent negative impacts of dispersant/dispersed oil exposure.

Long term Impacts of the Deepwater Horizon Disaster

Damage to deepwater ecosystems

Deepwater benthic ecosystems, including cold-water corals (White *et al.,* 2012, Fisher *et al.,* 2014a, 2014b) and benthic invertebrates (Montagna *et al.,* 2013) were significantly impacted by weathered oil sedimentation. Cold water coral ecosystems are critical benthic habitats in the Gulf of Mexico and elsewhere. Few people realize that only half of the world's coral reefs lie within the photic zone; the other half lies in deeper, dark water. These deep, cold-water coral environments provide fish-

ery habitat as well as other ecosystem services. Corals, and octocorals in particular, are excellent sentinels for anthropogenic impact in the deep sea: They sample the surrounding water, normally live for 100s to 1000s of years, and when impacted, their dead branches or skeletons remain attached to the sea floor providing a record of impact that can last for up to a decade. Exposure to dispersants and dispersed oil made a bad thing worse, at least for the corals (DeLeo *et al.,* 2015).

Cold water corals are slow growing animals; since they grow at a rate of around 1 cm per year, a meter tall coral is 100 years old. Several coral ecosystems in the vicinity of Macondo were severally impacted from the Macondo blowout. The most serious impacts with within about 11 km of the spill site, but corals over twice that distance away and at much deeper depth (to 1900m) were also visibly impacted resulting in dying branches on these normally very long lived corals. Full recovery will not happen in our lifetimes.

The injuries to corals were not confined to the nearby deep sea communities. The mesophotic corals were also injured in large numbers on the shelf. Prof. Ian MacDonald's group at Florida State documented 400 injured coral colonies at two sites, but this represents a small fraction of the total coral habitat known to exist on the shelf under the area covered by surface oil and under the airborne dispersant flight lines.

Resuspension and remobilization of sedimented oil could generate multiple and new exposures to both corals and invertebrate communities, prolonging Macondo's impact on vital deepwater habitats.

Benthic invertebrates may be considered "worms in the mud" but these animals provide important services to their environment: their movement, whether it be burrowing or simply trudging along the surface, serves to mix and oxygenate sediment, increasing oxygen penetration into sediments and allowing the microorganisms in the sediments to mineralize more organic carbon. Thus, benthic invertebrates can affect the rate of sediment organic matter turnover, which also serves to remineralize nutrients. These sedimentary processes are inherently linked to processes in the surface ocean: Remineralized nutrients from the deep are ultimately returned to the surface ocean where they support primary production. Primary production in surface waters fuels the food web but also supports a natural particle flux to the benthos. This delicate balance between nutrient supply to the surface ocean from the deep seafloor and return flux of some fraction to the deep through natural sedimentation was turned on its head by the massive sedimentation event following the Macondo blowout. This benthic-to-surface connection is poorly constrained at baseline levels and we need more data to constrain the magnitude of this perturbation.

Benthic invertebrate communities, especially within a 5–10 mile radius of the wellhead, were wiped out. How long it will take them to recover is unknown. Likewise, damaged coral communities have been documented 10s of miles from the wellhead. These communities are still showing impact and though we know it will require 100s of years for the most damaged coral communities to recover, we are still documenting impacts that were not documented in 2012 and it is likely that the true magnitude of the deepsea impact may never be fully appreciated.

Notably, there is no set-back distance that would have prevented these catastrophic impacts. The regulations in place still allow drilling and production to occur far too close (500m) to sensitive communities. I encourage Congress and the Administrative to review these set-back distances and to increase them to minimize damage to sensitive chemosynthetic communities. The deep sea is very poorly surveyed and its fauna are very poorly known. As noted previously, baseline studies of the distribution and status of deepwater communities near oil and gas development sites, even if this is video surveys run by the industry, need to be reviewed by BOEM/BSEE and trained scientists. We need to better understand the baseline conditions in the deep sea to better understand where the more unique communities are found in the sea of mud that is most of the deep sea floor. More in depth knowledge of the biodiversity and population connectivity of the deepsea fauna is needed to understand the effects of the next disaster or cumulative impacts of anthropogenic impacts on the oceans.

Microbial community shifts

The massive infusion of hydrocarbons to the Gulf system in the Macondo area resulted in a rapid shift in hydrocarbon-degrading microbial community composition that, in some places, remains detectable today (Yang *et al.,* 2014). Whether the present microbial hydrocarbon degrading community is providing the same ecosystem services or maintaining their previous levels of activity is unknown. Assessment of time-series changes in phytoplankton, zooplankton and meso-pelagic organisms is lacking, so it is unclear whether their populations were impacted similarly. However, given the variable ability of some organisms to tolerate oil exposure, shifts

in community composition are likely. The long-term impacts of such shifts and the time required for the base of the food web to achieve a new steady state is unknown.

Moving Forward

During the DWH response, it became clear that the research community lacked sufficient resources in the form of manned submersibles, ROVs, and AUVs to adequately and rapidly respond. Germany, France, Russia, Japan and China have invested much more vested in deep-sea technology than the U.S. has in the past twenty years and it shows. Deep-sea assets and technology development and instrument acquisition are necessary to support basic scientific exploration and discovery. These tools are also absolutely essential to track, quantify, map, and verify open ocean water column and benthic impacts of incidents like the Macondo blowout. Training and instrumenting an academic task force to aid in response to offshore blowouts and other natural disasters is a worthy investment. I encourage Congress and the Administration to increase BOEM's funding and scope of work to facilitate and improve future response efforts.

Thank you for the opportunity to testify today. I would be happy to answer any questions that you have.

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The CHAIRMAN. Thank you, Dr. Joye. I want to turn now to our distinguished Ranking Member of the Committee, Senator Nelson from Florida, who I know has a keen interest in this subject.

STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA

Senator NELSON. Mr. Chairman, it is just as well that my opening statement, which will be very short, is after the witnesses. This matter is very personal to me. Those of us on the Gulf lived through this.

We were first told that it was maybe 1,000 barrels a day, and over the course of time, what we found is it was upwards in excess of 50,000 barrels a day, a total spill over the course of 89 days that was a mind blowing just under five million barrels of oil, and the specific figure that Judge Barbier in the Federal Court in New Orleans has come up with is right at four million.

That is a lot of oil. The consequences were obvious. Some of you have pointed them out. In a state like mine, we lost an entire tourist season, not because there was oil on the beach, as there was on Pensacola Beach, and some tar balls got as far east as Panama City Beach, but because people thought there was oil on the beach, and they did not come to the Gulf Coast, all the way down to the southern tip of Florida, Marco Island.

In addition, almost 40 percent of the Gulf was closed to fishing, and all the livelihood that occurred from there.

About a year into this, I went to LSU and I talked to a couple of professors that were doing an investigation comparing what was happening in Barataria Bay with other bays that had not had the oil. The little fish that is about that big [indicating] called the "killifish," they found a lot of changes. They found mutations in the lungs. They found reproduction was down. They found stunted growth, et cetera, compared to those killifish in other bays.

We know there is an obvious effect. That is in part why we set up the money that is eventually going to flow from the RESTORE Act in the Trust Fund.

That is why we set up these centers of excellence in each of the states, and specifically for Florida, a real research organization, and it is the Florida Institute of Oceanography, a 21 university consortium located at University of South Florida, that will continue to do research on the health of the Gulf, which we do not know, as you all have suggested in your testimony, we do not know the effect, and we do not know how much oil is down there at 5,000 feet still below, and what are the long term effects. We saw in the food chain up from the killifish effects upon the higher food chain creatures.

There is a lot to know. I will be filing some legislation tomorrow that I will announce later that would ensure that NOAA and the Coast Guard have the tools to prepare and respond for the next marine oil spill.

Mr. Chairman, thank you.

The CHAIRMAN. Thank you, Senator Nelson. I guess we can start on questions. I know we have an event coming up before too long over in the House chambers, a joint session. A lot of people will probably be departing for that.

