Gulf of Mexico

Oil Spill
& Ecosystem
Science Conference

2018
REPORT

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James D. Watkins Student Award for Excellence in Research

For 2018, five students who gave outstanding presentations were recognized with the James D. Watkins Student Award for Excellence in Research. Sponsored by the Consortium for Ocean Leadership and Gulf Research Program of the National Academies of Sciences, Engineering and Medicine, the award helps cultivate the next generation of ocean scientists.

The student recipients are:

Smruthi Karthikeyan (Georgia Institute of Technology)
Macondimonas diazotrophicus: A Novel Hydrocarbonoclastic Gammaproteobacterium as a Potential Biomarker for Ecosystem Recovery from Oil Spills

Rebekka Larson (University of South Florida)
High-Resolution Sedimentary Record of the Deepwater Horizon Event: Impacts and Recovery

Jesse Ross (University of New Hampshire)
Detection and Monitoring of Oil by Snare

Samantha Setta (Texas A&M University at Galveston)
The Interaction between Phytoplankton and Bacteria Responding to Oil and/or Dispersants

Nicholas Turner (Nova Southeastern University)
Toxicity of Oil to Americamysis bahia and Deep-water Column Micronekton with Comparisons to Model Predictions

EXCELLENCE IN PARTNERSHIP AWARD

The conference also hosted the National Oceanographic Partnership Program's (NOPP) Excellence in Partnering Award, which is given annually to a NOPP project that best exemplifies the program's objective of developing a successful network of partnerships to advance the ocean sciences. The 2017 award recognized the Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, and Archaeology Project (GOM-SCHEMA) led by Dr. Leila J. Hamdan (University of Southern Mississippi) and Melanie Damour (Bureau of Ocean Energy Management). GOM-SCHEMA's 11 partners investigated the impact of oil exposure on historic shipwrecks from the microscopic to the macro scale during a four-year period and the subsequent recovery of these sensitive deepwater habitats in the Gulf of Mexico. The GOM-SCHEMA team gave an *oral* and a *poster* presentation as part of the scientific program.

2018 STUDENT PRESENTER SUPPORT

Bringing professional development opportunities to students has become a hallmark for the conference, as evidenced by the continued support for student presenters. The Gulf of Mexico University Research Collaborative; Harte Research Institute; and Gulf Research Program of the National Academies of Sciences, Engineering and Medicine provided student presenter support, covering registration fees for all student presenters.

Students and early-career scientists were also encouraged to volunteer as session organizers and made up about half of the organizing teams.

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GULF RESEARCH PROGRAM

EXECUTIVE SUMMARY

CONFERENCE OVERVIEW

Since its inception in 2013, the Gulf of Mexico Oil Spill & Ecosystem Science Conference (GoMOSES) has sought to link fundamental research on the Gulf ecosystem to practical application. The _2018 theme_, "**Response, Restoration, and Resilience in the Gulf**," continued this trend, exploring how fundamental science can help restore and maintain Gulf ecosystem integrity, inform response strategies, and strengthen resilience. After years of research targeted on the ecosystems and processes unique to the Gulf of Mexico, what has science taught us about response, restoration, and resilience in the region? How can we translate scientific discovery and advances to inform scientific understanding on an ecosystem scale? What do resource managers and policymakers need to assure the economic and environmental sustainability of the Gulf? This year's program also emphasized cross-cutting discussions among academics, industry, government agencies, and public interest organizations.

The conference was planned by an Executive Committee of 13 partners representing academia, federal agencies, and non-governmental organizations, with the generous support of two major sponsors.

An overview of the conference schedule is available in Appendix I (page 42). Program highlights include:

- Keynote address by Dr. Geraldine Richmond, Presidential Chair in Science at the University of Oregon;
- Opening plenary presentations by Ann Hayward Walker (SEA Consulting Group), Robert Twilley (Louisiana Sea Grant Program), and Larry McKinney (Harte Research Institute for Gulf of Mexico Studies);
- 24 conference sessions and 7 mini-sessions offering approximately 310 oral and 135 poster presentations; and
- Closing plenary panel discussion on the future of the GoMOSES Conference after 2020. A summary of audience feedback is provided on pages 6-7.

The conference also hosted over 20 associated workshops, meetings, and events during the week, offering attendees the opportunity to learn about and discuss interdisciplinary topics not covered during the breakout sessions. Many of these meetings emphasized collaboration among a variety of sectors, demonstrating the conference's role as a community-building platform. A summary of each meeting and its outcomes (if available) are provided in Appendix II (page 46).

The GoMOSES Conference was pleased to once again host the Gulf of Mexico Data Tools Café, which offered attendees a hands-on opportunity to learn about data management and analysis tools currently available. The 13 featured tools are listed in Appendix III (page 50).

The conference communications staff worked with partner organizations and universities, as well as local media outlets, to leverage networks and broaden the conference's reach through traditional and social media. A full report of communications activities is available in Appendix IV (page 54).

SCIENTIFIC SESSIONS

To further facilitate interdisciplinary and inter-sectoral collaboration, abstract submissions were accepted generally, and teams of experts developed the scientific program based on the following topical tracks:

- Gulf Ecology
- Physical and Chemical Connectivity
- Monitoring, Data Management, and Analysis
- Science for Response
- Science for Restoration, Management, and Policy
- Social and Ecological Resilience

Many key messages arose during the sessions to inform response strategies, restoration planning, and managing for resilience:

RESPONSE

- The response community is better positioned to understand the fate and transport of oil from a blowout, as well as the implications of subsea dispersant application, thanks to improved models and a better understanding of oil droplet dynamics, microbial responses, and the impact of chemical dispersants.
- Environmental conditions (sunlight, temperature, oxygen, pressure), as well as oil composition, will impact how different oil compounds distribute in the water column and how they degrade in various ecosystems. Sediment studies of the 1979 Ixtoc I oil spill show that weathering of coastal residues continues over years, via photooxidation and aerobic degradation, to a high-sulfur endpoint.

- Partial oil-photooxidation is the dominant photochemical degradation pathway of DWH surface oil, producing large amounts of a complex mixture of oil compounds within a short time. This substantially reduces dispersion effectiveness, which has implications for the window of opportunity for aerial dispersant application. Further, because these compounds are typically not detected by commonly used analytical methods, their chemical composition and toxicity are not well understood.

- UV-enhanced toxicity of oil to early life stages of estuarine species highlighted that estuaries naturally have multiple stressors, such as UV light and higher water temperature, that can worsen oil toxicity. Understanding the impacts of relevant environmental stressors in combination with crude oil exposure is useful in providing more accurate assessments of pelagic fish population-level impacts of Gulf oil spills.

- The chemical dispersant Corexit has a significant impact on marine snow forming aggregates, decreasing microbial diversity and bacterial growth needed for degradation, as well as changing the behavior of oil in seawater. Alternatives to chemical dispersants, such as food grade surfactants and alternative delivery systems, can enhance bacterial degradation and can be used in nearshore areas.

- Freshwater outflows can act as natural booms. Planned, restoration-focused river diversions are significantly larger in volume than diversions used for DWH, which may make this strategy effective in the future but not without consequences, including increased nutrient loading and significant ecological costs.

- The effects from oil contamination in heavily oiled marshes of Louisiana persisted for four to five years. The diversity of microbiomes associated with the dominant saltmarsh plant, *Spartina*, decreased with oiling. *In situ* burning is a viable option for cleaning oiled marshes and may encourage dominance of native marsh plants over invasive species, such as *Phragmytes*.

- An important yet underdeveloped field of oil spill science is understanding how fishers and other resource users adapt to sudden, massive-scale changes induced by regulatory measures imposed to achieve public health and conservation goals. Expansion of fishery closure boundaries should be based on observed and modeled oil distributions at the surface as well as modeled subsurface oil distributions.

- First responders and policy makers may benefit from including Community Health Workers on emergency management teams and from designing more nuanced disaster response and management strategies that address multiple dimensions of oil spill-related resource loss, since individuals experience oil spill impacts differently.

RESTORATION

- Restoration is a complicated process for many reasons—complex and interconnected systems; scale; the number of players involved; and biological, ecological, and social components.

- Restoration programs in the Gulf of Mexico have moved past co-existing and communicating and are now cooperating and coordinating. Whether at the federal, state, or local level, it takes time and effort to build relationships, but these are a prerequisite for collaboration. However, the diverse mandates for each of the programs will likely prevent them from being fully integrated with respect to funding and planning.

- There is a need for collaborative projects linking research and management requirements for effective and efficient data collection that can be used for assessment of restoration efforts of marine mammals, as well as other species and ecosystems.

- Most oil spill-related environmental impacts occur from chemicals released into the air and water, where they undergo oxidation and other chemical biological molecular interactions. Impacts from oily residues are mainly due to coating and smothering.

- Stable isotope analyses are an excellent example of a tool that can be used across taxa to trace the incorporation of petroleum hydrocarbons into planktonic food webs and to monitor long-term trends.

- It is important to acknowledge how the resilience (or lack thereof) of some nearshore ecosystems to the DWH oil spill and how other natural or human-induced environmental changes influence the success of restoration efforts aimed at speeding the pace of recovery.

RESILIENCE

- The dichotomy between "natural" and "technological" disasters may be inappropriate, given that natural events like earthquakes and tornadoes often include technological impacts, including oil spills.

- Having an interactive feedback loop is important; building a programmatic framework and adaptive management process across multiple scales saves time and money, gets to better outcomes when done correctly, and should be standard practice.

- Scientists' ability to communicate their science to those beyond individual scientific "silos" is of *mutual benefit*. Stakeholder groups benefit from gaining a scientific understanding of Gulf resilience and how related issues affect their own lives and work; researchers benefit from thinking about why and how their work matters to others and how to communicate and measure impact beyond funding dollars and journal articles. These exchanges help build societal trust in science.

- Biophysical modeling has shown that keystone species have different connectivity networks and therefore will react differently to perturbations such as oil spills.

- Freshwater discharge generates a stratified system containing intermediate water with a low suspended sediment load, making it a biologically important zone for larval species.
- Water column stratification factors have been used to understand hypoxia formation west of the Mississippi River plume. New work east of the plume indicates a combination of freshwater discharge and subsurface currents can generate prime physical conditions for an eastern dead zone.

A number of science gaps and challenges were also identified during the sessions and plenaries.

RESPONSE

- Conveying the messages that 1) no two spills are alike, and 2) research should focus on how to prepare for and respond to future spills, is paramount. Whether oil spill research can inform response strategies in hypoxic zones and other specific Gulf environments is a key consideration.
- Improving connections between field data and modeling efforts for a more holistic understanding is a continuing need. This is especially apparent in understanding oil fate and its overall effects and impacts, as experimental scales may not be realistic. In order to have realistic experimental conditions in the laboratory, researchers should consider collaborating more with industry and government organizations.
- Modeling a large-scale well blowout/oil spill event is still challenging, due to the accumulation of uncertainties from each individual process.
- Dispersing oil with Corexit can increase the total mass of nano-aerosol particles, resulting in an increase in human health risks. Response worker environmental safety information is still evolving and needs more research and technology development to meet human health and safety needs, have reasonable costs, and be readily available. Real-world applicability and scenarios of the use of alternatives to chemical dispersants and health risk assessments are lacking.

RESTORATION

- The big challenge remains: How do we roll up the results from individual restoration projects into an assessment of the impact of all restoration projects on the ecosystem? A focus on synthesis within the science community may be the answer.
- Improvements to recently developed data tools will hopefully lead to better data and science driven decisions that will improve the restoration and management of Gulf resources.
- A better understanding of interconnectivity and spatial processes and how they affect ecosystem health, as many factors influence changes in a trophic web over time, is needed. A long-term, multi-faceted approach, across disciplines, is necessary to collect standardized data that can be used to provide insight into impacts from stressors, disentangle natural variability from oil spill impact and recovery, and identify best management practices for restoration strategies.
- The need for a robust adaptive management approach was stressed as a mechanism for moving forward with restoration despite the challenges and uncertainties presented by habitat needs at different life stages, dynamic and changing environments, and limited information and data.
- Efforts to conserve and rebuild offshore, and especially pelagic, resources remain a challenge for damage assessment and mitigation. It is still unknown if the benthic community recovered (or will recover) to the original species composition or if it now exhibits an entirely new one, due to the lack of baseline data availability.

RESILIENCE

- The Gulf-based science community should not only be reactive (restoration) but also proactive and forward thinking (conservation and resilience). Innovation is needed, and a shift from pure research to restoration alone may not be enough.
- Development of baseline and reference sites continues to be a necessary component to better understand the impacts of DWH and other stressors.
- A system of deep ocean observations comprised of sensors at the surface with direct connections to deep sea bottom monitoring stations, tethered sensors, and autonomous underwater vehicles provide an excellent platform for a wide array of research applications.
- Identification and standardization of sampling methodologies across taxa are key to assessing population trends over time.
- More research is needed to understand how incorporation of oil into marine snow impacts marine ecology, as marine snow is a food source for many planktonic and benthic animals.

Abstracts for *oral* and *poster* sessions are archived online. Full session summaries are available in the report (pages 10-39).

INTRODUCTION

The Gulf of Mexico Oil Spill and Ecosystem Science (GoMOSES) Conference is an ideal forum, organized by institutions and agencies working in the Gulf, for the exchange of ideas and information among stakeholders to the benefit of the region. Since its inception in 2013, GoMOSES has sought to link fundamental research to practical application and to engage a broad range of Gulf researchers and coastal managers addressing advances in oil spill response and ecosystem restoration. The 2018 theme, "Response, Restoration, and Resilience in the Gulf," advanced this goal, exploring how fundamental science can help restore and maintain ecosystem integrity and inform response strategies. This year's program also emphasized cross-cutting discussions about how research can help strengthen resilience in the region's ecosystems and communities in light of the many pressures on Gulf resources.

The 2018 conference included a broad range of findings across key areas of research and built on highlights of previous conferences. The opening plenary examined what science has taught us about response, restoration, and resilience. These lessons were further explored in 24 scientific sessions, featuring approximately 320 oral and 130 poster presentations over three days. This year, the program included seven mini-sessions focused on emerging and cross-cutting topics that deserve attention. The conference closed with a look inward at its own resilience, as members of the Executive Committee discussed future scenarios and sought input from attendees as GoMOSES continues to evolve.

OPENING PLENARY

THE THREE R'S OF GULF RESEARCH: RESPONSE, RESTORATION, AND RESILIENCE

Keynote

Mulling Over Emulsions: Interfacial Molecular Structure and Adsorption at Oil-Water Interfaces

Geraldine Richmond, Ph.D., Presidential Chair in Science, University of Oregon

Following the keynote address, three speakers commented on the current state of science in their respective focal areas, assessed how GoMOSES science has contributed to our understanding of the Gulf of Mexico, and expanded on what challenges remain to be addressed.

Topical Speakers

Response: Real-time Decisions Informed by Best Available Knowledge
Ann Hayward Walker, Founder and President, SEA Consulting Group

Value Proposition of Monitoring Ecosystem Restoration Projects: Case Studies of Adaptive Management Frameworks
Robert Twilley, Ph.D., Executive Director, Louisiana Sea Grant College Program

The Resilient Gulf of Mexico: Will It Continue to Snap Back?
Larry McKinney, Ph.D., Executive Director, Harte Research Institute for Gulf of Mexico Studies

CLOSING PLENARY

THE FUTURE OF GOMOSES: MAINTAINING MOMENTUM – SEEKING SYNERGY

Members of the GoMOSES Executive Committee explored how to evolve the conference while retaining the essence of what has become one of the most important and successful science meetings about the Gulf of Mexico. Because many of the decisions involved depend on potential attendance, questions and comments from the audience were strongly encouraged. Questions specific to post-2020 conferences were included in the post-conference attendee survey; results are included here.

Discussion Panelists:

- Laura Bowie (Moderator), Gulf of Mexico Alliance
- Chuck Wilson, Ph.D., Gulf of Mexico Research Initiative
- Libby Fetherston-Resch, Florida RESTORE Act Centers of Excellence Program
- Larry McKinney, Ph.D., Harte Research Institute for Gulf of Mexico Studies
- Evonne Tang, Ph.D., Gulf Research Program of the National Academies of Sciences, Engineering, and Medicine
- Christopher D'Elia, Ph.D., Louisiana State University

Based on audience comments during the closing plenary, there was general consensus that GoMOSES fills a niche and provides a valuable networking platform that supports the mutually beneficial exchange of science and information between sectors. The conference is known for bringing together different scientific disciplines, and there is no other alternative for Gulf-focused science. GoMOSES provides state agencies the opportunity to hear about new and emerging science and incorporate it into fundable—and hopefully funded—restoration and resource management projects. It fills a void for the oil spill response arena and has raised its profile. Regional and local participants on response teams are now following scientific advances presented at GoMOSES, and academic involvement in response efforts has increased. The conference also allows for many workshops and side bar meetings, bringing together various groups who may not otherwise have the opportunity to meet in person.

Should it change focus?

The Gulf of Mexico is a multi-stressed region with many complex challenges, and integrated science is needed to inform holistic approaches to meeting these problems. Making data available and usable for those "on the ground," broadening the scope of the conference to include more disciplines, and opening up to neighboring Gulf countries are also essential. Oil spill research should remain a part of the program so that the emphasis on science and its integration in preparedness and response is not lost. However, it is logical for the program's emphasis to shift toward restoration, since after 2020, funding sources and priorities will also move from oil spill science to restoration science and resource management.

The panel also debated the frequency of GoMOSES. Research cycles may not align with timelines for an annual conference; perhaps GoMOSES should convene biennially. However, broadening its focus to include more topics might warrant an annual event.

GoMOSES should consider opportunities to work with other conferences and preserve a meeting focused specifically on the Gulf rather than become a session at a larger conference. Collaborations could also avoid topical overlaps and competition for attendees. Potential partnerships include the State of the Gulf Summit, GOMA All-Hands Meeting, CERF 2019, State of the Coast (Louisiana state-level meeting). The Alaska Marine Science Symposium, a legacy of the Exxon Valdez oil spill, could be a model for GoMOSES in the future.

Financial sustainability

Financial support from the community will be essential to the continuation of the conference. The GOMRI Research Board may provide funds to GOMA to finance future conferences and to help with contractual risks. GOMA supports the interaction between state resource managers and restoration science coming out of GoMOSES and would be willing to combine their All-Hands Meeting with the conference. The RESTORE Centers of Excellence are interested in providing financial support; this is dependent on linking to their priority disciplines, per U.S. Treasury Department guidance, and is contingent on the support of the state entities that issue Centers of Excellence research grants. Members of the oil and gas industry would like to see the conference continue in a financially and programmatically sustainable manner.

Community participation is equally important, as sponsors only want to commit funds to an event that many are interested in attending. GoMRI-supported researchers are currently required (or at least strongly encouraged) to attend, and funding is provided in their grants. This contributes to the current high attendance rate and could serve as a model to other funding programs moving forward. Conference planners should consider how attendees are funded to attend future conferences. Not all institutions have the resources to send people to a meeting, especially students. Student scholarships would help with this.

Key results from survey

A section of the 2018 attendee survey was dedicated to the future of GoMOSES to collect attendee preferences for key planning considerations. Most people who have attended GoMOSES before (82.3 percent) feel that the conference has improved over time, and 96.3 percent of survey respondents would consider attending again. The conference should convene every other year (55.9 percent) in early February (85.6 percent), avoiding Mardi Gras, AAAS, or Ocean Sciences. Pre-conference workshops received overwhelming support (90.7 percent). Most attendees (58.4 percent) would like GoMOSES to change locations within the Gulf; suggestions include:

- **Biloxi, MS**
- **Cancun, Mexico**
- **Galveston, TX**
- **Gulfport, MS**
- **Havana, Cuba**
- **Houston, TX**
- **Mobile, AL**
- **New Orleans, LA**
- **Tampa/St. Petersburg, FL**

SESSION ORGANIZERS, SESSIONS, AND SUMMARIES

Over three days, approximately 310 oral and 135 poster presentations (including 88 oral and 67 poster student presentations) discussed recent findings and advances in oil spill research. The Executive Committee thanks the 2018 session organizers and program leads(*) for their time, expertise, and dedication to review and arrange abstracts and to moderate this year's sessions.

GULF ECOLOGY

Brian Balmer (National Marine Mammal Foundation)

Ariella Chelsky (LUMCON)

Joel Kostka (Georgia Institute of Technology)

Ed Mager (University of North Texas)

Frank Parker (NOAA RESTORE)

Christina Pasparakis (University of Miami)

Isabel Romero (University of South Florida)

Patrick Schwing (University of South Florida)

Tracey Sutton (Nova Southeastern University)

Yadong Wang (University of Miami)

Chuck Wilson (Gulf of Mexico Research Initiative)*

MONITORING, DATA MANAGEMENT, AND ANALYSIS

Sandra Ellis (GRIIDC)

Amy Merten (NOAA ORR)

George Graettinger (NOAA)

Dave Reed (Florida Fish & Wildlife Conservation Commission)

Lauren Showalter (Gulf Research Program of NASEM)

Lisa DiPinto (NOAA ORR)*

PHYSICAL AND CHEMICAL OCEANOGRAPHY

Arezoo Ardekani (Purdue University)

Christoph Aeppli (Bigelow Laboratory for Ocean Sciences)

Laura Bretherton (Mount Allison University)

Roseanne Ford (University of Virginia)

David Hollander (University of South Florida)

Helga Huntley (University of Delaware)

Aprami Jaggi (University of Calgary)

Laura Lapham (University Maryland Center for Environmental Science)

Erin Pulster (University of South Florida)

Caitlin Young (NOAA RESTORE)

Denis Wiesenburg (University of Southern Mississippi)*

SCIENCE FOR RESPONSE

Christopher Barker (NOAA ORR)

CJ Beegle-Krause (SINTEF Ocean)

Anusha Dissanayake (University of Georgia)

Chris DuFore (BOEM)

Osman Karatum (Duke University)

Tamay Ozgokmen (University of Miami)

Suzanne Smith (Amazon River Dolphin Conservation Foundation)

Scott Socolofsky (Texas A&M University)

Robyn Conmy (U.S. EPA)*

SCIENCE FOR RESTORATION, MANAGEMENT, AND POLICY

Melissa Carle (NOAA Restoration Center)

Rebecca Green (BOEM)

Liza Hernandez (NOAA ORR)

Rachael Heuer (University of Miami)

Julien Lartigue (NOAA RESTORE)

Christine Mohrman (Gulf of Mexico Alliance)

Steve Murawski (University of South Florida)

Eilzabeth Fetherston-Resch (Florida RESTORE Act Centers of Excellence Program)*

SOCIAL AND ECOLOGICAL RESILIENCE

Becky Allee (NOAA OCM)

Melissa Finucane (RAND)

Rajeev Ramchand (RAND)

Tim Slack (Louisiana State University)

Laura Bowie (Gulf of Mexico Alliance)*

For the 2018 program, oral sessions were developed based on the abstracts received. Although many sessions are interdisciplinary, they were organized under six topical tracks representing key areas of research identified by the planning committee. Session moderators submitted summaries at the conclusion of their respective sessions; these are included in one of the six topical tracks:

GULF ECOLOGY

- Role of Microbes in the Response and Resiliency of Gulf Ecosystems
- Characterizing Crude Oil Exposure and Effects: From Molecular to Whole Animal Approaches
- Gulf-wide Impacts, Recovery and Connectivity of Marine Invertebrates in the Context of Oil Spills and Environmental Variability
- Offshore fishes: Deepwater Horizon Oil Spill Research from the Shelf to the Deep Ocean
- Development of Sampling Techniques and Identification of Indicator Species to Assess Coastal Ecosystem Health and Recovery in the Northern Gulf of Mexico
- Microbial Communities at Depth

MONITORING, DATA MANAGEMENT, AND ANALYSIS

- Northern Gulf of Mexico Marine Mammals: Baselines, Trends, Threats, and New Methodologies
- Remote Sensing Assessment of Surface Oil and Related Ocean Observing
- Innovative Mainstream Designs

PHYSICAL AND CHEMICAL CONNECTIVITY

- Dispersants: Disruption or Facilitation of Oil Degradation?
- Sedimentary Evidence for the Fate of Oil
- Hydrocarbon Transformation Processes and Products at the Sea Surface
- Currents, Winds and Waves: Moving Oil in the Gulf of Mexico
- Microbial Processes at Oil-Water Interfaces
- Marine Snow – Formation, Chemistry, Impacts
- Impact of Freshwater Discharge on Coastal-Deep Ocean Connectivity
- The Last Mile before Landfall: Measuring Coastal Transport
- Oil Degradation in Coastal Sediments
- Oil and Gas Plumes

SCIENCE FOR RESPONSE

- Oil Spill Modeling from Droplet Formation to Risk Assessment
- Laboratory and Field Experiments and Measurements
- How's the Weathering? Oil Chemistry, Dispersants, Toxicity
- Biological Aspects and Recovery and Operational Methods
- Response Planning and Management in the International Arena

SCIENCE FOR RESTORATION, MANAGEMENT, AND POLICY

- Linking Monitoring, Adaptive Management, and Restoration at the Local, State, and Regional Scale
- Restoring and Managing Ecosystems for Resiliency: From Coastal Communities to the Deep Ocean
- Fisheries Science and Management Tools for Recovery and Restoration following Deepwater Horizon

SOCIAL AND ECOLOGICAL RESILIENCE

- Fostering Individual, Social, and Community Resources to Build Resilience to Oil Spills and Other Disasters in the Gulf
- Measuring, Understanding, and Responding to Human Health Factors in the Wake of an Oil Spill
- Let's Give Them Something to Talk About – The Importance of Communication and Public Engagement in Gulf Research

ECO-001: ROLE OF MICROBES IN THE RESPONSE AND RESILIENCY OF GULF ECOSYSTEMS

Moderators: Joel Kostka (Georgia Institute for Technology) and Ariella Chelsky (Louisiana Universities Marine Consortium)

Session Overview

Microorganisms provide key services to Gulf ecosystems (including photosynthetic production, the breakdown of organic matter, and the recycling of nutrients) and these services are impacted by oil spills. This was a wide-ranging session that synthesized observations, experiments, and modeling to elucidate the microbially-mediated mechanisms that underpin the response, recovery, and resilience of Gulf ecosystems to oil impacts. The focus was on natural microbial processes that support Gulf ecosystems and the response of these ecosystems to oil contamination. A recurring theme was the investigation of microbiomes, microbes intimately associated with macrobial hosts and their surrounding environment, from the saltmarsh to the deep sea. The consensus indicates that indigenous microbial communities were profoundly impacted by oil from the Deepwater Horizon (DWH) discharge; however, communities also proved to be resilient within time scales of one to six years.

Session Highlights

- Carbon isotope composition is an effective tracer for the incorporation of petroleum hydrocarbons into planktonic food webs. The water column overlying natural seeps in the Gulf serves as an excellent natural laboratory to test isotopic tracers. Through comparisons with areas impacted by sustained oil input from seeps, it could be shown that a pool of isotope-depleted carbon, indicative of petrocarbon, remained in microbial communities of non-seep ecosystems six years after the DWH spill.

- The microbiomes of deepsea corals were described over large scales in the Gulf. Evidence indicates that coral species select for certain microbial groups that benefit them and microbial associates include sulfur-oxidizing taxa.

- In exposure experiments conducted in the laboratory, oil was shown to have a major impact on the gut microbiome of the important Gulf fish species, red drum. *Vibrios* dominated gut microbiome communities and known hydrocarbon-degrading bacteria such as *Acinetobacter* were detected.

- In heavily oiled marshes of Louisiana, it was observed that effects from oil contamination persisted for four to five years. While overall respiration measured as CO_2 flux declined in oiled sediments, methane production remained the same or increased. The diversity of microbiomes associated with the dominant saltmarsh plant, *Spartina*, decreased with oiling. In saltmarsh sediments, communities returned to baseline after three years.

- Evidence showed that DWH oil may enhance the corrosion of steel on historic shipwrecks. This work highlighted the fact that shipwrecks are non-renewable historic resources in the Gulf that deserve to be preserved.

Identified Gaps and Challenges

From the results presented in this session, it is apparent that although GoMRI researchers have made excellent progress, large gaps remain in our knowledge of the baseline microbial communities that are essential to the functioning of Gulf ecosystems. In order to provide a predictive understanding of potential impacts to ecosystem function during responses to future oil spills, it will be essential to fill in the gaps with regard to knowledge of the activity, abundance, and diversity of indigenous microbial communities.

ECO-002: CHARACTERIZING CRUDE OIL EXPOSURE AND EFFECTS: FROM MOLECULAR TO WHOLE ANIMAL APPROACHES

Moderators: Christina Pasparakis (University of Miami) and Edward Mager (University of North Texas)

Session Overview

This session explored sublethal and lethal effects of oil exposure to Gulf organisms spanning multiple levels of biological organization, from molecular to whole animal, and concluded with a consideration of topics important for assessing community trophic-level responses.

Session Highlights

- This session illustrated well the power and significance of linking effects of oil exposure across multiple levels of biological organization for providing a more holistic understanding of the impacts of an oil spill on native species in the Gulf of Mexico.

- Biochemical indicators of metabolic responses in birds were presented demonstrating the potential for long lasting impacts in terrestrial ecosystems from marine oil spills. Evidence also indicated oxidative stress responses in native Gulf fish species; however, questions remain regarding the specific roles of lipid peroxidation, protein and transcriptional responses and nutritional status.

- At the molecular level, micro RNA transcriptional responses supported cellular, tissue and organ level cardiac and eye functional and developmental impairments observed in native Gulf fish species.

- The impacts of relevant environmental stressors in combination with crude oil exposure were also explored to address more "real-world" exposure scenarios. Specifically, UV from natural sunlight was found to alter buoyancy control and yolk utilization of developing fish embryos that was exacerbated by crude oil exposure, indicating the potential for altering dispersal and quality of hatching environment. This may have implications for reduced cohort survival than would be anticipated from standard assessments of acute mortality. Such information will be useful in providing more accurate assessments of pelagic fish population level impacts of Gulf oil spills.

- The interaction of temperature with oil exposure in shrimp was also explored. A notable lack of observed effects was postulated to be explained by the resiliency of the organism due to their naturally stressful native habitats, although questions regarding most effective dosing methods for different life stages were posed as an important issue of consideration.

- The role of tagging mahi-mahi in captivity was presented as a critical first step for parameterizing spawning behavior data to be collected from tag-and-release fish. This will set the stage for future tracking studies of individual mahi-mahi and their behavior in the wild following exposure to crude oil. Such information will shed additional light on potential population level effects related to spawning success (e,g., ability to migrate long distances to spawning areas and spawning frequencies).

- Two studies illustrating the impacts of oil exposure on fish behavior were presented. These revealed effects of increased aggression among conspecifics and reduced sociability and anti-predator behaviors related to shoaling, both of which are likely to have significant ramifications for population and community level dynamics.

- Finally, the importance of considering the role of biodiversity in trophic level interactions was explored using mixed invertebrate/vertebrate cultures. Vertebrate predator identity, rather than species richness, was found to be a key determinant of energy transfer; further, similar performance was found among monocultures and polycultures, thereby informing the design of future studies of trophic interactions of Gulf species.

ECO-003: GULF-WIDE IMPACTS, RECOVERY AND CONNECTIVITY OF MARINE INVERTEBRATES IN THE CONTEXT OF OIL SPILLS AND ENVIRONMENTAL VARIABILITY

Moderators: Patrick Schwing (University of South Florida) and Yadong Wang (University of Miami)

Session Overview

The primary goals of this session include: 1) Defining impacts to, and resilience of, GoM invertebrates, 2) Integrating understanding across seminal invertebrate communities, 3) Identifying critical data gaps in invertebrate studies and 4) Determining how to better construct cohesive spatio-temporal invertebrate impact analysis in advance of future spills (response). These goals are intended to provide meaningful and integrative baseline data products in the event of a future marine petrochemical release.

Session Highlights

- Gulf-wide baselines are being set for many invertebrate communities, which will make it possible for quantification of impact and recovery following future oil spills. Connectivity, with regards to impact and resilience of seminal invertebrate communities, is being established.
- ISIIS (Chiaverano et al.) and SIPPER (Daly et al.) zooplankton imaging systems allow for establishment of baselines and document natural variability.
- Northern Gulf benthos reached steady state (resilience, not full recovery) within 3-4 years following Deepwater Horizon. Benthic megafauna species composition remains different at the Deepwater Horizon site versus other background sites. Complete benthic community recovery may take 50-100 years following accidental submarine petroleum release. Preliminary Gulf-wide (US, Mexico, Cuba) benthic baselines have been produced, currently being refined. Family level identification of benthic macrofauna sufficient for assessing impact/response following oil spills.
- Polycyclic aromatic hydrocarbon concentrations in cephalopod tissue has increased and transitioned from pyrogenic to Petrogenic from 2010-2016. Some, high trophic level cephalopods also consume marine snow (marine oil snow cycling implications).
- New species are being discovered (e.g. Cephalopod Bathyteuthis sp. and Gastropod Brookula murawskii). Genetic barcoding allows for identification of new species, corrects existing taxonomy, determines larval/adult connectivity. Atlantic may serve as genetic reservoir for Gulf of Mexico.
- Measurement of biodiversity and biophysical connectivity are important for recovery; biophysical modeling has shown that keystone species have different connectivity networks and therefore will react differently to perturbations such as oil spills. These models can help forecast impact areas in the case of future oil spills.

Identified Gaps and Challenges

- Baselines collected prior to oil spills have, again, been the largest challenge across multiple trophic levels and invertebrate communities to fully characterize impact/recovery and disentangle those impacts from natural variability.
- Need to reach agreement on the proper terminology regarding recovery, resilience, and steady state.
- Longer-term monitoring is needed for many communities to disentangle natural variability from oil spill impact/recovery.

ECO 004: OFFSHORE FISHES: DEEPWATER HORIZON RESEARCH FROM THE SHELF TO THE DEEP OCEAN

Moderators: Tracey Sutton (Nova Southeastern University), Isabel Romero (University of South Florida), and Yadong Wang (University of Miami)

Session Overview

This session presented results of a series of studies looking at fishes affected by the Deepwater Horizon oil spill (DWHOS). Talks were given in a shallow-to-deep order, beginning with coastal fishes (with pelagic offspring) to bathypelagic fishes living seaward of the continental shelf.

Session Highlights

- Presentations demonstrated the taxon-specific nature of Deepwater Horizon, from increased parasite load in contaminated red snapper hydrocarbon content to down-regulated reproductive genes and up-regulated cellular protection genes in contaminated golden tilefish.
- Another study showed that no growth changes were observed in tilefish before or after the DWHOS, and there was no added mortality, suggesting a potential for long-term acclimation in this species.
- A novel method for creating a highly-dense linkage map using whole genome amplification of DNA extracted from eggs of individual female fishes was presented.
- Results from parallel Atlantis modeling projects studying the IXTOC oil spill and DWHOS indicated similarities between the spills and hold implications for long-term recovery prospects.
- Two papers presented key aspects of organismal biology of fishes in the DWHOS effect area. The first examined spatial isotopic trends at the community level and found that the isotopic trends result from a combination of (1) geographic variation within species and (2) geographic variation in fish community composition. The second reported fundamental aspects of common dolphinfish metabolism, with these data forming a baseline with which to measure acute stressors.
- One paper detailed the effect of mesoscale processes on epi- and mesopelagic communities, an important consideration when assessing time-series data of oceanic fish abundance.
- Lastly, two papers reported dramatic declines in fish abundances between 2012 and 2017, namely red snapper and deep-pelagic (meso- and bathypelagic) fishes in total.