I will just ask a couple of quick questions and then I will turn it over to people here who may want to drill down a little further.

This would just be for the entire panel. That has to do with kind of the lessons learned from all this, and what has been the most important improvement in safety or response technology in the 5-years since *Deepwater Horizon*.

Mr. WILLIAMS. I will talk about what we are doing at the Center for Offshore Safety and SEMS. I think even though a lot of companies have good programs, we have really changed, we have come together, worked together, developed better systems for sharing learning in improving this, and it is really a key tool because it balances between focusing on protecting the individuals and protecting yourself from major incidents, and it gets that balance right.

I think that is what they talked about when they talked about safety culture in the Presidential Commission report.

The SEMS processes embed safety into every phase of learning, managing change, developing skills and knowledge, it is embedded into your whole work process. It continuously looks at assuring and measuring that you have built barriers and have those barriers in place.

I think building a place to learn, improve, and make that continuously better and maintain a continuous focus on that and get the balance right is one of the important additions.

The CHAIRMAN. Anybody else?

Dr. KINNER. Yes, I would like to address that, Senator. I think probably the seminal impact has been the influx of research dollars into oil spill R&D. Really, prior to the spill, the amount of money that went in both on the Federal side and on the industry side, et cetera, was really relatively low, and this effort through GoMRI, the National Academy, through industry, and to a lesser extent through the Federal Government, has really focused on some key questions.

I think the real issue is moving beyond figuring out what is going on in the Gulf, to figuring out how to do response better, and response in areas other than Gulf oil spills.

As you know, every day we see in the news spills of trains, spills with pipelines, potentially developing in the Arctic. There are some major, major impacts that could occur from those spills that we are really not addressing as well.

I would hope that we would see that research percolate into these other key areas.

The CHAIRMAN. Dr. Reddy?

Dr. REDDY. Thank you. My thoughts about response are it is a lot better than it used to be, and in part because after the *Exxon Valdez* spill, which was 13 million gallons of oil, we had only one million gallons of oil released in 1991. Business was incredibly good. In fact, the track record of oil spills was much, much better.

The oil spills were not from tankers but actually from ships carrying oil, like the *Cosco Busan* oil spill in 2007.

My biggest concern and perhaps the lesson learned is that there is a continued interest in understanding effects and damages of spills, and not putting enough input, as my colleagues have said, into response.

For all practice purposes, we are training the next generation of home insurance adjustors on how to do a better adjustment about a house that just burned down instead of training firefighters to stop the fire from being one story to a complete catastrophe.

If I could say one thing, the response has to get more attention because that is where the action is. That is where limiting damages is.

I originally would say we should double down on our response but I am pretty sure we should be all in. Thank you.

The CHAIRMAN. Thank you. Dr. Joye?

Dr. JOYE. I echo Dr. Reddy's sentiment on the value of response, but in terms of lessons learned, I think there were potentially three really critical lessons that we learned from the *Deepwater Horizon* moving forward, and they have to do with the Federal oil budget.

One is the absolute essential nature of determining the flow rate properly from day one, not 2 months after the spill—the discharge has become. The fact that the flow rate was not properly determined until almost 2 months into the event means we will never know how much oil was discharged from that well, which means making the oil budget and closing the oil budget essentially impossible. Techniques are available to do that and it should be done.

The second thing is if you look at the Federal oil budget, that little pie chart, there is a big part of the pie that is missing, and Dr. Reddy referred to that. That is oil sediment to the sea bottom, and the range of that is from two to 16 percent, and we do not know where in that 2 to 16 percent the actual number is. That is upwards of 10 million, it is a huge fraction of the discharge.

We know the mechanism now by which that oil got from the surface to the bottom, it is biological processes for the most part, and that needs to be included in the oil budget and it needs to be quantified during the next response.

Finally, the deepwater plumes. We do not really know how much of the discharged oil was in the deepwater plumes. It could have been 30 percent. I think that is a good number. That is a number that I use. What happened to all that oil. The only way you could have constrained that is if you were actually tracking the fate of that material continuously, and it was not.

One of the biggest holes in the oil budget is you have all this oil that you cannot really quantify. Nobody was measuring rates of oil by degradation. Why is that? Because it is really hard to do. It is painful, it is excruciating, it is expensive, it is time consuming, it is laborious, your graduate students hate you for making them do it. It is absolutely necessary.

Back in 2010, we were doing it in my group at a very minimum level because of the expense, and now we do it extensively because of the urgency, and the fact that we need to know what these baselines are.

Those sorts of things have to be factored into the next response because otherwise we are never going to be able to close the oil budget and understand what happened to all the oil that was discharged from the next well that blows up.

The CHAIRMAN. Thank you, Dr. Joye. I am going to turn now to Senator Nelson, followed by his colleague from Florida, Senator Rubio.

Senator NELSON. Are you talking about the oil that was floating on the surface?

Dr. JOYE. I am talking about both the oil that was floating on the surface——

Senator NELSON. No, the plumes.

Dr. JOYE. The deepwater plumes, I think we did a pretty good job of measuring methane degradation. In terms of oil by degradation, there are only two estimates. One was by Terry Hazen, and that was in a flask experiment done in the lab, and one was done by Rich Carmilli and Dr. Reddy here looking at oxygen depletion.

The two numbers of oil degradation that they get are vastly different. One was very fast and one was very slow. Those are the two numbers and neither of them were direct measurements using tracers.

Senator NELSON. You are talking about the oil that was floating on the top?

Dr. JOYE. All of it. We did not measure microbial degradation of any of the oil properly.

Senator NELSON. Were we not lucky that the loop current did not catch the oil and take it south and around the Florida Keys and up the southeast coast of Florida?

Dr. JOYE. Very lucky.

Senator NELSON. Where the Gulf Stream is right at the coast.

Dr. JOYE. We were very lucky.

Senator NELSON. We were. Tell us, Dr. Joye, about your study regarding the subsea oil sediment blizzard.

Dr. JOYE. Dr. Reddy has published on this as well. One of our original hypotheses was that there would be sedimentation of oil due to bacterial processes. The bacteria that degrade oil are renown for their ability to excrete mucous, really sticky, heavy, exopolymers, that help them essentially emulsify the oil and make it more bioavailable.

The unfortunate side of that is this stuff is sticky, and sediment particles, other organisms, it sticks to that material and makes it sink. It sinks like a stone, hundreds of meters per day. This material can get from the top to the bottom within a week, and it contains residual weathered oil.

We first found these deposits in August 2010 near the wellhead. They were as thick as five to 10 centimeters, as you go away from the wellhead, they thinned out, but these deposits were essentially everywhere that we looked. We have been tracking them for the past 5 years. In many places, if you put them side by side from 2010 to 2015, you would not be able to tell which were collected in 2015 or in 2010 because they are not going away.

Senator NELSON. How far out from the wellhead did you find that?

Dr. JOYE. Our most far field sample, I believe, was around 70 kilometers or so from the wellhead. Again, it is a huge area. One of the issues is you cannot possibly sample the entire area. It is so heterogeneous, as Dr. Reddy said, we are never going to know how much oil is on the sea bed, because there is just no way to physically sample it properly.

Senator NELSON. As we are researching in the future to try to determine the health of the Gulf as a result of this four to five mil-

lion barrels of oil spill, what are we going to look for other than the obvious, the food chain, the critters? What are we going to look for?

Dr. JOYE. The benthic impacts of sediments of oil are multiple. One is cold water corrals, for example, that were essentially wiped out because of oil sedimentation. Benthic invertebrates were wiped out in areas of high oil sedimentation.

The things you can look for in terms of long term impact, this material is not just sitting on the bottom, it is getting immobilized, it is getting re-suspended, and it is moving around, and it still contains a significant level of polycyclic aromatic hydrocarbons which are toxic.

The movement of this material could perpetuate its impact on benthic ecosystems. There are many bottom dwelling fish and organisms that live in the Gulf of Mexico. Anything that relies on the bottom as a food source or habitat could be potentially damaged by this material.