Identified Gaps and Challenges

The DWHOS highlighted the need to better understand interconnectivity and spatial processes and how they affect ecosystem health. The need for long-term monitoring programs was highlighted as impacts to offshore fishes are now being reported, and biological/ecological response factors are still not fully understood.

ECO-005: DEVELOPMENT OF SAMPLING TECHNIQUES AND IDENTIFICATION OF INDICATOR SPECIES TO ASSESS COASTAL ECOSYSTEM HEALTH AND RECOVERY IN THE NORTHERN GULF OF MEXICO

Moderators: Brian Balmer (National Marine Mammal Foundation) and Frank Parker (NOAA RESTORE Science Program)

Session Overview

The focus of this session was to highlight studies across taxa that are evaluating long-term trends, prior to, during, and post-Deepwater Horizon oil spill. A common theme was the importance of linking studies with standardized sampling methodologies to provide a comprehensive assessment of trophic web dynamics. The presentations provided an excellent example of this in the Barataria Bay salt marsh ecosystem, and how the effects of a given stressor (i.e. Deepwater Horizon oil spill) may change the composition of a trophic web over time. The studies in this session also illustrated the strength of using a community-based approach to identify long-term trends in populations that can be an effective strategy to evaluating the success of restoration efforts.

Session Highlights

- To fully assess the impacts, recovery, and restoration efforts for the Deepwater Horizon oil spill, it is crucial to establish long-term monitoring programs that encompass the entire trophic web including micro algae, salt marsh plants, benthos, insect, bird, fish, and mammal species.
- Developing collaborations across interdisciplinary fields is necessary to link biological processes and determine the impacts of cumulative stressors.
- Identification and standardization of sampling methodologies across taxa is key to assessing population trends over time.
- Stable isotope analyses are an excellent example of a tool that can be used across taxa to monitor long-term trends. These results in combination with other datasets, such as genetics, fatty acids, and life history, provide a comprehensive understanding of what roles species play in a salt marsh ecosystem and insight into impacts when one or more species may be removed.

Identified Gaps and Challenges

- The greatest challenge discussed in many of the presentations is that there are many factors that influence changes in a trophic web over time. A long-term, multi-faceted approach, across disciplines, is necessary to collect standardized data that can be used to provide insight into impacts from stressors and identify the best management practices for restoration strategies.

MS-002: MICROBIAL COMMUNITIES AT DEPTH

Moderator: Joel Kostka (Georgia Institute of Technology)

Session Overview

The deep ocean represents an extreme environment for all life which is dark, cold, and exposed to enormous pressures. Oceanographic parameters, such as temperature and nutrient availability, have been studied for years as controls of petroleum hydrocarbon degradation. However, consensus has not been reached on the influence of various environmental controls, and the effects of pressure have been heavily understudied. This session squarely focused on the effects of pressure on the activity and composition of microbial communities found in deep Gulf ecosystems. Research presented here was experimental and conducted ex situ in the laboratory. Isolated bacteria, seawater, or sediments from the deep sea were incubated in pressure cells. Abundance, community composition, and activity of microorganisms was then studied in the pressure cells at pressures equivalent to 1000-1500 m water depth in comparison to atmospheric pressure.

Session Highlights

- A hydrocarbon-degrading bacterium, Rhodococcus, isolated from 1000 m water depth in the northern Gulf of Mexico, was investigated. The growth of this deep-sea strain on crude oil was similar at *in situ* pressure in comparison to atmospheric pressure. Degradation of aromatic compounds in crude oil was enhanced at elevated pressure. Dispersed oil was toxic to the growth and metabolism of Rhodococcus, and elevated pressure appeared to enhance this toxicity.

- In slurry incubations of bottom water and sediments from the northern Gulf, *in situ* pressure had only a minor impact on microbial communities. In contrast, oil and dispersant represented major selective forces on microbial communities.

- In another study conducted with bottom water and sediments ex situ, *in situ* pressure was found to accelerate hydrocarbon degradation by up to 30%. Oil and pressure both acted as a disturbance that impacted microbial richness and evenness. Statistical analysis indicated that the pressure effect was more pronounced at RNA level, suggesting the metabolically active community was more affected by pressure. Different taxa were selected by pressure, suggesting that ex situ incubations should be performed at ambient pressure to accurately investigate hydrocarbon degradation in the deep sea.

Identified Gaps and Challenges

Overall, our understanding of the growth and metabolism of microorganisms under conditions relevant to the deep sea remains in its infancy. Evidence indicates that *in situ* pressure indeed impacts microbial metabolism and should be considered in oil plume models; however, results thus far are equivocal. More studies should be conducted ex situ under as close to *in situ* conditions as possible. In addition, future investments are needed to be able to retrieve samples from the deep sea as well as conduct experiments without decompression.

MDA-001: NORTHERN GULF OF MEXICO MARINE MAMMALS: BASELINES, TRENDS, THREATS, AND NEW METHODOLOGIES

Moderators: Liza Hernandez (NOAA) and Brian Balmer (National Marine Mammal Foundation)

Session Overview

The focus of this session was to highlight previous, ongoing, and future research initiatives to study marine mammals in the northern Gulf of Mexico, and assess the impacts of the Deepwater Horizon oil spill as well as other stressors on marine mammal populations in this region. The long-term data being collected and innovative sampling methods being developed are essential to understanding northern Gulf of Mexico marine mammal population trends and their resiliency in response to the Deepwater Horizon oil spill and cumulative stressors to which these populations continue to be exposed.

Session Highlights

- Strong emphasis on the need for collaborative projects linking research and management needs for effective and efficient data collection that can be used for assessment of restoration efforts.
- Overall, data collected across various sampling methods (e.g., aerial and vessel-based surveys, health assessments, remote sampling, passive acoustics, and telemetry) suggest that the majority of marine mammal populations in the northern Gulf of Mexico have declined as a result of the Deepwater Horizon oil spill. It is essential to maintain these datasets to fully evaluate the long-term impacts and cumulative effects of the oil spill on northern Gulf of Mexico marine mammal populations.
- Development of baseline and reference sites continue to be a necessary component to better understand the impacts of the Deepwater Horizon oil spill and other stressors that marine mammals are exposed to in the northern Gulf of Mexico.

Identified Gaps and Challenges

- Large data gaps remain for coastal and offshore marine mammal populations. The development of new sampling methods and technologies will be extremely valuable to collect the data necessary to better understanding impacts of the Deepwater Horizon oil spill and evaluate the success of restoration projects.
- There is a need for additional collaborations between researchers studying the same populations and/or region to have a more comprehensive assessment of impacts, management decisions, and restoration success.
- Continuing need to improve connections between field data and modeling efforts for more holistic understanding of, for example, current population status and future projections based on changes to various potential drivers.

MDA-002: REMOTE SENSING ASSESSMENT OF SURFACE OIL AND RELATED OCEAN OBSERVING

Moderators: Lisa DiPinto and George Graettinger (NOAA)

Session Overview

This session looked at the current and emerging trends in the effort to understand the appropriate use of remote sensing for environmental monitoring, oil spill response, and damage assessment. These presentations have examined subjects such as ocean color and salinity, extent and oil characterization, fate and transport of surface oil in the near shore and open waters of the Gulf of Mexico.

Announcing Oil Remote Sensing Workshop – NASA SPIERS:

NASA will be hosting a multi-agency and industry oil spill response and assessment workshop to be held in association with the MTS / IEE Oceans 2018 October 22 – 26, Charleston, SC. Many of the topics to be covered in this workshop are common with the GOMOSES session summarized here.

Session Highlights

- Where did slicks form and when did they dissipate? A now-cast surface oil advection model compiled shoreline accumulation of oil and tracked the deposition of coastal and open water oil across time. It also showed that the use of dispersants did not stop the deposition of oil on the shoreline.
- Tracking oil transport with unmanned aerial systems (UAS) and drifters allows greater understanding of oil fate and transport and indicates that surface oil moves more quickly than previously assumed.
- Remote sensing of platforms does work and more importantly identifies platforms not otherwise cataloged. Next steps include assessing the impact that these platforms may have on the environment.
- Using SAR data allows the estimation of flux of oil to the surface and daily discharge, as demonstrated by analyzing oil slicks generated by two distinct "pits" in Mississippi Canyon 20, visible from recent sonar survey.
- Bubble size and rise factors are critical to the assessment of hydrocarbon seeps in the Gulf; seeps form natural test beds for new technology and approaches to measure and monitor seep activity.
- Shoreline salinity is not well represented in current sea surface salinity models. Using MODIS imagery produces good agreement across multiple scale satellite data. However, this approach will likely not function optimally for upwelling or algal blooms.
- How can the relationship between backscatter and salinity aid in predicting seasonal variability? Compiling regionally specific anomaly data across time to can provide the input to seasonal variation and how best to predict these trends and use them as a forecast model. This allows the creation of Nowcast and Anomaly cycles which identified seasonal forecasts of bio-physical properties, as well as locations and seasons that can impact oil UV degradation.
- Chlorophyll signals do show progression of anomalies, including long-term anomalies.
- Sensors at surface with direct connections to deep sea bottom monitoring "stations", tethered sensors as well as autonomous underwater vehicles (AUV) provide excellent sensing platforms for a wide array of applications such as reef surveys and monitoring fisheries movement.
- Frontal boundaries are where there are enhanced biological activities with significance for fisheries and oil spill transport. Using the Color Index, frontal density maps have been developed for each calendar month and climatological month. The strongest frontal boundaries occur in summer.

MDA-003: INNOVATIVE MAINSTREAM DESIGNS

Moderators: Lauren Showalter (Gulf Research Program of NASEM) and Dave Reed (Florida Fish & Wildlife Conservation Commission)

Session Overview

Innovative Mainstream Designs was convened to highlight data and tools that provide the ability to answer "big picture" questions as well as aiding decision and policy makers for response planning in the wake of a disaster.

Session Highlights

The innovative mainstream designs session hosted a wide breadth of topics from birds to whales to restoration. This variety in topics shows the interest in using technological tools to answer complex questions and to better manage data and information in a more holistic way. The large number of tools for data collection and visualization that currently exist meet a variety of different goals and will continue to be developed as technology improves. It became apparent during this session that data (in all its various forms) are very valuable. We, as a collective group working with this large amount of data, need to take the individual data points and transform those points into information. This in turn expands our knowledge and provides specific levels of insight that ultimately afford us with the wisdom needed to protect our natural resources, inform future restoration and contribute to a more resilient Gulf.

After the spill the amount of data coming in was more than current structures could manage so organizations had to work to develop user friendly tools to collect and track this inundation of data. Now that these structures are in place organizations are working to add more user friendly elements to improve data quality, usability, and discoverability. These improvements will hopefully lead to better data and science driven decisions that will improve the restoration and management of Gulf resources.

The tools presented in this session seek to address these challenges in a variety of ways. The National Energy Technology Laboratory's Offshore Risk Modeling (ORM) Platform utilizes several big data & advanced analytical capabilities to develop a suite of open-source data, tools & model to provide new data-driven insights that can help improve safety, mitigate hazards, minimize infrastructure & equipment failure, reduce costs, and prevent future spill events. The Dauphin Island Sea Lab and NOAA have developed infrastructure to manage data from a wide variety of research and restoration endeavors. These platforms have tools for metadata creation, QA/QC, visualization, and data discovery. NOAA's DIVER also functions to integrate and standardize across datasets so they can be easily queried.

Other tools like the Nature Conservancy's migratory blueways, the Gulf of Mexico Avian Monitoring Network (GOMAMN), and Banshee (Computational Aid Tool for Visualization of Acoustical Data) are being developed to better understand and track highly migratory species in the Gulf of Mexico.

Improving communication and collaboration among the developers of these tools could lead to increased usability of scientific data. The hope is that during restoration and recovery efforts planners will turn to these tools and data sources to improve decision making and allow practitioners to make decisions faster and based on the best and most up to date science.

PCC-001: DISPERSANTS: DISRUPTION OR FACILITATION OF OIL DEGRADATION?

Moderator: Erin L. Pulster (University of South Florida)

Session Overview

The Dispersant session embodied the theme of GoMOSES 2018 which was "Response, Restoration and Resilience in the Gulf" by examining the role of dispersants in response efforts, ecosystem restoration and resilience. The session entailed discussions on the interactions and impacts of dispersants on microbial response, toxicity, mechanisms of marine oil snow (MOS) formation and the impacts of varying hydrodynamic forces.

Session Highlights

Chemical dispersants, such as Corexit, have a significant impact on marine snow forming aggregates (e.g., TEP, EPS, OSA), decreased microbial diversity, and bacterial growth needed for degradation, as well as changing the behavior of oil in seawater. In addition, it has been found that OSA formation is linked to sediment grain size. In terms of human health, research has indicated that Corexit can increase the total mass of nano-aerosol particles resulting in an increase in human health risks (i.e., lung cancer). Alternatives (aluminosilicate microstructures, lecithin, tween 80) to chemical dispersants were suggested, that not only promote bacterial degradation but can be used near shore. A new conceptual model was developed in VDROP-J in order to capture the tip streaming phenomenon and will aid in predicting DSD with the use of subsurface dispersant use.

Understanding oil behavior, environmental conditions and marine snow formation is critical in understanding, even predicting, where marine snow will form and its subsequent sinking.

The results from these studies will provide essential information for oil spill responders and assist in predicting the long-term fate of oil spills.

Identified Gaps and Challenges

- Gaps in integrating previous research (prior to 2010) with more recent research.
- Experimental scales may not be realistic.
- Real-world applicability and scenarios of the use of alternatives to chemical dispersants.

PCC-002: SEDIMENTARY EVIDENCE FOR THE FATE OF OIL

Moderator: Aprami Jaggi (University of Calgary)

Session Overview:

This session characterized the physical and chemical interactions taking place at the ocean floor to better understand the sedimentary fate of oil. It discussed the resiliency of sediments in context of isotopic baseline measurements and resident microbes in the Gulf of Mexico. This session deliberated on (1) the physical properties of sediments dictating the fate of oil at the ocean floor in terms of: accumulation rates, radiocarbon age-dating and marine snow events, and (2) the chemistry of oil transformation using various mass spectrometric techniques.

Session Highlights

- The session discussed the onset of recovery of the benthic ecosystem after the three-year mark following Deepwater Horizon Spill of 2010 indicated via different environmental proxies, namely- carbon (14C) and sulfur (34S) isotopic values; redox state conditions (measured with redox sensitive metals- Rhenium and Cadmium), and planktonic foraminifera.
- The similarities and learnings from Ixtoc-1 Spill, 1979 were discussed in context of the Deepwater Horizon Spill, to better characterize the recovery and sedimentary fate of oil and MOSSFA events.
- The application of ramped pyrolysis GC-MS was discussed in the context of characterizing the chemistry of weathered oil deposited in the ocean floor sediments.
- The hypothesis of suspended particulate penetration in the oil droplet was proposed as a more fitting model for the transport of particulate organics and oil, than the deposition of the particulate matter on the surface of the oil droplets.

Identified Gaps and Challenges

- While it is suggested that the benthic ecosystem started its recovery after the 3-year window following the Deepwater Horizon Spill of 2010, it is still unknown if the benthic community recovered to the original species, or comprise of new ones, due to the lack previous baseline data availability.

PCC-003: HYDROCARBON TRANSFORMATION PROCESSES AND PRODUCTS AT THE SEA SURFACE

Moderator: Christoph Aeppli (Bigelow Laboratory for Ocean Sciences)

Session Overview

About 10% of the spilled Deepwater Horizon oil formed oil at the sea surface. This session addresses the fate of this important oil fraction. Physical as well as biotic and abiotic chemical processes that changed the composition of the oil residues were discussed.

Session Highlights

- Sunlight has dramatic impacts on chemical and physical behavior of spilled oil.
  - When sunlight interacts with oil sheens, a large amount of the mass of oil and residual oil is transferred to the pool of dissolved organic compounds.
  - Partial photo-oxidation to oxygenated residues, rather than complete photo-oxidation to carbon dioxide, is the dominant photochemical degradation pathway of DWH surface oil. Two thirds of the of the partial oxidation of DWH surface from 2010-2016 occurred in less than ten days by abiotic photochemical processes.
  - The amount of dissolved organic carbon in the water photoproduced from a petroleum carbon source in the presence of dispersant increases when compared to systems without dispersant.
  - Numerous oxygenated photoproducts have been observed, including aldehydes, ketones, and molecules with multiple oxygen functionalities.
  - Exposure of spilled oil to sunlight alters gas-phase composition through photothermal volatilization and production of volatile photoproducts.
  - Photo-Ox generates interfacial material in weathered oils, and it is different than naturally occurring interfacial material found in petroleum.
  - The process of partial oil-photooxidation produces large amount of a complex mixture of oil compounds within a short time. These compounds are typically outside the analytical window of commonly used analytical methods. This fraction of oxygenated compounds is not well understood in terms of chemical composition or toxicity.
- The process of oil photo-oxygenation could affect risk and damage assessment.
  - Two mechanisms of sunlight-induced toxicity are possible: Photo-products can exhibit toxicity, and photosensitization can occur (i.e., interaction of UV light with oil compounds in organisms). Oil photo-products can accumulate in biomembranes and therefore contribute to the overall toxicity of oil hydrocarbons. In highly weathered oil, oil photo-products might be the major cause of an observed toxic effect.
- Besides photo-products, volatile hydrocarbons transmitted through the air can impact birds.
- Surface water sheens observed in the Gulf of Mexico can be comprised of hydrocarbons derived from plankton, oil and mixtures of the two.
- Bacteria produce surfactants in subsurface water and are transported to the surface microlayer.
- A slick identified in synthetic aperture radar (SAR) imagery may be an indicator of oil spill, other organic materials dissolved in the water column, hydrocarbons produced by plankton.
- Environmental conditions (sunlight, temperature) as well as oil compositions will impact how different oil compounds distribute in the water column, with impacts varying with the type of oil.

PCC-004 CURRENTS, WINDS AND WAVES: MOVING OIL IN THE GULF OF MEXICO

Moderator: Helga Huntley (University of Delaware)

Session Overview

The fate of oil spilled into the Gulf of Mexico is determined to a large extent by the chemical and biological breakdown processes, on the one hand, and by the physical redistribution of the oil and its derivatives, on the other hand. Therefore, an understanding of the physical processes is critical for effective response efforts, prioritizing restoration projects, and building the resiliency of the Gulf to oil spills. In this session, we explored the driving mechanisms of the oil redistribution in the ocean, including currents, winds, and waves. Contributions reported on modeling, observational, and technological studies and provided insights into the ocean flow, oil evolution, or their interaction.

Session Highlights

- Ocean circulation is the primary transporter of oil to the vicinity of the coast; waves via Stokes drift are responsible for getting oil onto the beaches.
- Inertial wind forcing causes eddies on the northern Gulf shelf to slide around, producing greater variability in transport properties. Wind forcing is also responsible for replenishing the eddy kinetic energy and feeding the ageostrophic velocity component of the shelf circulation.
- Drift cards were used to capture the Lagrangian flow in the top cm of the water column. Less than 20% of the cards were retrieved, and only launch point and time and retrieval point and time were collected, so that minimal information is available about drift speed and trajectory. Comparison with modeled trajectories confirmed the difficulty of endpoint predictions.
- An analysis of drifters and photographically tracked drift cards showed that geostrophic turbulence and an inverse energy cascade dominate at large scales, but small scales are characterized by clustering. Richardson and Stommel's scaling law for relative diffusivity was found to hold over a range of scales covering 6 orders of magnitude.
- A direct modeling approach for Langmuir turbulence showed that the traditional parameterizations account for the tilting of vertical vorticity due to mean wave effects but are missing the similarly strong effects of fluctuations.
- Data from dense drifter arrays indicated that divergence and strain rate exhibit high spatial and temporal variability. When averaged over larger areas, magnitudes agree with previous observations, but on smaller scales significantly larger values (~10 times Coriolis) were found.
- The observed quick and strong convergence of LASER drifters is inconsistent with the classical scaling underlying the theory of strain-induced frontogenesis (Hoskins & Bretherton, 1972). It was found that the frontal sharpening rate is well approximated by the convergence rate.
- A bottom-intensified turbulent layer was frequently observed on the northern Gulf shelf slope. It was generally less than 30 m thick and is likely a result of complex bottom topography.
- The feasibility of observing ocean currents down to 2000 m, along with salinity, temperature and biogeochemical properties, with an APEX-EM float was confirmed with a test mission in the Gulf.
- Direct numerical simulations of oil droplet evolution were used to derive droplet size distributions and parameterizations of their evolution as input for multi-phase plume models.
- Plumes of large oil droplets can lead to significant light attenuation near the surface, while smaller droplets tend to diffuse into the mixed layer and absorb less light.
- Experimental data from a wave tank showed that dispersant application changes the characteristics of the oil droplet size distribution, both decreasing the characteristic size by multiple orders of magnitude and steepening the slope of the distribution. The magnitude of these effects depends on the dispersant-to-oil ratio.

PCC-005: MICROBIAL PROCESSES AT OIL-WATER INTERFACES

Moderators: Roseanne Ford (University of Virginia) and Arezoo Ardekani (Purdue University)

Session Overview

One responsive action to the continuous release of crude oil over a period of 87 days following the Deepwater Horizon blow-out was the addition of chemical dispersants to break up the oil plume into smaller droplets and thereby increase the oil-water interfacial area. The overall impact of this strategy on cleanup efforts and the ecosystem are still being assessed. This session focused on microbial processes at or near the oil-water interface and the effect of dispersant on those processes. Presentations featured experimental, modeling and computational studies on microbial transport, adhesion, exopolymer secretion, proliferation, biodegradation, aggregation, sedimentation, and community dynamics. Understanding these processes is critical for evaluating their role in bioremediation, marine oil snow formation, oil droplet stability, and phytoplankton community dynamics.

Session Highlights

Marine microorganisms play a vital role in the degradation of oil released from the Deepwater Horizon blow-out. Many new insights about how microbes interact with oil droplets were reported:

- Swimming bacteria are able to transport particles that collect at the oil-water interface.
- Mathematical models that account for hydrodynamic forces of swimming bacteria and their chemotactic responses indicate that hydrodynamic trapping time at the oil-water interface decreases with drop size, while chemotactic responses to soluble hydrocarbon are enhanced around smaller oil drops due to steeper hydrocarbon gradients; dispersants increased the hydrodynamic trapping time for a given drop size.
- Observations of unexpectedly large numbers of attached bacteria to small oil droplets suggests that curvature of the surface may have an important role.
- Exopolysaccharides produced by bacteria associated with the oil-water interface form long streamers that may lead to the formation of marine oil snow.
- Both microbes and chemical dispersants lower the oil-water surface tension. Exopolysaccharides stabilize the oil-water interface and reduce the effectiveness of chemical dispersants.

Bacterial proliferation was enhanced on promising alternatives to chemical dispersants such as natural clay sheets and halloysite clay nanotubes that increase surface area at the oil-water interface.

New experimental tools (e.g cryogenic scanning electron microscopy and digital holographic microscopy and interferometry) allow direct visualization of biofilms at the oil-water interface. Modeling tools such as network analysis were used to represent the complex interactions between phytoplankton and microbial communities. The presence of oil increased the interaction between bacteria and phytoplankton. Progress was reported on an antibody assay to measure polycyclic aromatics in crude oil.

In addition to the impact of microbes on oil, the oil and chemical dispersants also affect the diversity and abundance of microorganisms that play a critical role in the carbon cycle. Oil and dispersants can apply selective pressure on microbial communities. In deep waters the addition of Corexit reduced the relative abundance of a known hydrocarbon degrader *Marinobacter*, while in shallow surface waters the presence of oil and nutrients enriched the *Marinobacter* population.

PCC-006: MARINE SNOW – FORMATION, CHEMISTRY, IMPACTS

Moderator: Laura Bretherton (Mount Allison University)

Session Overview

This session focused on three themes; understanding how marine snow aggregates form, understanding the characteristics of aggregates (in terms of structure, composition and biological activity), and understanding where these aggregates end up in the marine environment. Further research is needed to understand how sedimentation of oil via marine snow aggregates impacts the wider ecology of the Gulf, and in particular how dispersants interact with this phenomenon in order to inform future responses to oil spills.

Session Highlights

- *Processes of aggregation* – the composition of organic materials such as extracellular polymeric substances secreted by microbes can control the rate at which aggregation occurs. Higher protein:carbohydrate ratios lower surface tension and allow self-assembly of aggregates. Differences in these ratios can result in aggregation taking hours longer to occur – or not at all.

- *Marine snow as vectors of oil transport* – different fractions of oil are incorporated into aggregates both on different timescales and through different mechanisms. Heavier, and potentially more toxic, compounds are scavenged into marine snow faster, and the presence of dispersants influences this process. These aggregates are also hotspots for microbial activity, and succession of microbial communities on aggregates is also an underrepresented area of research.

- *Particle characteristics* – modelling techniques can predict the behaviour of particles, and are useful in predicting sedimentation events, and how much oil can be transported. However, there are several characteristics that have not been considered enough, such as the fractal dimension of the particles, and particle break-up. These factors, when modelled, impact processes such as particle collision, size distribution, and sinking velocity. Methods to measure such characteristics on real particles need to be developed.

- *Identifying marine snow sedimentation events* – using isotopic analysis of Pb, it is possible to identify where sedimentation events occurred across the Gulf of Mexico. Sediment cores show that sedimentation of oil occurred around the Deepwater Horizon site post-spill. This method could also detect a larger sedimentation event in the southern Gulf of Mexico following the Ixtoc spill in 1979.

- *Ecological impacts of marine oil snow sedimentation* – benthic organisms are negatively impacted by the presence of oil in marine snow particles, and is taxa specific. Organisms such as detritivorous snails are killed by oil incorporated into snow particles by ingesting them, which has the potential to bioaccumulate oil in marine food webs. More research is needed to understand how incorporation of oil into marine snow impacts marine ecology, as marine snow is a food source for many planktonic and benthic animals.

PCC- 007: IMPACT OF FRESHWATER DISCHARGE ON COAST-DEEP OCEAN CONNECTIVITY

Moderator: Caitlin Young (NOAA)

Session Overview

Freshwater discharge is a key control on coastal salinity, water column stratification and solute load in the Gulf of Mexico. An understanding of freshwater discharge control on water column stratification can improve decision making during oil spill Response phase. Post oil spill, diversions of freshwater discharge and sediment are proposed as a method to Restore coastal habitats and salinity regimes. The Gulf coast economy relies heavily on freshwater discharge dependent fisheries, thus freshwater discharge also plays a role in community Resilience.

Session Highlights

- Freshwater discharge from Mobile Bay enters offshore water as a plume, generating a stratified system containing intermediate water. Unlike surficial plume water and bottom water, this intermediate water typically has a low suspended sediment load, making it a biologically important zone for larval species.

- As freshwater discharge exists Mobile Bay, water column stratification first increases and then decreases in a parabolic fashion. This oscillating stratification can cause the flood limit to move seaward up to 150km.

- Remote sensing, in particular satellite imagery, is needed to understand daily and seasonal variation in sea surface Chlorophyll concentrations. Unfortunately, sun glint frequently obscures much of the Gulf of Mexico imagery taken for this purpose. A newly developed algorithm corrects for sun glint, generating a color index, which will be used to develop Chlorophyll concentration maps at relevant time intervals.

- Freshwater discharge export from the Mississippi River and the Campeche Bank to the Florida Straights is dependent on the position of the Loop Current. A new synthesis of satellite imagery indicates the Mississippi River export to the Florida Straights occurs more than previously thought, typically during the summer and fall for 4-6 weeks.

- Overall stability of the water column is dependent on water column shear, which is in turn dependent on factors such as sub-meso scale eddies, near inertial oscillation and freshwater discharge. These water column stratification factors have been used to understand hypoxia formation west of the Mississippi River plume. Yet, new work east of the Mississippi River plume indicates a combination of freshwater discharge and near inertial oscillation can generate prime physical conditions for an eastern dead zone.

- During DWH spill all existing river diversions were opened in an effort to keep oil out of estuaries and marshes. Although this attempt was largely seen as a failure, planned restoration focused river diversions are significantly larger in volume (~8x) which may make this strategy effective in the future, but not without costs. Modeled freshwater discharge from planned Louisiana river diversions shows a dramatic decrease in coastal residence time, from 28 days to just 2 days. This low residence time is likely to increase nutrient loading and have significant ecological costs.

MS-003: OIL DEGRADATION IN COASTAL SEDIMENTS

Moderator: David Hollander (University of South Florida)

Session Highlights

- As oil weathers, its composition changes to residues with diminished environmental impacts.
    - The severity of impacts depends on shoreline type, ie, sandy (least severe), coastal marsh (most severe).
    - Samples in less dynamic environments are slower to reach the final weathering stage.
- Environmental impacts occur more often from chemicals released into the air and water, where they undergo oxidation and other chemical biological molecular interactions.
    - Impacts from oily residues mainly due to coating and smothering.
- Minerals and nutrients reduce the bioavailability of degraded hydrocarbons.
- Degradation of buried oil linked to tidal groundwater level changes.
- Beaches "breathe" with tides, which drive gas, moisture and heat exchanges.
    - Degradation rates slow down over time; initial degradation rates in first months are faster than long-term (years) degradation rates.
    - Permeability of sand also a factor; solid thick embedded layers reduce breathing and buried oil degradation.
    - Oil degradation in anaerobic conditions (saturated sediments) occurs extremely slowly.
    - Temperature also a factor.
- Microbial degradation occurs more quickly in dry beach sands (high in oxygen, low in nutrients) vs submerged sediment (high in nutrients, low in oxygen).
- Ixtoc shows that weathering of coastal residues continues over years via photooxidation and aerobic degradation to a high-sulfur end-point.
- There are similarities between Ixtoc and DWH coastal residues – presence of oxygen containing classes. Analysis of Ixtoc samples showed how the ecosystem influences degradation. Mangroves are lower in sulfur, higher in oxygen.

MS-004: THE LAST MILE BEFORE LANDFALL: MEASURING COASTAL TRANSPORT

Moderator: Tamay Özgökmen (University of Miami)

Session Overview

This session was intended to summarize progress in the measurement of coastal transport processes, in particular those during SPLASH (Submesoscale Processes and LAgrangian Analysis on the Shelf) conducted by CARTHE in the Spring of 2017.

Session Highlights

- The role of freshwater outflows acting as natural booms, as well as quantifying the roles of wind and waves for surface transport was highlighted.
- New technological advances and tools such as large numbers of biodegradable drifters, plates, X-band radar, drones and polarimetric cameras, and in particular, their joint use in order to successfully attain high density measurements were presented.

MS-005: OIL AND GAS PLUMES

Moderator: David Hollander (University of South Florida)

Session Highlights

Several advances in our understanding of oil and gas plumes (and modeling these effects) were presented:

- Plume precession, a lateral displacement of a plume from its axis with anticyclonic spinning, is a new phenomenon.
  - Plume precession rate scales linearly with the rotation rate of the environment, can be modeled as a spinning top to explain observed plume precession.
- Deep northern Gulf bottom waters enriched in methane from seep bubble dissolution and accidental releases can now be traced through *in situ* methane and current speed/direction measurements. We're somewhat better prepared to monitor the next "big event."
  - Highest concentrations occur at the base of the friction layer at a seep; higher current speeds result in lower methane concentrations.
- Dissolved phase distribution depends on the *local current* direction, while bubble spreading depends on the *integration of currents*.
  - The main axis of the dissolved concentration distribution can be different from the long axis of the bubbles spreading in the plume.
  - The maximum concentration can be located at the edge of the plume.
- In experiments to characterize and quantify the surface signature of oil in free convection and connect characterization with flow and oil droplet dynamics, the primary preferential concentration effect is straightforward: droplets of all sizes cluster into convergence zones at the surface.
- Secondary preferential concentration effect is not so straightforward; large droplets concentrate in convergent "spirals" at the surface due to persistent vortices collecting and advection oil.

Identified Gaps and Challenges

Most experiments and modeling of ocean mixed layer have focused on Langmuir circulations; need more exploration of other forcings along with convection (heat transfer).

RSP-001: OIL SPILL MODELING FROM DROPLET FORMATION TO RISK ASSESSMENT

Moderators: CJ Beegle-Krause (SINTEF Oceans) and Christopher H. Barker (NOAA)

Session Overview

The session included numerical modeling approaches to answer questions about oil fate and transport over a range of scales from well blowouts to the beach in everything from Gulf of Mexico to arctic environments. The session was divided into two parts – the first part focusing on blowout plume dynamics and droplet formation, and the second part on large scale fate and transport processes after the oil left the plume. The latter half including both investigations into specific processes and full scale applications of modeling from source to shore.

Session Highlights

- The response community is better poised to understand the fate and transport of oil from a blowout, as well as the implications of subsea dispersant application.
  - Much better understanding of the dynamics of oil-gas plumes in the deep sea.
  - Better approaches to determine the droplet size distributions developing in plumes, and the behavior of droplets and bubble as they rise.
- There are still challenges with scaling droplet size experiments from lab to field scale.
- New knowledge of plume dynamics and droplet formation have been integrated into comprehensive fate and transport models.
  - Members of the modeling community continue to have two different views on the role of interfacial tension in formation and breakup of droplets.
  - There is also discussion of the specific mechanism of gas release from individual droplets.
- Still unknowns about how the oil-gas ratio influences the flow regime, and thus the bulk properties of the plume dynamics.
- Modeling a large-scale well blowout / oil spill event is still challenging, with the accumulation of uncertainties from each individual process.
- A new hypothesis is being explored regarding the Deepwater Horizon oil spill, related to whether or not the release at the well could have been "churn flow" rather than "bubbly flow" or have periods of transition between the two.
- The Laser experiments have provided a better knowledge of the transfer of energy from wind to water, which could lead to more accurate surface velocity forecasts to support oil spill transport modeling.

RSP-002: LABORATORY AND FIELD EXPERIMENTS AND MEASUREMENTS

Moderators: Scott A. Socolofsky (Texas A&M University) and Anusha Dissanayake (University of Georgia)

Session Overview

Laboratory and field experiments and observation provide important information to understand the chemical, physical, and biological processes that control the transport and the eventual fate of petroleum fluids spilled in the environment. This session focused on some laboratory observations carried out to study the droplet size distribution in blowout plumes and phase changes of droplets under high pressure and on some field observations used to understand the hydrodynamic conditions of the ambient environment, especially near the Mississippi Bight, and on the methods used to collect field data.

Session Highlights

This session presented new datasets from laboratory, field, and numerical observations. Laboratory-scale observations of oil and gas in the environment included testing at the Joint Maritime Test Facility (JMTF) by Hansen on *in situ* burn, observations of live oil in the Technical University of Hamburg-Harburg high pressure facility by Pesch and by Malone, and high-pressure autoclave testing of oil with different dispersants by Amon. Field-scale observations focused on the Mississippi Bight region and near surface currents, including field lidar measurements by Bogucki, drifter analysis by Bracken, and a new polarimetric methods for near-surface currents by Haus. Several new modeling studies were also discussed: O'Brien used the COAWST sediment transport model to study sediment transport in the Mississippi Bight; Cambozoglu used EOF analysis of NCOM output to understand contaminant transport modes in the Mississippi Bight; Shrestha studied the role of Langmuir circulations and their interaction with non-aligned wind and waves; Grossi asked whether artificial intelligence might eventually predict currents and oil transport via machine learning; and, Pan showed that higher-resolution wind and climate forcing improves circulation model predictions.