Dr. KINNER. Senator Nelson, might I follow up on that?

Senator NELSON. Please.

Dr. KINNER. I think one thing that we would credit the great state of Florida for is that some of this work was pioneered by researchers in Florida. Dave Hollander, for example, at University of South Florida.

The key question of what these scientists have found is how would we use that information in a future response, either in the Gulf or for Senator Sullivan in the state of Alaska.

If you have another spill, what does this sedimentation process mean. I think the question here is if we have oil in either the surface water or deep down and you have some kind of particulates, for instance, in Cook Inlet, if you have a lot of sediment in the water, or if you have this biological phenomenon in the Gulf during the spring, you are going to bring potentially a certain amount of that oil down to the bottom.

That is something that responders need to think about and factor in when they think about the tradeoff's in response. I think that is a great example of how research can impact the response we do in the future and the tradeoff's responders have to make and factor in.

That is where this scientific collaboration really would work. Another great example that both Dr. Reddy and Dr. Joye brought up is this question of flow rate. If we had a scientific network that responders could talk with scientists beforehand and say here is the situation we are worrying about, a blow out scenario, we could get scientists thinking ahead of time and say how would you measure the flow rate, and a dialogue would ensue, and I think we would have realized much more quickly that was a lack of what we knew in response.

Those are just a couple of examples, Senator.

Senator NELSON. I will just say in closing that we had to raise cain to get the pictures 5,000 feet below. Once we got that streaming video, and we actually put it up on my website, then you scientists could look and start making calculations. Whoa, this is a lot more than what was originally thought.

I will just say in closing that we had the Coast Guard Commandant here in the last couple of days. There are a lot of lessons learned about how to handle an emergency. I personally think it has to be a military command structure with a clear line of authority, since you have emergency conditions that are happening every day. It is a war zone out there.

I think there were quite a few mistakes made in that regard. Thank you.

Senator RUBIO [presiding]. Senator Peters?

STATEMENT OF HON. GARY PETERS, U.S. SENATOR FROM MICHIGAN

Senator PETERS. Thank you, Senator Rubio. Thank you to the panelists for the discussion here today.

We are looking at the fifth year anniversary of the oil disaster in the Gulf, but this could also be, this coming July, the fifth anniversary of another major spill disaster that occurred in my home state of Michigan, where we had a six foot break in a pipeline that resulted in over a million gallons of heavy crude oil, which overwhelmed the Kalamazoo River, that has been the most expensive pipeline break on shore in the history of this country, well over $1 billion has been spent in clean up. They are still working aggressively to complete that project.

One of the most troubling aspects of the disaster is it took 18 hours before a utility employee reported the spill and the pipeline company learned of the spill into the waters.

Unfortunately, as I am sure all of you will agree, failures in pipeline oversight have become the norm, not the exception. Last week, in fact, there was an article here locally in *Politico* that showed the gaping holes that we have in pipeline safety regulations.

We had the Commandant, as Senator Nelson mentioned, of the Coast Guard here earlier. I asked him specific questions about an issue that I am particularly concerned about, and that is pipelines that we have in the Great Lakes, particularly after the pipeline break we had in the Kalamazoo River.

It would be absolutely catastrophic to have a pipeline break in the Great Lakes. We currently have a pipeline that goes through the Straits of Mackinac, a little over five miles of beautiful Lake Michigan and Lake Huron water. It is a pipeline that is nearly 60 years old. It is operated by the same company that had the pipeline break that has resulted in a major disaster on our shore, and there are other pipelines.

Dr. Kinner, I appreciated your earlier comments that we need to be looking at these other areas. I would argue that the Great Lakes is particularly troublesome given the fact of not only the recreation and other activities but we have tens of millions of people who drink the water of the Great Lakes. This is a depository of most of the world's fresh water.

If you would comment on a spill in the Great Lakes, Dr. Kinner, Dr. Reddy, Dr. Joye. The Commandant from the Coast Guard mentioned that if we had a spill in the Great Lakes, it would be even more problematic because some of the microbes that exist in the ocean do not exist in fresh water. He also needed to review some

of the response plans which he was not able to comment on at least immediately, although I am sure they have some.

If you could comment as to how comfortable you feel having pipelines in one of the largest bodies of fresh water in the world, and what are some of the unique challenges we may face in the Great Lakes, and what are things we need to be thinking about particularly as we look for reauthorization of PHMSA and other legislation in the future. I will start with you, Dr. Kinner.

Dr. KINNER. Thank you very much, Senator. The key difference that I see, and there are response plans certainly for that region—the key difference that I see is one of the tools right now would be out of the toolbox of response, and that is dispersants, because dispersants are not really functional in fresh water. That tool, which was quite valuable and obviously has some utility in the Gulf, is not available.

There is research being done to work on that, but that would make it very, very difficult if you had high wind and wave conditions, for example, and we know the Great Lakes can be very, very dangerous, that would be very difficult to recover that oil, and it could be quite problematic.

I think that is one thing that troubles me more than anything else, how we would respond. Mechanical recovery is great, but it does not work well if you have very stormy conditions.

Senator PETERS. Dr. Reddy?

Dr. REDDY. Senator Peters, I could not agree with you more. In fact, I actually am no longer going to do any more research on the *Deepwater Horizon* in the Gulf of Mexico. We are in fine hands with Dr. Joye and others.

I believe the future of oil spill science is with Bakken oil spills and dilbits, like what happened in Kalamazoo, and I am currently working on the Bridger pipeline release that was in the Yellowstone River on January 17.

To make an example, Bakken oil spills, which is probably then newest source of oil to the United States and North America, there is not one published paper on a Bakken oil spill in the United States.

As much as we know about the Gulf of Mexico and the baseline knowledge, it pales in comparison to future oil spills, and I might even be so frank as to say that we are particularly lucky because NOAA and the Coast Guard and other responders are outstanding and did a fantastic job after the *Deepwater Horizon,* and they are battle hardened for marine spills.

I do not think we have the same level or experience in land spills, so in many respects, we have a lot of work to do. I think your concerns are validated.

Senator PETERS. In the Great Lakes in particular.

Dr. REDDY. Throughout these areas where we have pipeline movement of these new types of products, whether it is Bakkens or dilbits or other products.

Dr. JOYE. I am in total agreement. I see this as a huge issue in terms of response, Federal response and natural ecosystem response. The microbiology of oil and gas is not nearly enough known in marine systems. When you go to fresh water, there is quite a

bit of data on groundwater, but not in surface fresh water systems. We do not really know how those systems are going to respond.

Many of these lakes have been very well characterized in terms of the basic biology and microbiology, but in terms of hydrocarbon dynamics, there is next to nothing known about how the systems would respond to a major infusion of oil, and that is a tremendous data gap that needs to be filled.

Senator PETERS. Thank you for your comments. Very troubling and something we have to pay very close attention to. Thank you, Senator.

Senator RUBIO. Thank you. I am going to skip my turn in interest of time because I know everyone is anxious to hear from the Prime Minister. Senator Klobuchar?

STATEMENT OF HON. AMY KLOBUCHAR, U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Thank you very much, Mr. Chairman. Thank you. I just want to follow up a little bit, Dr. Reddy and Dr. Joye, being in a state right next to North Dakota, where it has really been in many ways a good thing that we have gotten some more domestic oil, but we have also seen all the trains and some spills.

What kind of scientific research exactly do you think would be helpful? I know you talked about the effect on fresh water, and how do we get that research going so we know and make good decisions as we move forward?

Dr. REDDY. I do not even know where to start to be frank because there is such little knowledge known. For example, every oil is different. Oil has different personalities and characteristics and these dictate their behavior. Ultimately we have not had a full comprehensive examination.

If we are going to keep talking about health, we have not done a physical on some of the products that are being moved in your backyard. In order for us to even start to make plans, we have to get a good understanding of the behavior and the chemistry of oil spill science and Bakken oils.