Identified Gaps and Challenges

It is difficult to simulate naturally-occurring live oil. Most researchers use methane to simulate live oil. The equation of state of methane alone is quite different from a C1-C5 mixed gas, even if the mixed gas is over 90% methane. Experimental results are instructive for cases with pure methane, but not directly translatable since the density of the gas and potentially phase changes (gas to liquid) may not be modeled properly in a pure-methane system compared to a mixed-gas scenario. Methods to create realistic live oils would benefit these experiments.

There is continued debate regarding methods to predict oil droplet size distributions in blowouts. The current Weber-number based models were criticized. A new dimensional correlation based on turbulent dissipation rate was introduced, but it remains important to have better data closer to field-scale jets of live oil and gas.

TUHH experiments with live oil give larger droplets than dead oil. This was non-intuitive because viscosity decreases with dissolved gas, which should yield smaller droplets. Interfacial tension also does not predict this behavior. One possible hypothesis to predict this behavior is that changes in elasticity change the break-up mechanism. However, there are insufficient observations to test this hypothesis at this time. A pressure drop over the nozzle eliminate this effect, but the correct model for the pressure drop over the Deepwater Horizon release remains uncertain.

RSP-003: HOW'S THE WEATHERING? OIL CHEMISTRY, DISPERSANTS AND TOXICITY

Moderators: Chris DuFore (BOEM) and Robyn Conmy (US EPA)

Session Overview

Session RSP-003 was diverse in nature with presentation topics including dispersant effectiveness, alternative compounds for dispersing crude oil, effect of photo-oxidation on oil dispersion, toxicity of oil to aquatic biota and improved techniques for the chemical characterization of oil. Each of these topics contributes to the conference theme of translating scientific research to improve spill response. Dispersion research informs our understanding of the behavior of spilled oil and selecting appropriate response measures. Toxicity research informs the impact of spills in specific aquatic and shoreline environments. Improved chemical characterization of oil allows for deciphering the unresolved compounds within crude oil. Photo-oxidation and hypersaline work allows for understanding environmental factors that influence oil and dispersant interactions. Alternative dispersant, solvent and nanotube research strives to identify additional products that can be used in future spills.

Session Highlights

- Scientific advances presented in the session highlighted novel research to improve the community's understanding of oil behavior and the effects on Gulf environments. A number of presentations emphasized the need for continued research efforts to improve the effectiveness and influence of utilizing various response techniques. In particular, the DROPPS III presentation eloquently represented how many of the research topics inform spill response decision-making.

- New research on (1) impact of hypersaline conditions on dispersion effectiveness was presented and how the lab scale tests are translated to field scales, (2) role of oil photo-oxidation is greater than previously recognized and substantially reduces dispersion effectiveness with implications for window of opportunity for aerial dispersant application, (3) stable emulsions formed when using halloysites nanotubes as a stabilizer for spill remediation, (4) evaluation of alternative solvent bases for improved effectiveness of dispersants, and (5) development of artificial oil systems to assess dissolution of specific PAHs.

- New technologies included better characterization of crude oil SRM from NIST where advanced chromatography methods can now identify 333 PAHs, of which many are highly toxic HMW PAHs than previously characterized on the NIST certificate. Better characterization improves the ability to determine compounds with potential exposure. Also presented was research on food grade surfactants and an alternative delivery system, where combinations of soy lecithin and tween80 create smaller more uniform droplets that stay in suspension longer. This emulsion stability can enhance biodegradation by increasing the time for it to take place.

- The impact of spills on PAH uptake in marsh vegetation air canopy and leaves was presented and suggests PAH concentration in gulf marsh vegetation has decreased since 2014 and compounds are present throughout the leaf tissue and not just the cuticle. Also presented were the potential impacts of oil on urea and ammonia transporters within Gulf mahi mahi. The D-TOX researchers presented toxicity of oil to *A. bahia* and deep micronekton and a case for using deep diel vertical migrating crustaceans because they are easier to keep alive, but recognized that animal stress during dosing experiments may bias LC50 numbers reported. UV-enhanced toxicity of oil to early life stages of estuarine species was also presented and highlighted that estuaries naturally have multi-stressors that can worsen oil toxicity. UV light and higher water temperature increased toxicity and sublethal effects in shrimp were also observed in a full life cycle assessment.

- Each of the presentations offered findings that were relevant to improving response methods and informing decision-makers in the Gulf. This rang true in the DROPPS III presentation that offered a larger view of the issues spill responders face and the critical and time dependent information needs for an effective spill response. Conveying the message that no two spills are alike and research should focus on how to prepare for and respond to future spills is paramount. Audience members were also challenged with whether research could inform spill response within a hypoxic zone or other specific Gulf environments.

Identified Gaps and Challenges

Noted were the challenges with scaling from the lab to the field, a need for the better characterization of crude oil and its weathering products, and the expenses associated with chemical characterization and toxicity analyses. It was clear that an emphasis on how research can improve spill response is essential.

RSP-004: BIOLOGICAL ASPECTS AND RECOVERY AND OPERATIONAL METHODS

Moderators: Osman Karatum (Duke University) and Suzanne Smith (Amazon River Dolphin Conservation Foundation)

Session Overview

Considering the achievements in physical and biological sciences over the past few decades, this session focuses on advancements in oil spill response methods and technologies.

Session Highlights

- Mechanically durable advanced aerogel fabrics were presented as new oil sorbents that enhance oil spill remediation and recovery, enable ocean towing, automate deployment with minimal human intervention, and mechanical extraction to recover spilled oil.
- Poseidon, a new operational approach to oil spill analysis, uses several sensors detecting specific features of oil, including day and night detection. Advantages over visual assessment include increased productivity, effectiveness, and cost efficiency. It provides information via web-based GIS distribution and the data processed is easy to transfer and defendable.
- Lab-scale experiments show that *in situ* burning releases oxidized organics with higher water solubility into the water column. Many are condensed aromatic compounds with unknown toxicity impacts.
- Following *in situ* burning of an oiled tidal freshwater marsh (*Phragmytes australis*), initially increased total PAHs decreased to background levels within months. Non-native *Phragmytes* had not fully recovered by the end of the study; however, native plants and wildlife showed rapid recovery. Other factors impeding *Phragmytes* recovery should be considered, since overall loss of marsh could lead to further coastal erosion.

Identified Gaps and Challenges

- There is a need for new models and technologies to better understand response tools and their outcomes.
- Dispersant and its impact to environment, and analytical techniques are challenges for scientists and industry. In order to have realistic experimental conditions in lab, it might be good to collaborate more with industry and government organizations (one of the talks in specific received critique from industry about applicability).
- Microbes at the oil-water interface produce insoluble biofilms. How can we model biodegradation of a single microdroplet?

MS-007: RESPONSE PLANNING AND MANAGEMENT IN THE INTERNATIONAL ARENA

Moderator: CJ Beegle-Krause (SINTEF Oceans)

Session Overview

Science used in oil spill planning and response outside the U.S.

Session Highlights

- Oil spill science does not always reach the academic scientific community, particularly during an oil spill response, when responding agencies are focused on emergency actions. The locations of the response level and scientific aspects is available, but not through normal academic channels.
- Planning and preparedness standards may be different, e.g. in the UK, the Secretary of State has the power to seize property in order to prevent a spill.

Other Key Take-aways

- Access to low cost, easily transported drifters can improve real-time information about ocean currents.
- Response worker environmental safety information is still evolving and needs more research and technology development to both meet HHS needs, have reasonable costs and be readily available.
- The international community looks at the USA policies, as well as other countries.

RMP-001: LINKING MONITORING, ADAPTIVE MANAGEMENT, AND RESTORATION AT THE LOCAL, STATE, AND REGIONAL SCALE

Moderators: Julien Lartigue (NOAA) and Christina Mohrman (Gulf of Mexico Alliance)

Session Overview

- Acknowledgement that restoration is a complex process for many reasons - complex and interconnected systems, scale, the number of players involved, biological/ecological AND social components.

- Adaptive management saves time, money, and gets to better outcomes when done correctly and should be standard practice. As mentioned by Robert Twilley in the opening plenary, having an interactive feedback loop is important and the Monitoring and Adaptive Management Manual is a guide for setting up such a feedback loop.

- The amount of monitoring and adaptive management should track to the amount of uncertainty and the frequency with which a decision has to be made. If there is a high amount of uncertainty or a management decision will need to be made often, then a higher degree of monitoring and adaptive management is warranted.

- Whether at the federal, state, or local level, it takes time and effort to build relationships, but these relationships are a prerequisite for collaboration.

- Understandably there has been a focus on restoration in the Gulf because of the damages from the oil spill and the legal framework and resources that mandate that damaged resources be restored. However, we should pause and ask the question of whether we need to move from a reactive (restoration) to a proactive (conservation) approach. Innovation is needed and a shift from pure research to restoration alone may not be enough.

- Building a programmatic framework and adaptive management process across multiple scales, not just at the individual project level. State coordination on beneficial use of sediment provides an example of how this is working across state lines - looking at the system as a whole, not just one project or keeping within state boundaries.

- Along the collaboration continuum, restoration programs in the Gulf of Mexico have moved past co-existing and communicating and are now cooperating and coordinating. The mandates for each of the programs will likely prevent them from being fully integrated with respect to funding and planning.

- The big challenge remains how do we roll up the result from individual restoration projects into an assessment of the impact of all restoration projects on the ecosystem. A focus on synthesis within the science community may be the answer.

- Conference theme begins with response…that's not where we should be starting. We don't just want to be reactive, we need to be proactive and forward thinking. Need to build a conservation ethic with researchers and others.

Resources:

- *Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0*
- *NOAA DIVER* – Deepwater Horizon NRDA Data
- *NOAA ERMA (Environmental Response Management Application)* - NRDA support
- *RESTORE Council Comprehensive Plan*

RMP-002: MANAGING ECOSYSTEMS FOR RESILIENCE: FROM COASTAL COMMUNITIES TO THE DEEP OCEAN

Moderators: Rebecca Green (BOEM) and Melissa Carle (NOAA)

Session Overview

This session explored recent scientific studies, restoration projects, and strategic restoration planning related to preserving and restoring ecosystem integrity in the Gulf of Mexico at both the species-specific and ecosystem level. Topics considered included post-DWH measurements of species injury and recovery, strategic restoration planning and early restoration projects to assist the recovery of injured resources, and methods for addressing benthic habitat mapping and characterization in the Gulf of Mexico. All of the talks in the session were linked by the common goal of using data and information to design appropriate restoration and management strategies for the region.

Session Highlights

- Mapping and characterization of benthic habitats was identified as an important research and monitoring gap relevant to the restoration of many of the species that were injured by the DWH spill, as well as a general need to inform the conservation of the most critical habitat and hardbottom areas that support the abundant living resources in the Gulf of Mexico. The speakers identified the need for comprehensive habitat-classified benthic maps from nearshore to the open ocean, including through use of novel towed video and environmental sensing systems. The value of using deep water corals as indicator species for the health of deep ocean communities was also discussed.

- The speakers explored the challenges of planning restoration for groups of species that utilize different habitats across the Gulf of Mexico during different life stages and are subjected to a different set of threats at each stage. Similarly, talks considered the challenges of performing conservation and restoration in a dynamic and changing environment (barrier islands) or where information is limited (deep benthic and mesophotic habitats). The need for a robust adaptive management approach was stressed as a mechanism for moving forward with restoration despite these challenges and uncertainties.

- Speakers in the session also highlighted the resilience of some nearshore ecosystems to the impact of the DWH oil spill and other natural or human-induced environmental changes and the success of restoration efforts aimed at speeding the pace of recovery. Certain fish species utilizing nearshore habitats were found to exhibit considerable resilience to the oil spill, although the exact mechanisms for this resilience needs to be better explored. By contrast, microbial communities tended to exhibit sharper fluctuations in response to oiling, and changes in microbial communities may be indicative of the longer-term impact of oil in the nearshore environment. Finally, the effectiveness of coastal salt marsh restoration using cordgrass planting and nutrient amendments was demonstrated to aid in recovery of marshes impacted by the DWH oil spill.

RMP-003: FISHERIES SCIENCE AND MANAGEMENT TOOLS FOR RECOVERY AND RESTORATION FOLLOWING DEEPWATER HORIZON

Moderators: Rachael Heuer (University of Miami) and Steven Murawski (University of South Florida)

Session Overview

Fisheries and fishes in the Gulf of Mexico were affected not only by the direct and indirect toxic effects of oil exposures, but also by the mitigation efforts used to protect the integrity of the seafood supply and to restore damaged wildlife and mitigate economic losses. In this session, a variety of spatial planning tools, as well as biological and economic assessments were summarized. As well, in efforts to restore affected resources, compensatory conservation measures, such as reduction of bycatch mortality in pelagic resources and stock enhancement strategies were discussed. The *ad-hoc* development of the expanding network of fishery closures during the DWH spill was based on sea surface observations from satellite and aircraft imagery. In retrospect, these closures were successful in preventing tainted seafood from reaching the market, but 4-dimensional models indicated that about 10% of the volume of spilled oil may have been transported to sub-surface regions beyond the closure boundaries. Assessment tools for documenting injuries to specific resources such as *Sargassum* habitats, injuries to specific resources such as snappers and groupers, assessing how fishers responded to fishery closures were evaluated, and modeling the complex behavior of fish migratory behavior were presented. Two papers considered the ability to predict habitats of demersal fishes using an array of habitat variables, fish abundance measures, and advanced statistical approaches. Impacts on Gulf of Mexico fisheries and associated tourism industries were reviewed across the large domain of industry sectors directly, and indirectly (support services) involved in these activities. Ongoing work on the PAH contamination of fishes in the southern Gulf demonstrate the difficulty in in deconvolving oil spill signals from a variety of land-based human inputs.

Session Highlights

An important but yet underdeveloped field of oil spill science is understanding how fishers and other resource users adapt to sudden, massive-scale changes induced by regulatory measures imposed to achieve conservation and public health goals. In the case of fisheries this can involve the institution of wide-spread fishery closures. Two papers in this session examined and quantified the predictability of how fishers choose between alternative locations as influenced their personal histories of EETO (exploit-explore trade-offs) and linear predictive models of input vs. output variables such as vessel size, weather, and other constraints on the ability to adapt. This is a very important area of research and one that should allow oil spill responders and fishery managers to better predict the impacts of future spatial closures.

A specific recommendation arising from the session was that in the event of a significant spill similar to DWH, that the expanding boundaries of fishery closures be based on observed and modeled oil distributions at the surface as well as modeled sub-surface oil distributions.

Management responses to conserve and rebuild offshore, and especially pelagic, resources remain a challenge for damage assessment and mitigation. Two studies offered differing approaches to (1) reducing the environmental footprint of pelagic longline fisheries through reduction of bycatch mortality by supporting alternative gears, and (2) proposing large-scale wild stock enhancement programs for offshore fishes. The session discussed the potential merits and challenges of both approaches.

SER-001: FOSTERING INDIVIDUAL, SOCIAL, AND COMMUNITY RESOURCES TO BUILD RESILIENCE TO OIL SPILLS AND OTHER DISASTERS IN THE GULF

Moderator: Becky Allee (NOAA)

Session Overview

This session presented research on individual and community preparedness and resiliency following natural or manmade disasters. Presenters examined community experience with multiple disasters to determine how communities learn and become more resilient. Discussions and research findings centered on factors such as social connectedness, economic status, and presence of health and social workers in the communities.

Session Highlights

- This session was focused on social science surveys with community members who had experienced one or more disasters. Findings from the many surveys presented were interesting and informative but a clear connection of the utility of these findings to improving the resilience of communities was lacking.
  - In social science research, it is important to make contact with communities for survey purposes as near to an event as possible. Time lags between surveys and events of interest can influence survey results.
  - Person-to-person interviews are more successful than telephone interviews.
  - It is important to have solid community contacts for successful participation in survey, e.g., well known or established community leaders.
- Inclusion of Community Health Workers on emergency management teams would be highly beneficial to the community.
- Benefits of social capital (i.e., the connection to and resources within a community) do not always positively affect community well-being.
- Social media offers an excellent resource during disasters.

Identified Gaps and Challenges

- Time lags between research and disasters.
- Relocation of survey participants.
- Lack of follow up.
- Incorporation of survey results into policy.
- Lack of funding to utilize survey results.

SER-002: MEASURING, UNDERSTANDING, AND RESPONDING TO HUMAN HEALTH FACTORS IN THE WAKE OF AN OIL SPILL

Moderators: Melissa Finucane and Rajeev Ramchand (RAND Corporation)

Session Overview

This session contained a series of talks focused on the human impacts of responding to the oil spill among first responders, the spill's impacts on the mental and behavioral health of community residents, and insight into new research that will better estimate the impact of oil spills on the health and safety of coastal beaches.

Session Highlights

- The dichotomy between "natural" and "technological" disasters may be inappropriate, given that things like earthquakes and tornadoes often include technological impacts, including oil spills. Thus, "competing" the impacts of different types of events may be unwarranted.
- Better understanding of what constitutes "exposure" to oil spills is needed. Some of the reported mental and behavioral health consequences of oil spills may be, in part, attributed to underlying trauma prevalent in the community.
- The shortage of mental and behavioral health care providers in the Gulf Coast region requires new models to deliver quality-based care; the integration of mental/behavioral health care in primary care offices should be enhanced.
- Ethical considerations for studying some effects of oil spills (i.e., randomizing children to play at oil-exposed vs. unexposed beaches) requires new and creative methods. Video surveillance and mathematical modeling is one way to further understand the threat of oil spills on kids playing on beaches.