Bakken oil has been well characterized and there are excellent studies by the United States Department of Transportation in the last year. That is about looking at whether or not there is an explosion. There is much less known about the behavior of oil.

I would start off by saying let's investigate our patient, get an idea as to the behavior, and then we can make the most well informed decisions about how to put our assets in place in future research.

Senator KLOBUCHAR. Very good. I wanted to go back to some of the other spills and what has happened. There has been legislation that has been passed since then. Mr. Williams, do you think these policy changes—I am thinking of the *Exxon Valdez* spill—has these policy changes resulted in reduced incidents and safety improvements?

Mr. WILLIAMS. I think absolutely. All these were great tragedies and the focus has to be on how we can continuously improve. I agree we have to be ready for a response, but we have to be really focused on prevention as well.

I think all the focus that is put on prevention and improving prevention, like the things we are doing on safety and environmental management systems and making those more effective in prevention are extremely important as we move ahead. We have to learn and improve and do the prevention and also be ready for the response.

Senator KLOBUCHAR. Thank you. One of the concerns that we had with the Gulf spill was just the effect on migratory birds. We have over a million, if you can believe, water fowl, in Minnesota, including loons, ducks, geese. I remember we were really concerned about their nesting grounds and what is going to happen when they are headed down to the Gulf of Mexico. Our state bird is a loon.

What has been the spill's long-term impact on migratory bird habitat? I guess I would ask one of the three of you, whoever wants to take it. Dr. Joye?

Dr. JOYE. I can take a shot at that. I have done quite a bit of work in coastal ecosystems. In the marshes of Louisiana, there are still some fairly devastating impacts of the *Deepwater Horizon.* There are places in Barataria Bay where if you looked at it, it would appear to be fresh oil, shows upon the marsh banks. This is a continuing impact on avian populations in those areas that are impacted.

Some marshes are fine, some marshes are not. It is very splotchy, very heterogeneous, and it is the same along the Gulf Coast. Some places were hardly impacted, some places were heavily impacted. The coast of Louisiana took a very, very hard hit, and it is going to take a very long time for that oil to get completely out of the system.

I remember a colleague of mine was telling me recently that they had set up a project, a monitoring program, about four years ago, and some of their control plots at the time were free of any visible oil. They took sediment cores, there was no oil there. Everything looked fine.

Two years later, their control plots were covered in oil and had become completely transformed from a natural control to a very contaminated site. That is what the animals that inhabit these marshes are dealing with. The system is still changing 5 years after the incident.

Senator KLOBUCHAR. Thank you very much.

Dr. KINNER. Senator, I would like to just follow up on that if I could. I think Dr. Joye is right on, but I think the other thing as I said in my remarks and in my testimony is when an oil spill happens, very bad things happen. Tradeoffs have to be made. That is one of the primary reasons why dispersants were used, to minimize as best as possible the impact on the near shore and coastal habitats. You cannot eliminate the impact because it is so much oil. You are trying to minimize that damage.

Senator KLOBUCHAR. Mitigate it, that is right. Thank you very much.

Senator RUBIO. Senator Markey?

STATEMENT OF HON. EDWARD MARKEY, U.S. SENATOR FROM MASSACHUSETTS

Senator MARKEY. Thank you, Mr. Chairman, very much. Congress has still failed to put in place the safety reforms recommended following the *Deepwater Horizon* disaster, the independent Blue Ribbon BP Spill Commission gave Congress a grade of D+ on its legislative response to the spill.

More than 5 years after the spill, we still have not enacted key drilling safety reforms such as significantly raising the liability cap for an offshore spill and increasing civil penalties.

Dr. Joye, Dr. Reddy, can you speak to that and whether or not—good to see you both again, and welcome to the Committee. Your recommendation on those issues, D+ from an independent commission really does not give any great reassurance that we are going to be protected.

Dr. JOYE. I think one way to move forward in a very positive way that would benefit both industry and the response side of this problem is to form an academic response network that is well integrated into the National Incident Command that works with Federal responders.

I think that many of the issues that were faced and the challenges that were faced in the response to the *Deepwater Horizon* by both the Federal side and the academic side was just incredibly poor communication between Federal responders and academic responders.

Academics have a lot to offer. We have a lot of system knowledge. We have a lot of expertise, and that should be fully taken advantage of, and it was not.

Senator MARKEY. Should Congress take action to make sure the spill recommendations are put in place?

Dr. JOYE. Absolutely.

Senator MARKEY. OK, great. Dr. Reddy?

Dr. REDDY. I could not agree more. Furthermore, I would like to make sure that credit is due to you, Senator Markey, because in many respects while you were a Congressman, you actually paved the way, and you broke down many of these walls that led to what I think is a much better place now between academia and responders.

It was a big problem at the beginning of the spill, and certainly you broke down these walls, and I think we are in a much better place.

Unfortunately, scientists always say three things, we wish we had more time, we wish we had more money, and we are not quite sure. In this case, I would say that in order for us to grease these wheels and to get academia and response working more closely together where I think we have great synergistic effects, we are certainly going to have to grease these wheels and provide more funding that in many cases was outlined in the President's Commission.

Senator MARKEY. Dr. Kinner, do you want the recommendations of the BP Commission to be implemented?

Dr. KINNER. Absolutely. I think they are critical. I think the other thing——

Senator MARKEY. Do you think it is critical for Congress to act to put them in place?

Dr. KINNER. Yes, sir. What I think also to follow on with what my colleagues have said, it is not only critical to have the academic community interacting with responders during a spill, but I think it is critical before a spill.

I think now is when we should be having responders talking more with scientists and getting into the issues. Science has a lot to bring to the table. It could be brought to the table now. It is too chaotic during a spill to be discussing what is going on.

It is thinking ahead of time, here is a spill, as the Senator from Michigan and Senator from Minnesota pointed out, here is a spill that could occur in the Great Lakes. What are the issues we would face? How could we deal with them?

Senator MARKEY. The same issues that the BP Commission are recommending that we implement.

Let me ask you this, natural gas, right now it is not counted in terms of release and when there is a calculation for fines, should natural gas be included in terms of potential damage? Dr. Joye?

Dr. JOYE. In my opinion, absolutely. It has an ecosystem impact. It should be included without question.

Senator MARKEY. Dr. Reddy?

Dr. REDDY. I could not agree more.

Senator MARKEY. Dr. Kinner?

Dr. KINNER. Yes.

Senator MARKEY. Mr. Williams?

Mr. WILLIAMS. I think the key thing is to really look at the gaps, and when you find gaps, close the gaps.

Senator MARKEY. Should natural gas be included?

Mr. WILLIAMS. I do not have a comment or position on that. Thank you.

Senator MARKEY. OK. Thank you. Just one final question. The BP is saying there has been no significant long-term population level impact to species in the Gulf. Do you believe that is accurate or is that just a premature overstatement of a conclusion that cannot yet be determined? Dr. Joye?

Dr. JOYE. I disagree with that statement.

Senator MARKEY. Great. I am going to run out of time. Dr. Reddy?

Dr. REDDY. I believe it is premature and I would rather be in the long game of science to make sure we get everything in place before we can really hammer out what we know and what we do not know.

Senator MARKEY. Thank you. Dr. Kinner?

Dr. KINNER. I do not think we know yet.

Senator MARKEY. That is great. Thank you, Mr. Chairman.

Senator RUBIO. Thank you. Senator Ayotte?

Senator AYOTTE. Thank you, Chairman. Thank you all for being here. Dr. Kinner, I wanted to follow up based on my recent visit, where I had the opportunity to visit the Coastal Response Research Center, and ask you as we address the challenges of preventing spills and also properly responding to spills, to protect the environment and to really use the best means available in technology, how at the Center have you had discussions with the private sector and worked with the private sector as we look at really their responsi-

bility and their piece in this of using the best technology to prevent spills and also if we have one, of properly responding?

Dr. KINNER. Yes. I think we really as the Center, and as you know, the Center focuses on bringing together all stakeholders, so we bring industry to the table.