Session Summary

The session touched upon the immediate and longer-term consequences of oil spills on human health. It began with a study that examined how first responders who responded to the DHOS reflected upon that experience, including how the exposure impacted their health and what they thought was needed to better respond to future disasters. A number of studies have previously shown that communities are also impacted by oil spills, primarily persons who experience resource loss as a result of the spill; thus, a number of speakers tried to further "unpack" this relationship. These studies focused on the interplay between other life events and traumas and how oil spills may potentially exacerbate mental and behavioral health conditions for those who have endured such events, as well as how symptom profiles evolve over time among persons who are impacted by oil spills. A series of studies then proposed new care delivery models for addressing the behavioral and mental health conditions among residents exposed to oil spills, including integrating such care in primary care.

A second theme that emerged was a gap in our understanding of the physical impact of oil spills on beaches, and the impact of children who play on beaches. Researchers described a new study that will combine ecological science with mathematical modeling and data capture strategies (video surveillance) to provide more insights to better understand how oil spills impact kids on beaches.

Overall, the research presented in this session suggests that there are multiple dimensions of oil spill-related resource loss and that oil-spill impacts are experienced in different ways by different people. First responders and policy makers may benefit from more nuanced disaster response and management strategies that address these multiple dimensions.

MS-006: LET'S GIVE THEM SOMETHING TO TALK ABOUT – THE IMPORTANCE OF COMMUNICATION AND PUBLIC ENGAGEMENT IN GULF RESEARCH

Moderator: Tim Slack (Louisiana State University)

Session Overview

- The session was comprised of three paper presentations: Citizen science in oil spill research: An evaluation of trust and value in CONCORDE; Effectiveness of a web-based virtual lab application to disseminate and communicate GoMRI science; Evaluating interdisciplinary program performance and impact.

Session Highlights

- The overarching theme was the need to better develop the skill of scientific communication to those beyond individual scientific 'silos', whether that be to the broader scientific community, to students, or to the general public. Further, it was emphasized that doing so was of *mutual benefit*, not only the benefit of stakeholder groups. Stakeholder groups benefit from gaining a scientific understanding of Gulf issues on terms that they can engage toward Gulf resilience in their own lives and work; researchers benefit from taking a step back from the technical concerns of their field and thinking about *why* and *how* their work matters to others, how to communicate and measure impact beyond funding dollars and journal articles, and generally by helping build societal trust in science.

ATTENDANCE AND DEMOGRAPHICS

11 COUNTRIES

Australia, Canada, China, France, Germany, Italy, Mexico, Netherlands, Norway, United Kingdom, and United States
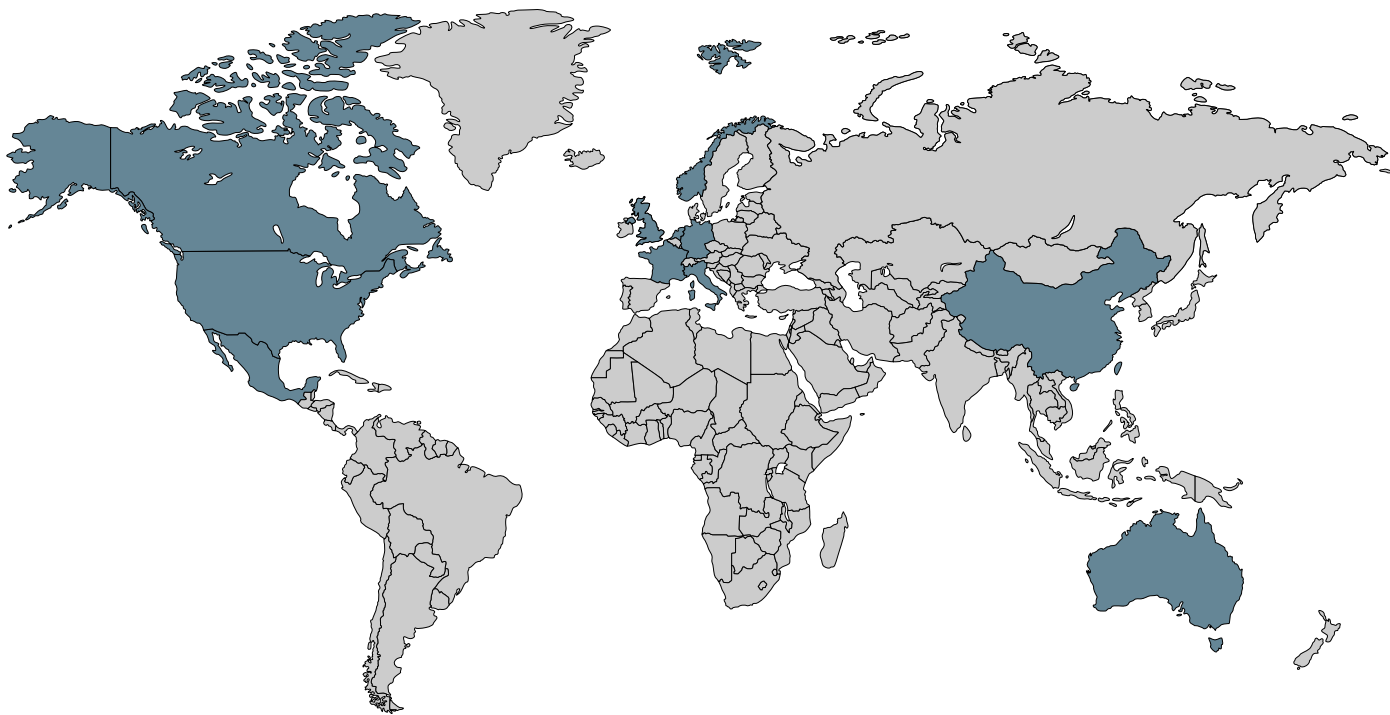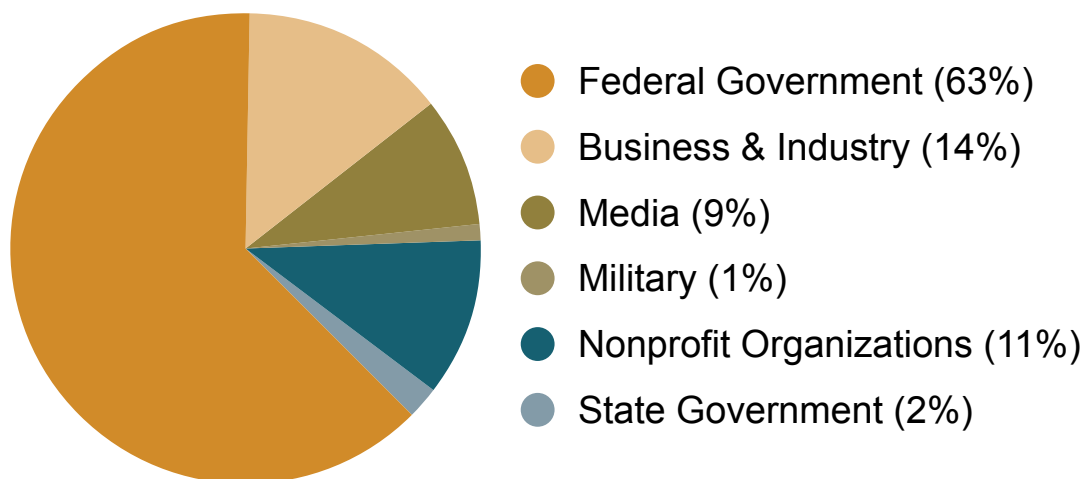

FIGURE 7: ATTENDEES BY SECTOR

- Federal Government (63%)
- Business & Industry (14%)
- Media (9%)
- Military (1%)
- Nonprofit Organizations (11%)
- State Government (2%)

33 STATES

Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Indiana, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, Washington, West Virginia, Wisconsin and Washington, DC.
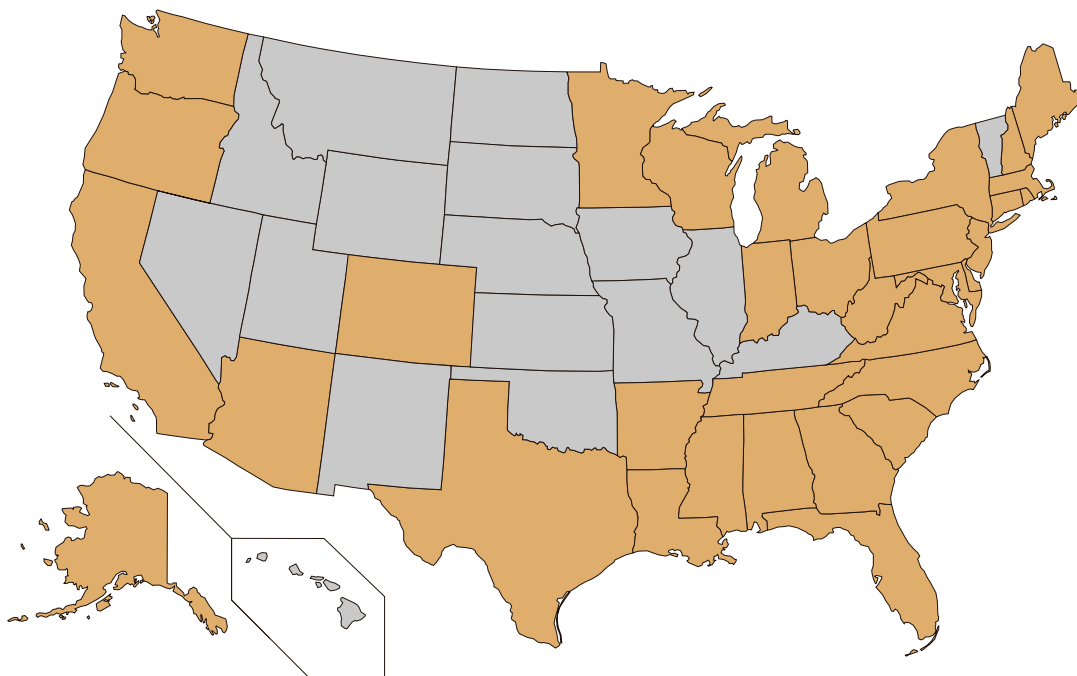
MEDIA

Increased local engagement was a key component of the 2018 Communications Plan; communications staff worked with partner organizations and universities, as well as local media outlets, to leverage networks and broaden the conference's reach. Two press releases were distributed through PR Newswire, conference partners, and online newsletters for *Ocean News & Technology, ECO Magazine*, and the Consortium for Ocean Leadership *Ocean News Weekly* e-newsletter. Conference staff also conducted in-person visits with seven local media outlets, resulting in at least two journalists' attendance. Searches through Meltwater returned 211 examples of coverage before, during, and after the meeting with a total reach of 26.4 million. Engagement through social media resulted in 166 uses of the conference hashtag (#GoMOSES) on Twitter, and the conference currently has 386 Twitter followers and 316 page "likes" on Facebook.

The full media report is available in Appendix IV (page 54).
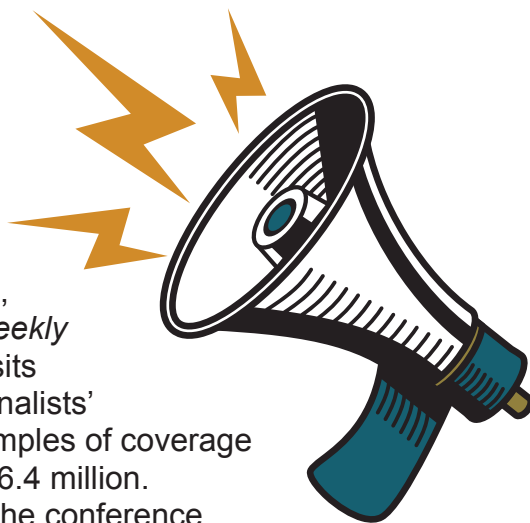
APPENDIX I: CONFERENCE AGENDA

MONDAY, FEBRUARY 5

Time	Event	Location
8:30a – 3:30p	Registration & check-in open	Celestin Foyer
12:00p – 5:30p	Speaker ready area open	Celestin Foyer
2:00p – 6:00p	Exhibit set up	Storyville Hall
2:00p – 6:00p	Poster set up	Storyville Hall

Associated Meetings and Events

Time	Event	Location
8:00a – 6:00p	MTS TechSurge: Advancing oil spill response	Morial Convention Center
8:00a – 5:00p	OSR 201: Oil spill preparedness & response for scientists and researchers: Bridging science and response	Celestin A
8:30a – 5:00p	Ecological indicators for an ecosystem assessment of Barataria Basin, Louisiana	Celestin H
9:00a – 12:00p	Sharing science effectively: Know your audience and speak their language	Celestin E
9:00a – 1:00p	Assessing the state of Gulf of Mexico benthic habitat maps part 1	Celestin C
9:00a – 12:00p	GRIIDC data management training workshop	Imperial 12
1:00p – 5:00p	Challenges to understanding the potential impacts of environmental disturbances on fish biodiversity in the Gulf of Mexico: Identification, assessments, and data gaps	Celestin D
1:00p – 5:00p	Recent advances in estimating and measuring oil slick thickness	Celestin E
1:00p – 5:00p	Examining the 1990 Oil Pollution Act to improve the governmental and scientific response to future oil spill event	Celestin F
1:00p – 5:00p	Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS): Research updates and related programs	Celestin G
2:00p – 5:00p	Assessing the state of Gulf of Mexico benthic habitat maps part 2	Celestin C

TUESDAY, FEBRUARY 6

Time	Event	Location
7:30a – 5:30p	Registration & check-in open	Celestin Foyer
7:30a – 6:00p	Speaker ready area open	Celestin Foyer
7:30a – 7:30p	Poster hall and exhibits open	Storyville Hall

Opening Plenary Program Schedule

Starting at 7:30a	BREAKFAST	
9:00a – 11:00a	The three R's of Gulf research: Response, restoration, and resilience	Celestin D/E
11:30a – 12:30p	Mini-Session: MS-001	Celestin D/E
12:30p – 2:00p	LUNCH	

Scientific Program Schedule

2:00p – 3:30p	ECO-001	Celestin A
	ECO-002	Celestin F
	MDA-001	Celestin H
	PCC-001	Celestin E
	RSP-001	Celestin D
	SER-001	Celestin C
3:30p – 4:00p	BREAK	
4:00p – 5:30p	ECO-001	Celestin A
	ECO-002	Celestin F
	MDA-001	Celestin H
	PCC-001	Celestin E
	RSP-001	Celestin D
	SER-001	Celestin C
5:30p – 7:30p	Poster session & reception (featuring Tracks 001, 003, and 005)	Storyville Hall

Associated Meetings and Events

11:00a – 11:30a	Introduction to the GoMRI Data Management Program	Imperial 12
3:30p – 4:00p	Organizing data – Best practices and GRIIDC submission	Imperial 12
5:30p – 7:30p	Gulf of Mexico Data Tools Café	Celestin B

WEDNESDAY, FEBRUARY 7

Time	Event	Location
7:30a – 5:30p	Registration & check-in open	Celestin Foyer
7:30a – 6:00p	Speaker ready area open	Celestin Foyer
7:30a – 7:30p	Poster hall and exhibits open	Storyville Hall

Scientific Program Schedule

Time	Event	Location
Starting at 7:30a	BREAKFAST	
8:30a – 10:00a	ECO-003	Celestin D
	MDA-002	Celestin C
	PCC-002	Celestin F
	PCC-003	Celestin E
	RMP-001	Celestin A
	RSP-002	Celestin H
10:00a – 10:30a	BREAK	
10:30a – 12:00p	ECO-003	Celestin D
	MDA-002	Celestin C
	PCC-002	Celestin F
	PCC-003	Celestin E
	RMP-001	Celestin A
	RSP-002	Celestin H
12:00p – 2:00p	LUNCH	
12:30p – 1:30p	Mini-Session: MS-002	Celestin C
	Mini-Session: MS-003	Celestin A
	Mini-Session: MS-004	Celestin H
2:00p – 3:30p	ECO-004	Celestin D
	MDA-003	Celestin C
	PCC-004	Celestin H
	PCC-005	Celestin F
	RMP-002	Celestin A
	RSP-003	Celestin E
3:30p – 4:00p	BREAK	
4:00p – 5:30p	ECO-004	Celestin D
	MDA-003	Celestin C
	PCC-004	Celestin H
	PCC-005	Celestin F
	RMP-002	Celestin A
	RSP-003	Celestin E
5:30p – 7:30p	Poster session & reception (featuring Tracks 002, 004, and 006)	Storyville Hall

Associated Meetings and Events

Time	Event	Location
8:00a – 8:30a	How to submit data to GRIIDC	Imperial 12
10:00a – 10:30a	Introduction to the GoMRI Data Management Program	Imperial 12
12:15p – 1:15p	Understanding and predicting the Gulf of Mexico Loop Current: Overview of NASEM report and upcoming GRP funding opportunity	Imperial 10
12:30p – 1:30p	"Dispatches from the Gulf 2"	Celestin F
3:30p – 4:00p	Organizing data – Best practices and GRIIDC submission	Imperial 12
6:00p – 6:30p	"Jewels of the Gulf" short film and discussion: deep sea coral research and outreach	Celestin F

THURSDAY, FEBRUARY 8

Time	Event	Location
7:30a – 12:00p	Registration & check-in open	Celestin Foyer
7:30a – 10:30a	Speaker ready area open	Celestin Foyer
7:30a – 12:00p	Poster hall and exhibits open	Storyville Hall

Scientific Program Schedule

Starting at 7:30a	BREAKFAST	
8:30a – 10:00a	ECO-005	Celestin E
	PCC-006	Celestin A
	PCC-007	Celestin D
	RMP-003	Celestin H
	RSP-004	Celestin F
	SER-002	Celestin C
10:00a – 10:30a	BREAK	
10:30a – 12:00p	ECO-005	Celestin E
	PCC-006	Celestin A
	PCC-007	Celestin D
	RMP-003	Celestin H
	RSP-004	Celestin F
	SER-002	Celestin C
12:00p – 2:00p	LUNCH	
12:30p – 1:30p	Mini-Session: MS-005	Celestin A
	Mini-Session: MS-006	Celestin H
	Mini-Session: MS-007	Celestin C

Closing Plenary Program Schedule

2:00p – 3:30p	Research Awards The Future of GOMOSES: Maintaining Momentum – Seeking Synergy Conference Wrap-Up	Celestin D/E

Associated Meetings and Events

10:00a – 10:30a	How to submit data to GRIIDC	Imperial 12
12:30p – 1:30p	"Dispatches from the Gulf 2"	Celestin F

APPENDIX II: ASSOCIATED WORKSHOPS, MEETINGS, AND EVENTS

MTS TechSurge: Advancing Oil Spill Response

This event brought together the GoMRI and MTS communities to share research results and begin discussions of how the two communities might work together.