I am sure you remember my little circle pin. We bring everybody to the table. They all have an equal seat at the table, and industry is very important in that mix, because industry, as Mr. Williams mentioned, is the group that is going to implement changes.

We can legislate changes. We can have requirements. They are the ones who have to implement them. We do bring industry to the table in our discussions.

For example, I was just mentioning a bit ago about if there was a spill in the Great Lakes, we need to be developing dispersants that work in fresh water. Industry is certainly a partner there and they are working on that.

I am not saying we should just take what industry does without any kind of evaluation. I think they are a big player here, and they have spent quite a bit of money on research. Those researchers are valuable parts of the community of researchers to discuss these problems.

I think they are important to bring to the table.

Senator AYOTTE. Thank you for that. I just want to understand, because I see this as we all have a piece in this, making sure that we are using the best practices and then also responding properly going forward.

I know you had a forum that was hosted and really brought not only public sector research, industry groups together last fall, and wanted to get your insight of what the discussion and conclusions were of that forum that we might be able to use as policymakers as we address these issues.

Dr. KINNER. Yes. I will say all of my colleagues up here were at that forum.

Senator AYOTTE. They are happy to jump in, too.

Dr. KINNER. We have taken away basically three messages from that. The first is the concept of involving academics and scientists in thinking about how to improve response. My colleagues have talked a little bit about that.

As I mentioned, I think it is more than just interacting during a spill, it is getting those dialogues going and those evaluations happening before spills to think about the new types of threats we face.

The second thing, and I think this is really important, is thinking about communication. We have a real problem of communicating with the public during a spill, prior to a spill, et cetera. The *Deepwater,* we saw that. We see that continuing today with the kinds of spills, with the energy renaissance.

To that end, as you know, we are having a forum where we are bringing together folks from the media and folks from the government and folks from industry to talk about how we can prepare for communications that are more effective ahead of spills, and what kinds of communication strategies, what will the media bring that are issues that we have not dealt with.

The third thing, as you know, Senator, and helped us sponsor last week, bringing the best people to the table to brief congressional staff, and I know several people were at our briefing last week, about the latest and important issues that we as a community see developing.

Those are three things. Thank you, Senator.

Senator AYOTTE. Thank you.

Dr. REDDY. I would take home one message from that meeting. Commandant Allen said do not exchange business cards during a crisis. That is certainly a lesson learned.

Last week, I was lecturing in a marine pollution class at the United States Coast Guard Academy for cadets who will be graduating this year. I could have talked about science to them. Instead I talked to them about how they were going to play a critical role in the future of oil spills.

At the end of the day, I tried to give them a lesson in sociology and about different cultures, and that ultimately they are going to interact with a wide range of different stakeholders. I told them when they get stationed, instead of exchanging e-mails, I think quite frankly that a cup of coffee and exchanging e-mails is going to save many miles of coast line.

We have to not only start to, but we have to recognize that it is an important median to build relationships before a spill.

Senator AYOTTE. I thank you all for sharing your testimony today. I have to say with many of the crises we face and challenges, this seems to be a take away, that you cannot be exchanging business cards at the time when you have a crisis situation.

I think that is a good lesson for us to take, not only in this context, and hopefully we can help facilitate your work there, but in every context as we respond to challenges in communities and also for our environment. Thank you.

Senator RUBIO. Thank you. Senator Sullivan?

STATEMENT OF HON. DAN SULLIVAN,
U.S. SENATOR FROM ALASKA

Senator SULLIVAN. Thank you, Mr. Chair. I want to thank the panelists. This is a very important issue that you are shedding light on. I think we all struggle in many ways with the issue of certainly mitigating risk to human live, as we saw in the Gulf. Also, to the environment, and while maintaining the opportunities that we have in the energy sector, whether it is robust jobs, great opportunities, energy security.

Of course, you know in my state you see a lot of that. We struggle with a lot of that. They are very, very important issues. We are very proud of our record in Alaska, some of the highest standards on the environment and protection literally in the world.

I have had the opportunity to be in other parts of not only the country but the world, Russia, Azerbaijan. The standards do not even come close to what we have in Alaska, the highest.

At the same time we have significant opportunities. You mentioned Cook Inlet. We have a jobs boom in Cook Inlet, a basin that was considered a dead basin a couple of years ago is now providing enormous opportunities, energy, jobs, and exports for this country.

I think we all know this is a critical issue that we need to balance. I appreciate all the work that you all have done on this issue.

Let me just start with a quick question. I think a lot of times we get the sense, particularly in the Federal Government, that one size can fit all, on these issues. As you know, there are many, many different types of basins, many different types of resources.

I will give you one example. We were talking about the *Deepwater Horizon.* There was, of course, a Gulf moratorium that Secretary Salazar put on the Gulf during that time. He also slapped a moratorium on Alaska that summer, which I thought as Attorney General of the state was not legal. Two very, very different scenarios, 100 feet of water in the OCS off the coast of Alaska, 6,000 feet in the Gulf. They put a moratorium on us anyway.

Do you agree that we should be looking at these issues not as one size fits all but very, very particular given the different basins, different challenges that we have in different regions of the country? Mr. Williams?

Mr. WILLIAMS. I think there has to be a framework, obviously, but I think it is absolutely key, and that is one of the principles we work on in the Center for Offshore Safety, that you have to plan, identify hazards, build barriers, manage your program all to address the circumstances of where you are.

The real key to preventing incidents is this planning and continuous monitoring around the circumstances and conditions in which you are going to have to operate.

Senator SULLIVAN. Thank you. Dr. Kinner, do you have a thought on that?

Dr. KINNER. Yes. I think that is correct, but I think we can take some resources and knowledge that we have from other areas and help it inform how we do work.

I will give you an example. During the spill in the Gulf, there was a common operating picture called "ERMA," the Environment Response Management Application, that NOAA used, and there was even a public site, that was actually a resource for all sorts of environmental data coming in and being a home for that data where responders and the public could look at it and scientists.

That application has been applied in your state, but it takes a different kind of application because, for instance, in the Arctic, there may not be connectivity during a spill with the Internet, which in the Gulf is much, much easier.

A stand-alone version of ERMA had to be developed. These kinds of things sometimes do have some overlap, but they need to be tailored to the unique situation, as you pointed out, sir.

Senator SULLIVAN. Great. Thank you. Let me ask another question, you raised the issue of the Arctic. I think one take away that hopefully is positive, hopefully you would agree, that the level of cooperation between government and industry has changed in a positive direction since the *Deepwater Horizon* spill.

I do not know if any of you have seen the National Petroleum Council's recent study on the Arctic. To me, this is to Secretary Moniz, this is a good example of industry, science, academics, all collaborating on an important issue, Arctic oil and gas development and potential.

Have you read this report and do you agree with the recommendations? Mr. Chairman, I would like to submit for the record the summary. This is a very large study that was recently released to Secretary Moniz.

Senator RUBIO. Without objection.

[The information referred to follows:]

ARCTIC POTENTIAL: REALIZING THE PROMISE OF U.S. ARCTIC OIL AND GAS RESOURCES

Committee on Arctic Research
Rex W. Tillerson, Chair
National Petroleum Council 2015

The executive summary of the report can be found at *http://npcarcticpotentialreport.org/pdf/AR-Executive__Summary-Final.pdf*

Senator SULLIVAN. Mr. Williams?

Mr. WILLIAMS. No, I actually have not read that report.

Senator SULLIVAN. It would be interesting to see what you believe after reading this study, maybe we can follow up with questions for the record, if you agree with some of these recommendations in this study.

Mr. WILLIAMS. I will. Thank you.

Senator SULLIVAN. Dr. Kinner?

Dr. KINNER. Yes, I have looked at the report, sir, and I think one of the key things that is important to point out here is not only the Federal Government and the state government and the industry working together, but also to involve especially in your state the Alaskan Native knowledge and the Alaskan Native culture that is so important to how we would respond and the impact a spill would have in the Arctic. I think that is a real key.

Senator SULLIVAN. I agree with that.

Dr. REDDY. Senator, I saw a presentation about it but I have not read the report. I would love to go back to your other question about lessons learned. It is like buying a house, location, location, location. Alaska is not as conducive to responding to oil spills as the *Deepwater Horizon.*

In fact, I have an ongoing research project studying the *Exxon Valdez,* and I can tell you I can find fresher less weathered oil from the *Exxon Valdez* than I can in the *Deepwater.*

Senator SULLIVAN. But 100 feet of water is not 6,000 feet of water.

Dr. REDDY. No.

Senator SULLIVAN. There is no reason for an Arctic moratorium.

Dr. REDDY. No, my point is I am very concerned that we use one size fits all.

Senator SULLIVAN. Me, too.

Dr. REDDY. And that we have to recognize in how we put our assets in place with the limited infrastructure that you have in place in the Arctic so we can use and tailor what we know from these very small studies that we have done in the last 25 years, and not use what we used in *Deepwater Horizon.*

Senator SULLIVAN. I think this study has a lot of the issues that we are looking at in my state certainly. Thank you very much, Mr. Chairman.

STATEMENT OF HON. MARCO RUBIO,
U.S. SENATOR FROM FLORIDA

Senator RUBIO. Thank you. I thought I saw Senator Blumenthal. Stand by.

I think what I will do for the record while I wait for Senator Blumenthal, I had a statement I was going to enter into the record, and I will just enter it verbally.

I wanted to thank all of you for being here to discuss one of the most devastating events that happened to the Gulf of Mexico and the states that border it.

I do think first and foremost today we should pay tribute to the 11 souls who lost their lives on that tragic day, their families and friends are in our thoughts, especially today as we reflect on the past 5 years and on the need to assure other Americans do not suffer the same fate.

This oil spill in April 2010 had an impact on small businesses that rely on fishing and tourism dollars, and that impact has been tremendous. The event happened during the busy time for my state's beaches and local economies along the Gulf coast and felt the blunt of it. Hotel reservations were canceled, restaurants sat empty, and those vital tourist dollar plummeted.

Coupled with what I believe were the Administration's actions to close 88,500 square miles of the Gulf to fishing, 131,000 jobs that were supported by $12.8 billion per year, were negatively impacted.

The environmental impacts were also widespread. An estimated 4.9 million barrels of oil flowed through that habitat that is home to more than 15,000 species. Wildlife washed ashore covered in oil, marshes which serve as a habitat for wildlife suffocated and died, and deep sea coral colonies showed signs of tissue damage.

The term "blowout preventer" was on everyone's tongue while live underwater shots of oil spewing into the waters of the Gulf was happening. For 87 days, the Nation watched and waited for a fix.

Today, we have been hearing from you about how technology has evolved to address the shortcomings of that well. Innovations and equipment design and important changes to response measures will hopefully prevent another catastrophic event, and technological advances have also been made to address any remediation necessary as quickly and effectively as possible.

I am encouraged by this progress made through ongoing recovery efforts, and I am even prouder of the resiliency of the communities, the businesses, and the people that were impacted.

I am pleased, as Senator Nelson highlighted earlier, that the RESTORE Act money is finally being made available to continue the recovery efforts on the ground.

I want to again thank all of you for your insight here today. I look forward to a continued dialogue on these issues. Senator Blumenthal?

STATEMENT OF HON. RICHARD BLUMENTHAL,
U.S. SENATOR FROM CONNECTICUT

Senator BLUMENTHAL. Thanks, Mr. Chairman. Just very briefly before we close the hearing, as you know, there was a joint investigation by the Department of Homeland Security and Interior in

April 2010 which revealed, and I quote, "Numerous systems deficiencies and omissions by the *Deepwater Horizon* crew as well as poor maintenance of equipment, ignoring alarms, and lack of training personnel."

In 2012, two years after these recommendations were issued, Shell had to significantly roll back drilling plans in the Alaskan Arctic because of several accidents and missteps that revealed the company was ill prepared to be drilling in the harsh conditions of the Arctic, and had not been taking safety precautions serious enough.

Let me just ask Mr. Williams, has the oil and gas industry in your view heeded the lessons of the Gulf disaster and the subsequent recommendations from this investigation and others in its activities in other parts of the world?

Mr. WILLIAMS. Yes, sir. I think if you look at the Center for Offshore Safety, it was set up as a place where we could collaborate and learn together, and learn these lessons on how we could improve safety management.

The industry in general, I think one of the key changes that I mentioned is how we came together and made new industry standards and made new systems for subsea containment, and have worked together to improve this.

The key thing is looking at safety management systems, not only are we learning and looking at how we can improve safety management, but we are also measuring it, so we get measurements that feed back into this continuous improvement of how to make it better.

Also, if you do the SEMS' audit, you have to have a mandatory action plan to address any findings that are found in the audit. There is also this system of measurement and oversight that leads to improvement also.

Senator BLUMENTHAL. Is there adequate collaboration among the companies?

Mr. WILLIAMS. Yes, sir. That is why really the Center for Offshore Safety was created, so we have this one place that is entirely focused on safety, where we can come together, share learning, share data, and share good practices and develop good practices together to do that.

Senator BLUMENTHAL. But is that adequate?

Mr. WILLIAMS. Sir?

Senator BLUMENTHAL. Can more be done?

Mr. WILLIAMS. Always more can be done. That is what our focus is, our focus is on doing the audits, doing the learning from incidents, and seeing if there are gaps and opportunities. If they are, what are the good practices that can close them. We are going to continuously look at that and continuously learn and address that.

Senator BLUMENTHAL. Is there anything that Congress should do to assure even greater collaboration or greater preemptive and proactive action?

Mr. WILLIAMS. What I would say again is I think the best thing to do is now that we have data and we are collecting data, lots of people are collecting data, we have the government reports and the industry reports, look at the activities now, look at what needs to be done. If there are gaps or opportunities for improvement, let's

close those gaps and make those improvements in the best manner that we can.

Senator BLUMENTHAL. Have you identified gaps that exist now?

Mr. WILLIAMS. We have improvement items that we have already seen from the first set of audits and from our first annual report. It is around things like making sure that we have more effective processes, making sure people follow those processes, looking at station keeping, so the good news is we found these things we know we need to work on and we set up task groups and we are working on it, and we are going to develop the good practices to help the industry get better in those areas that we have seen.

Senator BLUMENTHAL. Did you have——

Dr. JOYE. I just want to make a comment. John Amos, who runs the SkyTruth program, released a report last week that pointed out that since 2010, there have been 9,800 hazardous materials spills in the Gulf of Mexico. I think that is a number that we all need to keep in mind.

The other thing I wanted to point out is that in 2004, the energy platform sank after Hurricane Ivan. That platform was producing 26 wells, nine of the wells have been plugged, the other 16 are still leaking oil into the Gulf of Mexico. That has been ongoing now for almost 11 years and it has not been dealt with.

Situations like that should not be allowed to proceed, and I think in cases like that, legislation is needed to force the responsible party to deal with and seal those wells so there is not a perpetual discharge of oil and gas into nearshore waters.

Senator BLUMENTHAL. Do you have a response, Mr. Williams?

Mr. WILLIAMS. Absolutely. Our goal is zero spills and zero accidents, and we work hard to achieve that goal every day, and want to learn and put all our efforts into that goal.

Certainly, any of these is a tragedy, and the key is to do all we can to be prepared and prevent these, and then if in the regrettable circumstance that we have one, to have the proper response to mediate it as best as possible.

Senator BLUMENTHAL. I guess what I am driving at is what specifically can and should be done to address the kind of problem that we just heard that seems to be ongoing. Dr. Joye has raised it very specifically. I think there is a need to consider specific action.

Mr. WILLIAMS. Like I said, we have worked on standards. We have worked on response systems. What I work on, and what I think the key focus has to be is you have to have planning, you have to have execution, you have to have the skills and knowledge in the staff, you have to have the business processes, especially how you manage change going forward, and those all have to be effectively and continuously done and monitored, that it is all being done well.