Subject areas addressed during the program included:

- Hydrocarbon detection technologies
- Modeling and prediction of where oil will go during a spill
- Mitigation strategies
- Impacts to an ecosystem after a spill

Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS): Research Updates and Related Programs

The GoMMAPPS study is a multi-agency partnership program involving BOEM, NOAA, USFWS, and USGS with the objective to improve information on protected species in the Gulf of Mexico and provide a comprehensive assessment of marine mammal, seabird, and sea turtle abundance and spatial distribution in offshore waters (https://www. boem.gov/GOMMAPPS/). The program is conducting repeat broad-scale surveys over multiple years and seasons using various methods, including aerial surveys, ship-based surveys, and satellite tagging. GoMMAPPS began its 3-year field campaign in April 2017, as guided by a well-considered science framework developed to collect this comprehensive dataset. Outreach and coordination are important aspects of GoMMAPPS, including annual meetings held as part of the GoMOSES Conference.

A third annual informational and public outreach meeting was held during the GOMOSES Conference and brought together an audience of approximately 100 people. The goal of the meeting was to provide overview presentations and a forum for an interactive discussion regarding the evolving program, science considerations, coordination with other Gulf programs, and incorporation of stakeholder input. The public meeting included presentations from the GoMMAPPS PIs and from other Gulf funding programs, including DWH NRDAR and the NOAA RESTORE Act Science Program, as we continue to identify synergies across Gulf programming. The GoMMAPPS project team will continue to actively engage various Gulf stakeholders and the community to ensure that GoMMAPPS best meets our common goals for a healthy and productive Gulf ecosystem. Following the public meeting, a 2-hour closed meeting brought together program PIs to discuss logistics for ongoing field work and data analyses.

Sharing science effectively: Know your audience and speak their language

Many people could directly benefit from your scientific findings, but what are you doing to make sure they understand your message and why your results are important? This workshop was designed to create a comfortable environment for scientists working on oil spill research to learn techniques for communicating research effective presentations and results to a variety of audiences, both technical and non-technical. Scientists participating in this communications workshop received training and tools on identifying the audiences they are serving.

Goals and objectives of this workshop included:

- Learn about common challenges researchers have when presenting their science.
- Provide scientists with tips on how to identify their audiences, specifically:
    - Understanding how audiences perceive and process information,
    - Techniques for engaging lay and professional audiences,
    - Meeting the information needs of specific audiences, and
    - Refining presentation skills and learn how to design informative slides.

Assessing the State of Gulf of Mexico Benthic Habitat Maps

This workshop brought together agency, industry, academic and other partners to discuss and examine the inventory and quality of existing benthic habitat data, and opportunities to share, reprocess, digitize and modernize this information in support of a single baseline map to serve as source information for activities to come (including a collaborative partnership or community of practice for data sharing and habitat mapping). Participants were invited to bring maps and/or understanding of the benthic environment and take part in an interactive discussion of existing resources, gaps in the current understanding of bottom habitats and potential collaborations and partnerships to advance the state of Gulf of Mexico habitat maps.

OSR 201: Oil Spill Preparedness & Response for Scientists and Researchers; Bridging Science and Response

This one-day workshop offered an in-depth look at oil spill preparedness and response from the practitioners' perspective, providing insight into how oil spills are planned for and responses conducted. It highlighted the information and science requirements to make the best decisions and conduct an effective response. The course was presented by leaders in both the response and academic communities.

Examining the 1990 Oil Pollution Act to improve the governmental and scientific response to future oil spill event

The Macondo oil spill was unlike any discharge event ever to fall under the aegis of the 1990 Oil Pollution Act (OPA). That legislation was passed by the US Congress and signed into law by the President to deal with the potential of future Exxon Valdez spills that were anticipated to occur because of increased oil tanker traffic. The Act did not anticipate a spill that continued to gush oil and natural gas for weeks on end, nor did it anticipate a spill of the magnitude of a major breech in an active oil well. Federal and state governments were overwhelmed by Macondo, and while their responses were generally remarkable, several persistent problems emerged: 1) Jurisdictional issues caused tension between federal and state agencies; 2) the focus of the US Coast Guard, the legal entity designated to lead all response efforts, was legislatively directed to clean up the spill rather than understand its dynamics scientifically; 3) the vast resources, knowledge and talent in the university research community were not effectively mobilized until funding was cobbled together by federal agencies like NSF and BP itself made available the $500 million GOMRI program, which led to an initial dearth of scientific informa   tion about the spill; and 4) with all of the settlement money, NRDA penalties, etc., little stable funding has been directed to establishing important observation and monitoring activities that will provide baseline information for the next major spill.

The Gulf of Mexico University Research Collaborative (GOMURC) led a workshop to consider the Oil Pollution Act of 1990 and lessons learned from the Deepwater Horizon Oil Spill. *This report* summarizes discussions and provides access to workshop outputs.

Recent Advances in Estimating and Measuring Oil Slick Thickness

Characterization of the extent and degree of surface oil during and after an oil spill is a critical part of emergency response and Natural Resource Damage Assessment (NRDA) activities. More specifically, understanding floating oil thickness in real-time is a key piece of information needed to:

1. Help guiding response efforts by directing limited assets to priority cleanup areas (actionable oil).
2. Aid in the assessment of 'volume released' estimates.
3. Support modeling platforms for predicting transport and fate of oil.
4. Support natural resource injury determinations.

This workshop aimed to bring together first responders, researchers from agencies, academia, and oil spill industry who are advancing *in situ* and remote oil characterization tools and methods.

Ecological Indicators for an Ecosystem Assessment of Barataria Basin, Louisiana

This workshop brought together state and federal agencies, non-governmental organizations, academic researchers, and other stakeholders to discuss and provide input on the selection of relevant ecological indicators. These indicators are to be used in an integrated ecosystem assessment of the Barataria Basin to assess the baseline of the system before a proposed long-term restoration project is operational. The organizers presented a vetted socio-ecological conceptual model of the Barataria Basin and led the discussion of the availability of long-term monitoring data relevant to an integrated ecosystem assessment. The workshop participants discussed, debated and assisted in the selection of the insightful ecological indicators and their ranking for prioritization via a consensus framework.

Challenges to understanding the potential impacts of environmental disturbances on fish biodiversity in the Gulf of Mexico: Identification, Assessments, and Data Gaps

Understanding the impacts of environmental disturbances like DWHOS and climate change on deeper-water (>200-m) communities in the Gulf of Mexico (GOMEX) requires knowledge of their structure and diversity. Ichthyofaunal communities from deeper GOMEX waters have received little attention compared to fishes from euphotic waters. Deep-water collections from the DWHOS event dwarf those made during the Census of Marine Life and other marine surveys, and offer an unprecedented opportunity for insight into the ecology and structure of deep-water communities. Areas of discussion during this workshop included:

- Assessment of historical baseline data and identification of data gaps;
- Identification of ecologically-important taxa and functional groups that can be reliably identified and may have potential as 'indicators' of ecosystem change;
- Identification of taxa\groups from DWHOS collections that remain difficult to resolve below family level;
- And given the increasing scarcity of taxonomic experts, a discussion of experts who specialize in those groups.

Other topics included a discussion on sources of funding support, and areas for further collaboration.

"Jewels of the Gulf" short film and discussion: deep sea coral research and outreach

During and after the Deepwater Horizon accident, images in the media portrayed the dire consequences to human lives and livelihoods, animals, and shorelines in the northern Gulf of Mexico. Less visible, but no less important, were the impacts to the Gulf's deep sea ecosystem. ECOGIG scientists and their colleagues have set out each year since the spill to document the ongoing impacts of the accident on the unique and beautiful deep sea corals. These corals and their associates form the basis of diverse biological communities in the deep ocean, and serve as sentinels for environmental change. Outreach specialists joined the June 2017 ECOGIG "Jewels of the Gulf" research cruise to experience first-hand the excitement and challenges of deep sea research and share their experience with the public. The sixteen-minute film, "Jewels of the Gulf," was followed by a discussion with panelists Dr. Chuck Fisher, Fanny Girard, Sam Vohsen, and Emily Davenport.

Understanding and Predicting the Gulf of Mexico Loop Current: Overview of NASEM Report and Upcoming GRP Funding Opportunity

A new National Academies of Science, Engineering, and Medicine report, *Understanding and Predicting the Loop Current: Critical Gaps and Recommendations*, was released in January 2018 by the Gulf Research Program. The report identifies existing knowledge gaps about the Loop Current System and outlines recommendations for an international, multi-institutional campaign of complementary research involving observations, modeling, and analysis activities that would help improve understanding and prediction of the Loop Current System. This event featured a presentation about the report along with discussion of associated future funding opportunities from the Gulf Research Program, including one opening in February 2018.

"Dispatches from the Gulf 2" documentary and discussion

This second film continues the remarkable stories about the global scientific team studying the Deepwater Horizon oil spill, and features post-spill issues such as:

- Why are so many pregnant dolphins losing their young?
- Why did much of the oyster population in Louisiana disappear?
- Did Deepwater Horizon oil affect the health of sharks?
- Did the use of dispersants help mitigate the impact of the oil spill?
- Will we now be able to predict where ocean currents will carry the oil that results from future spills?

The movie, narrated by Matt Damon, will air later this year as a new episode of the award-winning Journey to Planet Earth Series.

Coastal Response Research Center Meetings

State-of-the-Science of Dispersants and Dispersed Oil in Arctic Waters

This update provided a brief overview of the process and results of this 3-year CRRC project on the state-of-the-science of DDO in Arctic waters.

Leveraging Since and Academic Engagement during Incidents

This was an overview session on defining science coordination and how it applies to spill response and preparedness. The overall goal is to improve NOAA's Office of Response & Restoration, in its unique scientific approach and responsibility during spill response, by leveraging science and academic engagement to promote improved response.

Long-term Data Management

This session gave an overview of the DWH Long Term Data Management Coordination workshop, held June 7 – 8, 2017. One of the recommendations of this workshop was the formation of three working groups: data management standards, interoperability, and discovery/searchability. Individuals interested in finding out more about this process and/or participating on one of these working groups are encouraged to attend.

GRIIDC Data Management Training Workshop

GoMRI funded researchers are required to submit data to the Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC). Part I introduced participants to a variety of topics including the GoMRI data management program and required data management training; data management best practices; and submitting data to the GRIIDC system. Part II provided more in-depth training and guidance on data management planning, data management, and organization best practices based on participants interest. This included a walk-through of the dataset information form (DIF) and data management in Excel. Participants had the opportunity to indicate topic preference when they registered online.

Introduction to the GoMRI Data Management Program

GoMRI funded researchers are required to submit data and data management planning documents to GRIIDC. This workshop provided information about the GoMRI Data Management Program and GRIIDC data management planning requirements.

Organizing Data – Best Practices and GRIIDC Submission

GRIIDC is a leading resource for researchers to manage and share data about the Gulf of Mexico. Proper data management during the course of a project can facilitate data sharing through GRIIDC or a national data archive. If data are not properly managed, they may be lost or improperly documented, preventing the researcher from sharing and getting credit for work completed. This workshop provided information about data management best practices.

How to Submit Data to GRIIDC

GRIIDC operates a data management system that stores datasets and related information collected and generated by GoMRI funded researchers. Datasets are submitted to the GRIIDC data management system directly or by providing a link to the dataset if housed at a National Data Archive. Digital Object Identifiers (DOIs) are automatically assigned when a dataset is submitted to GRIIDC. This workshop demonstrated how to submit data to GRIIDC and obtain a DOI for the dataset.

APPENDIX III:
GULF OF MEXICO DATA TOOLS CAFÉ

A large number of tools and platforms have been developed to support scientific efforts in the Gulf of Mexico. The Tools Café permitted developers time to give hands on demonstration of tools/applications and allowed for collaborative discussions among developers and potential users. This event provided a highly interactive environment where participants learned how to use and apply the following tools and products:

An Integrated Online Platform for Offshore Risk Modeling

National Energy Technology Laboratory

Efforts to prepare for and reduce the risk of hazards, from both natural and anthropogenic sources, that threaten our oceans and coasts requires an understanding of complex dynamics and interactions. However, evaluating the range of hazards posed to and by offshore energy exploration and production requires robust analyses capable of incorporating multi-source, multi-format, multi-scale, and multi-dimensional data. Not only must these analyses address the unique challenges posed by the local environment, but they must also handle large volumes of individuals, information, and activities required to effectively inform prevention efforts. Researchers at the Department of Energy's National Energy Technology Laboratory (NETL) and Pacific Northwest National Laboratory (PNNL) have developed an integrated suite of spatio-temporal tools to synthesize information from disparate sources to support offshore spill prevention efforts. This suite includes the Blowout and Spill Occurrence Model (BLOSOM), Cumulative Spatial Impact Layers (CSIL) and the Spatially Weighted Impact Model (SWIM). These tools underpin a workflow that allows users to model potential spills and assess potential impacts on various social, economic, and environmental variables. BLOSOM is a comprehensive 4-dimensional model, enabling users to follow the fate and transport of offshore oil spills and blowouts. CSIL are a set of GIS-based tools that are used to consume impact and response-related data to rapidly quantify potential environmental and socio-economic impacts. SWIM is a multi-attribute decision support tool that leverages BLOSOM and CSIL outputs to compare and rank different spill and management scenarios. All of these tools are made available through an online Common Operating Platform (COP) that provides both the data and tools to support rapid analyses. The data and tools in the COP can be implemented to assess a range of offshore oil spills scenarios within U. S. waters considering over 150 different potential social, economic, and environmental impact variables.

Chemical Aquatic Fate and Effects Database (CAFE)

Research Planning, Inc.

The Chemical Aquatic Fate and Effects (CAFE) database is a centralized data repository that allows for rapid and unrestricted access to fate and effects data. This database was developed in response to the needs by the National Oceanic and Atmospheric Administration's Emergency Response Division (ERD), which since 2003 responded to at least 2,500 spill incidents in aquatic environments. CAFE gathers existing data from several databases, as well as from peers, peer-review and gray literature, and required a comprehensive review and standardization process to ensure data quality. Data are integrated into a user-friendly tool containing two primary modules: the fate module and effects module. The fate module contains data (e.g., chemical properties, partitioning coefficients, etc.) useful in understanding and predicting chemical behavior in aquatic environments. The effects module contains acute toxicity data which can be queried allowing for on-the-fly data searches and data plotting in the form of Species Sensitivity Distributions (SSDs). To date, the fate and effects modules of CAFE contain information for 32,377 and 4,498 chemicals, respectively. Toxicity data are also available for over 200 oils, dispersants and chemically dispersed oils. Data in CAFE can aid spill responders in their assessment of the fate and potential environmental effects of the spilled material in aquatic environments. While this database is designed to help inform spill responders, its design and query capabilities could easily be expanded to address other research and management needs by the scientific community.

Conceptual Modeling Tool of the Influence of the Mississippi River and Delta on the Gulf of Mexico

National Wildlife Federation

Recovery from the 2010 oil spill requires conservation and restoration of priority ecosystems and marine resources. The Mississippi River drains 41% of the contiguous U.S. and is the largest single source of sediment, fresh water and nutrients to the Gulf of Mexico. Over the last 7,000 years, sediment from the river has built one of the largest deltas on Earth. Together, the Mississippi River and its Delta are widely regarded as important drivers in the Gulf of Mexico

Larger Marine Ecosystem. Since 2016, with funding from the NOAA RESTORE Act science program, a series of working group meetings of a range of subject matter experts with experience in the Gulf of Mexico have been held to evaluate the breadth and limitations of our knowledge of the river and delta's influence that is needed to inform research, resource management and restoration. One of the products from this work is a web-based/interactive nested conceptual model that is under development that will synthesize our current understanding of the influence of the Mississippi River and Delta's influence on the major processes in the Gulf. The conceptual model links to summary descriptions of the processes, available data sets and relevant bibliographies. The goal of this conceptual model tool is to aid in exploring and prioritizing research and monitoring needs to support comprehensive Gulf restoration.

Distribution of Ecosystem Integrity Indicator Monitoring Efforts on the Coastal Resilience Mapping Portal

NatureServe

As part of an effort to identify a set of robust indicators for coral reef, oyster, seagrass, mangrove and salt marsh ecosystems, we have compiled ecosystem distribution maps and provide a foot print of all existing monitoring programs that are collecting data on our proposed suite of indicators. This tool provides generalized (100 km2) and actual footprints of the monitoring programs that are collecting data for particular indicators. The product can be used to understand where indicator data are being collected and identify areas where additional sampling may be needed.