That is where the focus really should be, in safety and environmental management systems, making those effective and continuously working.

Senator BLUMENTHAL. My time has expired.

Dr. KINNER. Senator, might I just make a quick comment as a follow-up? I think this kind of dialogue is exactly what I was talking about in my testimony. What we really need to do is get people

like John Amos together with people from industry and really talk about the details and talk turkey about these situations.

Lots of times, just this kind of back and forth in the media or in one conference or another is not really moving the problem forward, and that is what I am talking about, really to focus on the details of what is this data showing, what might the situations be, et cetera. Those are all the important questions, but they are not well discussed in a media forum.

Senator BLUMENTHAL. Good point. Thank you, Mr. Chairman.

Senator RUBIO. I want to thank all four of you for being here today, for your testimony, for your time.

Before we adjourn, on behalf of the Chairman, I want to enter two letters into the record. One is from the Gulf of Mexico University Research Collaborative dated April 28, 2015, and the other is from the Louisiana State University Office of Research and Economic Development dated April 28, 2015.

I enter the second letter despite the fact that LSU will be routinely humiliated by the University of Florida on the football field.

[Laughter.]

Senator RUBIO. We will enter them into the record without objection.

[The information referred to follows:]

GOMURC

GULF OF MEXICO UNIVERSITY RESEARCH COLLABORATIVE

April 28, 2015

The Honorable David Vitter
858 Convention Street
Baton Rouge, LA 70802

Subject: Statement related to Senate Committee on Commerce, Science, and Transportation hearing, *Five Years After Deepwater Horizon: Improvements and Challenges in Prevention and Response.*

Dear Senator Vitter,

We wish to provide a statement for the record associated with the April 29, 2015, Committee on Commerce, Science, and Transportation hearing, *Five Years After Deepwater Horizon: Improvements and Challenges in Prevention and Response.*

Universities from the five U.S. Gulf of Mexico states initiated state-based research consortia over the past two decades. In 2010, in the wake of the oil spill, these consortia joined to form the Gulf of Mexico University Research Collaborative (GOMURC) intended to promote large-scale, long-term science and education initiatives required to address Gulf ecosystem-wide stressors such as hurricanes, oil spills, and climate change. GOMURC continuing priorities and recommended actions for 2015-2016 for promoting successful ecosystem recovery efforts include:

- Support Relevant, Meritorious Science and Technology Development: ecosystem restoration must be based on the "best available science"; all restoration programs use independent, expert peer review and science-based requirements to select projects, and treat ecosystem restoration projects as science experiments with appropriate monitoring and research.
- Support Ecosystem Research, Observing, and Monitoring Capabilities: Environmental monitoring at the project- and ecosystem-scale is required to evaluate restoration efforts, for baselines needed to assess long-term impacts, and to prepare for future events; over 80% of projects funded to date do not support any environmental monitoring. All restoration funding programs need to leverage plans and capabilities to support the required system.
- Coordinate Restoration Science Programs: Gulf restoration will involve dozens of programs and thousands of projects, many with overlapping objectives. Coordination among programs is currently mostly informal. Best practices include: conceptual model to identify gaps and fund priorities, recovery community of practice to promote engagement, and unified data and information management system.
- Support Syntheses and Assimilation: Damage assessments need to include

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non-market ecosystem services, such as protection of life and property afforded by green infrastructure; values are required to explain the true worth of Gulf natural capital, for NRDA, and to credit responsible parties for related restoration costs. Restoration project findings need to be assimilated in a Gulf-wide status report of ecosystem recovery, prepared and vetted by experts and adapted to new results. A regional capacity should be established to support this outcome, again cost-shared by all restoration program partners.

- Economic and Work Force Development: Science-Technology-Engineering-Mathematics (STEM) education programs are required to teach secondary school educators and students, and to train and prepare the skilled workforce required to support ecosystem restoration and long-term sustainability. All restoration programs dedicate support for secondary school and university level activities, including infrastructure, experiential learning opportunities, curriculum development and access, internships, fellowships, graduate and post-doctoral programs.

First responders live near the disaster and are the most critical element in mitigating damages. Immediate response has to be urgent, while accounting for factors that dictate caution, such as public safety and not causing more harm than good. In the case of the Deepwater Horizon disaster, initial response was from academic institutions, which immediately shared their results and data in open and unprecedented ways. The latest OCS oil and gas lease blocks sold in the eastern Gulf are tens of miles from the Deepwater Horizon well site. We rely on and need to maintain the research capacity of Gulf academic institutions, and education of the next generation of scientists and engineers required to support Gulf recovery and response to future events.

Sincerely,
GOMURC Board:

Dr. William T. "Bill" Hogarth, GOMURC Board Chair
Director, Florida Institute of Oceanography (FIO)

Dr. John Valentine, GOMURC Board co-Chair
Executive Director, Alabama Marine Environmental Sciences Consortium

Dr. William "Monty" Graham
Chair, Department of Marine Science, University of Southern Mississippi, Mississippi Research Consortium

Dr. Larry McKinney, Executive Director, Harte Research Institute, Texas Research Consortium

Dr. Christopher F. D'Elia, Dean, LSU School of the Coast and Environment, Louisiana Universities Gulf Research Collaborative

830 First Street South, Suite 128, St. Petersburg, FL 33701, ph: 727-553-3374 http:/www.gomurc.org

Alabama Marine Environmental Sciences Consortium, Florida Institute of Oceanography, Louisiana Universities Gulf Research Collaborative, Mississippi Research Consortium, Texas Research Consortium

LSU

Office of Research & Economic Development

April 28, 2015

The Honorable David Vitter
858 Convention Street
Baton Rouge, LA 70802

Re: Senate Committee on Commerce, Science and Transportation Hearing, *Five Years After Deepwater Horizon: Improvements and Challenges in Prevention and Response*

Dear Senator Vitter,

Louisiana State University is pleased to provide the following statement to be read into the record for the April 29, 2015 hearing in the Committee on Commerce, Science and Transportation on *Five Years After Deepwater Horizon: Improvements and Challenges in Prevention and Response*

The Deepwater Horizon oil spill of April 2010 resulted in serious impacts to oceanic and coastal ecosystems and human coastal communities, and also stimulated an unprecedented scientific and engineering response involving networks of scientists from across the gulf coast and beyond. LSU in particular has been deeply involved in the scientific, engineering, and human impact aspects of the Deepwater Horizon oil spill. As a major research institution situated in the gulf coastal region in the state that received the most damage from the spill, LSU and our inter-institutional network of gulf researchers have been heavily involved in studying the effects of this event on our home territory. At last count, more than 65 LSU investigators spanning more than 20 academic units were funded to study a wide variety of problems related to the oil spill. These include:

- Studies focusing on the complexities of capping sub-sea wells, facilitated by the faculty at the LSU Petroleum Engineering Research and Technology Transfer facility
- Studies of the fate and transport of oil and dispersants, including visualization of the fluid dynamics involved, using remote sensing satellite technology to monitor surface movements of the oil, studying the behavior of dispersants at different salinities/pressures/temperatures, and using synchrotron radiation to study the degradation of oil and dispersant over time
- The deepwater impacts of the oil spill using remotely operated vehicles to conduct deep sea imaging of zooplankton, experimental studies on fish fauna, and studies of microbial community responses
- The shallow water and coastal impacts such as developmental toxicity in embryos, seafood exposure, and the effects on coastal wetlands and marshes such as the differential effects of oiling on dominant vegetation, impacts on the food web, and prospects of bioremediation
- The human health impacts in terms of psychosocial responses to the oil spill, tracking of community resilience over time, impacts on business owners, and citizen decision making during the context of a disaster.

The results of these studies have not only documented the impacts of the spill, but also fundamentally advanced basic scientific and technological understanding of a variety of complex problems. This expanded knowledge base will be put to good use and expanded upon even further when future

adverse events take place. Research institutions situated in the gulf coast are the most well positioned to study the impacts of events such as the Deepwater Horizon. The deep local knowledge of the unique conditions of the Gulf of Mexico combined with decades of prior scientific data on which to build future studies cannot be matched. The scientific and technological expertise of gulf coast researchers should always be consulted and pressed into service when future disasters occur in this region.

Sincerely,

Kalliat T. Valsaraj

Kalliat T. Valsaraj
Vice President, Research & Economic Development

Senator RUBIO. Again, I want to thank all of you for being a part of this. The hearing record is going to remain open for 2 weeks, so we are going to ask Senators to submit questions for the record. During that period of time, we would ask that if you receive these questions that you would submit the written answers to the Committee as soon as possible.

Again, thank you for being a part of this today, and with that, the hearing is now adjourned.

[Whereupon, at 11:08 a.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARCO RUBIO TO CHARLES (CHARLIE) WILLIAMS II

Question. Mr. Williams, I recognize the importance of oil and natural gas development in the U.S. and the positive impact that it has on our economy. I also recognize that we must be vigilant and continue to learn and improve. I understand that the Center serves the U.S. offshore oil & gas industry with the purpose of adopting standards to ensure continuous improvement in safety and offshore operational integrity and I truly respect that. Can you describe what the Center is doing to coordinate and share what industry has learned and what the process is to do that?

Answer. Safety is a core value for our industry, and in recent years, the oil and natural gas sector has made substantial improvements to the safety of offshore operations and drilling. The industry has revised existing standards or created new ones to guide the design, construction and integrity of deepwater wells, blowout preventers, subsea capping stacks and many other aspects of offshore exploration and production and established the Center for Offshore Safety (COS) to ensure continuous improvement in safety and environmental protection.

The Center for Offshore Safety (COS), launched in 2011 to promote the highest level of safety for offshore drilling, completions, & operations by effective leadership, communication, teamwork, utilization of disciplined safety management systems, independent third-party auditing & certification, and monitoring continuing improvements, released a first-of-its-kind annual report in 2015 to measure safety performance, compiled from industry data and independent third-party audits.

Additionally, COS develops guidelines and best practices to help companies embed a strong culture of safety into all their operations. It is important to understand that safety culture is not a checklist. Safety culture is a daily decision by companies and their employees to choose safety first in everything they do.

COS has created tools to assist companies in building or enhancing safety and environmental management systems, and three COS guidelines have been adopted by the Bureau of Safety and Environmental Enforcement (BSEE) into its own regulations. In 2015, BSEE also formally recognized COS as the first and only organization with the authorization to accredit Audit Service Providers who conduct the BSEE-required Safety and Environmental Management System audits, which are required for all offshore oil and gas operators.

An important component of SEMS is the ability to assess and measure its effectiveness and continually improve as well as sharing SEMS knowledge. COS will continue to gather and use the information in its annual reports to develop data-driven improvements and good practices as part of our mission to promote the highest levels of offshore safety.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARCO RUBIO TO CHRISTOPHER M. REDDY, PH.D.

Question. Dr. Reddy, it is great to hear that the tide has turned, so to speak, for the government to be inclusive to the academic community and I hope that cooperation continues and you and your peers are able to fill gaps the various government agencies have. As far as local response, I have heard in the past from Floridians that a nationally led team is not the most efficient way to prepare for a spill to reach the shores. Can you tell me about your experience on the ground, working with local governments and officials?

Answer. In my near 20 years of responding and studying the fate and impacts of marine-based oil spills, I have had very few interactions with local and state officials. I have never participated in any planning exercises, worked closely during a spill event, or had a direct line of communication with local officials. When I have had such interactions (summarized below), it is during general public discussion of

interested parties, unofficial briefings, acts of courtesy for accessing an impacted area, or updates months/years later during the damage-assessment phase.

However, it has been my experience and understanding that local and state officials do interact with Federal responders by attending planning meetings, participating in drills, and coordinating/sharing assets during spill events. For example, two weeks ago, I was invited to brief the Southeastern New England Area Region command response group, which included Federal (Coast Guard, NOAA, EPA, Homeland, Interior) and state environmental officials. Before my presentation, I observed collegial and earnest exchanges as each group provided updates. This group appeared to share a unified goal of reducing damages during a spill (or preventing a bad one from getting worse). After the meeting, I was invited to participate in all future meetings. In addition, state representatives for RI and MA invited me to give presentations within their teams. This is certainly evidence that "tides are changing" and suggests that during future spills there will be a greater chance for academics to be more involved with both Federal and local officials.

Attending meetings and an occasional brief is certainly encouraging, but funding would create richer and more fruitful relationships amongst state and local officials and academia. One of the key lessons learned from the *Deepwater Horizon* disaster stated by former NOAA administrator, Dr. Jane Lubchenco, was that NOAA had the greatest benefit from tapping academic talent from past and pre-existing relationships fostered by prior extramural funding and coordination. While states continue to struggle with difficult budget environments, small investments in cultivating state and local relationships with the public and private academic spill response communities has the potential to provide significant benefits and reduced impacts when such events occur.

I will conclude by stating the obvious, it should not be a matter of local versus national during environmental incident response, which by their nature know no borders. Rather it must be a coordination of local, who understand their water ways and issues the best, national, who may have years of experience in spills across the country, and academia who can provide fact based *in situ* information for those teams to coordinate better responses. Therefore, supporting academia in participating with these groups before, during and after an incident, is crucial.

Christopher Reddy's involvement with state and local officials prior to, during or after oil spills:

Presentations that included local and state officials in the audience:

- Reddy, C.M. *An update on the Bouchard 120 oil spill.* New Bedford Whaling Museum, New Bedford, MA, May 3, 2003. Presentation. Invited.
- Reddy, C.M., *Chemistry and weathering of the oil. Cosco Busan* Oil Spill Technical Workshop January 25, 2008. Oakland, CA (Presentation). Invited.
- Reddy, C.M. *Hunting for subsurface plumes in the Gulf of Mexico after the Deepwater Horizon Disaster.* Are we in DEEPWATER? Applying Lessons Learned from our SONS Experiences, March 22, 2011, Portsmouth, NH (Presentation). Invited.
- Reddy, C.M. *An argument for better aligned relations with academia and the oil-spill response community.* Southeastern New England Area Region command response meeting. Massachusetts Maritime Academy, Massachusetts Maritime Academy, Bourne, MA, October 21, 2015. (Presentation). Invited.

Briefings, workshops, and testimony:

- Testified on oil spills for Joint Committee on Natural Resources and Agriculture, State of Massachusetts, Boston, MA. May 25, 2004.
- Advised Massachusetts Dept. of Environmental Protection on spills of alternatives fuels and lubricants, Boston, MA. Mar. 13, 2007.
- Advised city, state, and Federal officials following the *M/V Cosco Busan* oil spill in San Francisco Bay (Nov. 2007).
- Participant in *Research & Development Priorities: Oil Spill Workshop,* The Coastal Response Research Center, U. of New Hampshire (Mar. 2009); included state representatives
- Briefed Lt. Governor Elizabeth Roberts (Rhode Island) and Emergency Management Council on oil spills, Warwick, RI, August 10, 2010.

Access to field samples with help from state officials:

In 2012 upon request from me via e-mail, Mr. Garrett Graves (LA/DNR) arranged for a boat to access an oiled salt marsh (from the *Deepwater Horizon*).

Assisting state officials during a natural resource damage assessment:

I worked with the Rhode Island Department of Environmental Management (Summer/Fall 1997) on the toxicity of oil released during the *North Cape* spill (coast of Rhode Island; January 1996). I had found that the oil was more toxic than thought and communicated it in several talks to diverse audiences. Only the Rhode Island officials, months later, acted upon it, leading towards an additional 1.5 million dollars added to the damage settlement for Rhode Island. I received numerous honors for this work including one from the Honorable Lincoln Almond (Governor of Rhode Island).

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