DIVER (Data Integration, Visualization, Exploration, and Reporting) Tool

NOAA

The DIVER (Data Integration Visualization Exploration and Reporting) application is a data warehouse and query tool that manages the integration of environmental data and restoration project information and monitoring data, and makes this data available to stakeholders, scientists, and the public for querying and download for further analysis. The vast majority of environmental data that supports the Programmatic Damage Assessment and Restoration Plan (PDARP) that was collected by Trustees (Federal/State/Local) are available through DIVER Explorer. The data warehouse aspect of the DIVER application supports the ability to integrate and organize field collected data including observations, samples, photographs, oceanographic data and laboratory analysis or interpretation, and make the results and supporting information available for query and download. DIVER Explorer is a web-based querying tool which provides the user with the ability to search and filter environmental data and information by keywords (e.g. "salt marsh") or by a specific project or workplan; search by a specific area (draw a shape on the map or choose from existing state or water boundaries); and download results with metadata and additional notes and documentation. The DIVER data warehouse provides the opportunity to integrate or link restoration monitoring data from across the Gulf of Mexico and make data available through the DIVER Explorer query tool. Restoration project information from NRDA funded projects is also managed and made available through the DIVER tool, with collaboration workspaces for each Technical Implementation Groups (TIG).

GNOME Suite

NOAA

The GNOME™ (General NOAA Operational Modeling Environment) Suite is a set of modeling tools for predicting the fate and transport of pollutants (such as oil) spilled in water. These modeling tools are used for NOAA's spill response support and are also publicly available for use by the broader academic, response, and oil spill planning communities. The GNOME modeling suite can be used and accessed in multiple ways and includes the following features:

- Web interface as WebGNOME, including Location Files that no longer need to be downloaded

- 3D transport modeling

- Weathering algorithms from the ADIOS weathering model, with updates

- Integration of the Response Options Calculator (ROC) to assess performance of spill response systems (i.e., skimming, burning, application of chemical dispersant)

- A scripting interface (PyGNOME) for automation and batch processing.

- An open-source code base

- The GNOME Online Oceanographic Data Server (GOODS) for accessing operational modeling results in a GNOME-compatible format.

Gulf of Mexico ERMA (Environmental Response Management Application)

NOAA

ERMA is a mapping and visualization tool that provides access to a vast amount of environmental and operational data that is key to decision making for environmental responses, assessment, planning and restoration. ERMA has most recently served as the USCG Common Operational Picture (COP) for Hurricanes Harvey, Irma and Maria to coordinate activities across Federal and State partners. ERMA was used intensively by the Federal DWH Response effort as the COP during the active clean-up phase, providing up to the minute updates on things like status, trajectories, sampling and results that were used for decision making. ERMA served as the primary visualization tool for environmental datasets that were used to develop the Deepwater Horizon Programmatic Damage Assessment and Restoration Plan. The team of trustees that spanned Federal, State and other partners used ERMA to visualize and communicate analysis and results. Gulf of Mexico ERMA is now used in the DWH environmental restoration effort, including a partnership with the Ocean Conservancy where the datasets used for their Gap Analysis of Gulf of Mexico Long-Term Monitoring are displayed in ERMA. The ERMA application is also actively used for responding to current environmental disasters including hurricanes and oil or hazardous materials spills.

Gulf of Mexico Migratory Species Conservation Project Tools: New Spatial Decision Support Tool

The Nature Conservancy

Blueways Conservation Decision Support Tool (DST) to provide support for planners, resource managers, government officials, and the ocean conservation community to understand marine species blueways, threats, and key stopovers.

Gulf of Mexico Research Initiative Information & Data Cooperative (GRIIDC) Data Management System

GRIIDC

The tool was initially designed to manage and distribute data generated by Gulf of Mexico Research Initiative (GoMRI) funded projects. The data management applications that assist with planning, documenting, and submitting data to GRIIDC are designed for investigators and data managers. These tools are available to GoMRI and Florida RESTORE Act Centers of Excellence Program (FLRACEP) funded investigators. The GRIIDC program hopes to develop new partnerships to continue our mission of ensuring a data and information legacy that promotes continual scientific discovery and public awareness of the Gulf of Mexico ecosystem. Potential partnerships with Louisiana, Mississippi, and Alabama RESTORE Act Centers of Excellence, the National Academy of Science Gulf Research Program, and others, will allow more investigators to use these tools to manage and share their data using the GRIIDC system. The system allows data submissions to be tracked through the data package workflow by both investigators and program administration via the dataset monitoring application. The GRIIDC data discovery portal and dataset landing pages are designed for anyone who is interested in obtaining data about the Gulf of Mexico, including academic researchers, natural resource managers, policy makers, emergency responders, non-governmental organizations, and the general public.

Interactive Plotting of Fine-scale Zooplankton Distributions and Oceanographic Data using R Shiny

Department of Marine Science, University of Southern Mississippi

The tool is a graphical user interface (GUI) app that allows a user to easily create a customized plot of oceanographic data and zooplankton distributions in an interactive manner. The GUI is implemented using the R package "shiny," which is used throughout academia and industry to create tools for data exploration. For this app, the user selects the background color data type (temperature, salinity, sigma-t, PAR, chlorophyll-a, or dissolved oxygen), the contour data, the number of transects to view, and choose to see data collected during the day or night. The user can also select which zooplankton type (16 taxa total) they want to see overlaying the oceanographic data. These organisms are plotted as dots, with the size of the dot proportional to the organism concentration (individuals m-3). Once the user is satisfied with the choices, he or she clicks "Plot," which generates a plot by filtering the data to the user-provided specifications. The user can make plots interactively, and the app provides a "download" button for saving as an image.

LandScope Gulf Coast: A Collaboration between the Strategic Conservation Assessment of Gulf Coast Landscapes and NatureServe

US Fish and Wildlife Service

The Strategic Conservation Assessment Team is partnering with NatureServe to develop the LandScope Gulf Coast portal. This web portal will be a spatially-enabled digital library that will act as a clearinghouse of data layers, important documents, and pertinent resources relative to land conservation in the Gulf Coast Region. Data will reflect local and regional objectives and priorities for Gulf Coast landscape conservation. The ultimate product of the SCA project will be will be a dynamic map-based tool that will allow users to weigh ecological and socioeconomic priorities and view the conservation opportunities that meet those criteria. The SCA tool will provide the science that can aid stakeholders in prioritizing land conservation projects in the region. While this final dynamic SCA tool will be available in 2020, the data layers and building blocks of the SCA project will be available to stakeholders immediately on LandScope Gulf Coast.

The SINTEF OSCAR and DREAM Models for Oil Spill Contingency and Response

SINTEF Ocean

OSCAR is a state of the art oil spill model. OSCAR predicts the fates and effects of accidental oil spills, from platforms, vessels or from subsea blowout situations. OSCAR provides insight in the behavior of oil during an accident and captures the effects of contingency and response, allowing for contingency analysis and planning as well as hind- and forecasting.

The model accounts for weathering, the physical, biological and chemical processes affecting oil at sea. Many of these processes are strongly coupled with laboratory activities at SINTEF on oil weathering. Contingency and response strategies provided ranges from mechanical collection of oil to dispersant application on surface and in water.

OSCAR is continuously updated and actively developed with the industry in order to improve the existing model and applying the model software to new problem areas.

The model software contains several sub-models which also exist as separate model products:

- Oil Weathering Model describes with both first principles and experimental results the weathering processes of oil on the sea.
- DeepBlow describes the spreading of oil from a subsea release, describing the multiphase plume trajectory including oil and gas.
- OSCAR also supports doing statistical or stochastic modeling, providing insight in how a typical oil spill scenario behaves under a wide range of weather or seasonal conditions.

Geography and Scale

OSCAR is actively used for planning, hind- and forecasting of accidental releases in locations such as the Northern and Baltic Sea, Gulf of Mexico and the Mediterranean Sea, and can be set up to model accidental oil spills in all geographical areas of the world.

The Microbial Genome Atlas Project (MiGA) for Diversity and Classification Studies of Microbes at the Whole Genome Level

Georgia Institute of Technology

The small subunit ribosomal RNA gene (16S rRNA) has been successfully used to catalogue and study the diversity of microbial species and their communities to date as exemplified by the Ribosomal Database Project (RDP) and Silva projects. Nonetheless, several aspects of rRNA gene-based studies remain problematic. Most importantly, how to better resolve microbial communities at levels at which the 16S rRNA gene provides inadequate resolution, namely the species and finer levels, and how to best catalogue whole-genome diversity and fluidity. To bridge this gap, we have developed the "genome-equivalent" of RDP called the MiGA project (available at: www.microbial-genomes.org). MiGA allows the classification and gene-content diversity analysis of query genome(s) or assembled contig(s) against a reference database of microbial genomes using the ANI/AAI concept (currently using the ~13,000 isolate genomes available in NCBI's Genome database). Examples of using MiGA to perform high-resolution analysis of microbial genomes associated with oil biodegradation, including metagenome-assembled genomes (MAGs) of uncultivated taxa, and microbial source tracking in riverine ecosystems will be presented.

APPENDIX IV: MEDIA PLAN & OUTCOMES

Plan for Increased Local Engagement

A key element to the 2018 GoMOSES Communications/Media Engagement plan was to increase local engagement at the conference in order to lay the foundation for the 2019 conference in New Orleans as well as future years. This specifically focused on two elements of the conference communications plan:

Engage partner organizations and universities

A key element of this plan included increased engagement with GoMOSES Executive Committee (ExComm) Communication representatives as well as GOMRI Consortia and other related organizations local to the area. The goal of engaging communications representatives from these additional organizations was to leverage each of our assets in order to expand the reach of our individual efforts. To that end, a collaborative strategic communications flier was created with key information and dates. This was distributed to these reps so that all information could easily be found in one place, and the flier could serve as a rallying point to legitimize the effort. Two meetings were held with communication reps from the GoMOSES ExComm in order to discuss conference communication efforts as a whole as well as to get an idea of their individual efforts and how we may be able to increase their reach. GoMOSES press releases were distributed to these representatives so they could cross post on social media or through their website, and the offer was made for them to do likewise. Additionally a *guest blog* was written for posting on the NOAA Office of Response and Restoration website to advertise the conference.

Continue to build relationships with media outlets

Increased effort was made to engage local media. To that end, S. Garrett visited local media outlets in January during a conference planning trip. Each media outlet was provided with promotional materials and a conference handout. Additionally, emails about the conference were sent to a media distribution list (50 people) consisting of previous media attendees, journalists who have published articles about Gulf research, regional papers, and others who asked to be on our list. We received feedback from media in attendance that they heard about the conference from this personal email.

While at the conference, relationships with media were cultivated, in particular with The Times-Picayune and WWNO. These two outlets have a recently increased focus on environmental reporting with their new "*Coastal Reporting Team*" and weekly Coastal News Roundup radio shows, respectively. A reporter from each – Tristan Baurick and Travis Lux, respectively – attended the conference and have been engaged since. To further cultivate this relationship, Leslie Smith has opened up an email dialogue with the intent of building toward increased involvement next year with the potential for articles and interviews leading up to the conference.

Media Outreach Objectives & Outcomes

Entice Media Attendance

- Provided easy access to conference information for media on the *conference website*
- Reached out to potentially interested media
  - Created targeted media lists to send pre-event release and invitation
  - Sent out two pre-conference press releases via PR NewsWire
    - PR1 (Dec. 13): Total Pick-ups = 235, Potential Audience Online = 17,283,703, Twitter = 1,296
    - PR2 (Jan 24): Total Pick-ups = 251, Potential audience = 16,567,284; 4,907 Twitter followers
  - Both PRs were also distributed through "Ocean News & Technology" and "ECO Magazine" online newsletters.
  - PR2 was distributed through the Consortium for Ocean Leadership Ocean News Weekly (ONW) e-Newsletter with a distribution of more than 7,000 people.
  - In person media outlet visits were conducted by S. Garrett on Jan. 11, 2018
    - Visited seven local NOLA media outlets, dropped off promo materials including a conference handout
- The New Orleans Advocate
- The Times Picayune
- WWL TV
- Louisiana Weekly
- WWNO (local NPR; 89.9)
- WVUE New Orleans (Fox 8)
- WTUL New Orleans (91.5 FM)
  - Updated information on AP planner website
  - Wrote *guest blog* on the NOAA Office of Response and Restoration website to advertise the conference.

Inform media of key findings presented at the conference

- Created a media kit for distribution at the conference (in press room)
    - Key message document
    - "Hot topics" document – Summaries of 10 noteworthy abstracts distributed across tracks
    - Schedule of events & speaker bios (conference program)
- Promoted the conference on social media accounts

Obtain positive, in-depth conference media coverage

- Provided and staffed a press information table in the main registration area
- Provided access to a quiet interview space as needed
- Connected media with scientists from "hot topics" document
- Received and coordinated media inquiries
- (See discussion of publications in below sections)

Take full advantage of social media

- Promoted and encouraged use of #GoMOSES hashtag
    - Included hashtag on all conference materials and press releases
    - Total number of uses of conference hashtags: 170
        - #GoMOSES: 166
        - #OneGulf: 2
        - #gulfscienceconference: 2
    - Number of uses of the #GoMOSES hashtag by GOMOSES: 27
    - Number of uses of the #GoMOSES hashtag by conference participants: 139
    - Successful transition to and adoption of new hashtag given the very limited use of previous hashtags
- Monitor following on Facebook and Twitter:
    - Facebook followers: 316 page "likes"
    - Twitter followers: 386
        - 7,215 impressions from 25 tweets across the 5 days of the conference
        - Gained 34 followers in February

Summary Numbers

- Media Tracking
    - Before Conference
    - PR 1: 17.3M; PR 2: 16.6M = 33.8M (potential audience)
    - Meltwater Coverage: 202 articles with a reach of 22.3M
    - After conference
        - 9 articles published with a reach of 4M
- Media attendees at the Conference
    - 9 Media Attendees
- Interviews before, during and after the Conference
    - Before: WWNO Interview Friday before the conference
    - During: Times Picayune & WWNO
- Social Media
    - Twitter Followers: 386
    - Facebook Followers: 316 page "likes"
    - #GoMOSES use: 166
    - #OneGulf Hashtag use: 2
    - #gulfscienceconference use: 2

PRESS COVERAGE SUMMARY REPORT

Mechanisms Accomplished: 2018 GoMOSES Conference Media Plan

- Created and updated media section on the *conference website*
- Created targeted media lists
- Distributed two press releases through email and PR Newswire
- Received media inquiries and facilitated media interviews
- Promoted conference on social media accounts
  - Continued conference Facebook and Twitter accounts using
  - Hashtag: #GoMOSES
- Developed key message document specific to the conference
- Determined conference "hot topic" science sessions and pitched to media
- Provided a Press Info Table with quiet interview space available upon request

QUANTIFYING SUCCESS:

News media attendance: 9 members of news media registered

News media outlets represented, include: The Times Picayune, WWNO (local NPR affiliate), and 10/12 Industry Report

News coverage: Searches through Meltwater returned 211 examples of coverage before, during, and after the meeting with a total reach of 26.4M. Full media list in attached Excel Document. The coverage includes stories in newspapers & magazines; on radio & television; and on various Internet sites, including blogs & press-release aggregators. Note that there is some overlap between the Meltwater results and the Press Release results from PR Newswire.

Examples:

- **The Times-Picayune:** "*Dispersants used in BP disaster hampered growth of oil-earing bacteria*"
- **WWNO, New Orleans Public Radio:** "*Coastal News Roundup: Roseau Bug Devastation, Oil Spill Research And Glitter*"

Total Circulation

To date, total circulation (Meltwater + PRNewswire) for the event is 60,217,209.

Social Media Statistics

- Twitter account: 386 Followers
- Twitter hashtag (#GoMOSES) use: 166
- Facebook: 316 page "likes"

For further information, please contact Leslie Smith at lsmith@oceanleadership.org or 202.787.1613.

PRESS RELEASE 2: Scientists Examine Oil Spill Response, Restoration, and Resilience in Upcoming Conference

Posted Jan. 24, 2018 9:17 AM ET

Total pick up:	**245 Postings**	**6 Twitter**
Total Potential Audience:	**16,567,284 visitors/day**	**4,907 Twitter Followers**

PRESS RELEASE 1: Gulf of Mexico Oil Spill & Ecosystem Science Conference Explores Response, Restoration, and Resiliency in the Gulf

Posted Dec. 13, 2017 9:17 AM ET

Total pick up:	**233 Postings**	**2 Twitter**
Total Potential Audience:	**17,283,703 visitors/day**	**1,296 Twitter Followers**

BEFORE CONFERENCE ARTICLE TOTALS (MELTWATER)

PR1: **50 Articles** **8,032,778 Reach**

PR2: **151 Articles** **14,302,492 Reach**

POST/DURING CONFERENCE ARTICLES (MELTWATER)

2/9/2018	NOLA.com	Roseau cane, oil spill research and Mardi Gras glitter: This week's coastal news roundup	1,000,000
2/9/2018	WWNO	Coastal News Roundup: Roseau Bug Devastation, Oil Spill Research and Glitter	17,000
2/12/2018	EnvironmentGuru	Jon White - From the President's Office: 02-12-2018	5,000
2/15/2018	NB - National News	Make sure the $16 billion for Gulf restoration is well spent	984
2/15/2018	NOLA.com	Make sure the $16 billion for Gulf restoration is well spent	1,000,000
2/15/2018	NOLA.com	Dispersants used in BP disaster hampered growth of oil-earing bacteria	1,000,000
2/15/2018	NB - National News	Dispersants used in BP disaster hampered growth of oil-earing bacteria	984
2/20/2018	NOLA.com	Biting flies mean recovery from BP oil disaster	1,000,000
2/20/2018	NB - National News	Biting flies mean recovery from BP oil disaster	984
TOTAL	**9**		**4,024,952**