
2019
Report
Gulf of Mexico
Oil Spill & Ecosystem
Science Conference
February 4-7, New Orleans, LA

2019 Partners & Supporters

Gold Sponsors

Bronze Sponsors

GULF OF MEXICO OIL SPILL & ECOSYSTEM SCIENCE CONFERENCE EXECUTIVE COMMITTEE

Larry McKinney (Chair)
Gulf of Mexico University Research Collaborative

Laura Bowie
Gulf of Mexico Alliance

Thomas Coolbaugh
American Petroleum Institute/ExxonMobil

Elizabeth Fetherston-Resch
RESTORE Centers of Excellence Research Grants Programs

Bethany Kraft
Volkert

Stacey McLeroy
U.S. Food & Drug Administration

Jonathan Porthouse
National Fish & Wildlife Foundation

Chris Robbins
Ocean Conservancy

David Shaw
Gulf of Mexico Research Initiative

Kevin Sligh
U.S. Coast Guard

Gregory Steyer
U.S. Geological Survey

Buck Sutter
Gulf Coast Ecosystem Restoration Council

LaDon Swann
Sea Grant in the Gulf of Mexico

Evonne Tang
Gulf Research Program of the National Academy of Sciences, Engineering, and Medicine

Gregory Wilson
U.S. Environmental Protection Agency

Dave Westerholm
National Oceanic & Atmospheric Administration

Denis Wiesenburg
Gulf of Mexico Research Initiative

Chuck Wilson
Gulf of Mexico Research Initiative

The Executive Committee thanks the following partner organizations for their time and support.

The Gulf of Mexico Research Initiative Management Team provided logistical and programmatic assistance throughout the conference.

Volunteers from regional universities and organizations assisted with onsite registration, check-in, and session support.

Table of Contents

Appendices

James D Watkins Student Award for Excellence in Research

For 2019, 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 Award for Excellence in Research is named after Admiral James D. Watkins, a hero in the ocean community who passed away in 2012. Admiral Watkins lived a life of public service, and his extraordinary influence on the ocean science community is immeasurable. He served as the chair of the U.S Commission on Ocean Policy, co-chair of the Joint Ocean Commission Initiative, and founder of the Consortium for Oceanographic Research and Education, the precursor to the Consortium for Ocean Leadership. Given his lifelong pursuit of encouraging and building the next generation of ocean scientists, it is appropriate that the award given in his name recognizes excellent research and that it motivates students to continue to excel in the field of oceanography.

THE STUDENT RECIPIENTS ARE:

Alexander Freddo *(Texas A&M University)*
Advanced Oil Spill Transport Across the Bay/Coastal Boundary

Lindsay Jasperse *(University of Connecticut)*
The Effect of Oil Exposure on Reproduction and Development of Sheepshead Minnow (Cyprinodon variegatus) *in Different Environmental Scenarios*

Alexis Khursigara *(The University of Texas at Austin)*
Impacts of Crude Oil Exposure on Ecological Performance in Fish

Kelli Mullane *(Scripps Institution of Oceanography)*
Insights into the Adaptation of Hydrocarbon-Degrading Microbes to Life at High Pressure: The Role of Motility and Chemotaxis

Kendall Valentine *(Louisiana State University)*
Spatial Patterns of Long-Term Marsh Edge Loss in Barataria Bay

EXECUTIVE SUMMARY

CONFERENCE OVERVIEW

The 2019 GoMOSES Conference, "Minding the Gaps: Research Priorities for Response, Restoration, and Resilience," sought to bridge basic and applied research in the Gulf of Mexico to highlight new discoveries and to inform and update decisions and strategies, emphasizing the identification of remaining information gaps. After nearly nine years of dedicated research in the Gulf of Mexico, which questions have been answered and which questions remain? How do we prioritize areas of remaining uncertainty to guide research needed to inform future management decisions? The conference program also aimed to reach beyond the Deepwater Horizon oil spill to consider how various stressors contribute to ecological and social resilience in the Gulf of Mexico and inform response, restoration, and resource management strategies.

The conference was planned by an Executive Committee of 16 partners representing academia, federal agencies, and nongovernmental organizations, with the generous support of three major sponsors.

An overview of the conference schedule is available in Appendix I (Page 30). Program highlights include:

- Keynote addresses by Robert Spies, Chief Scientist of the Exxon Valdez Oil Spill Trustee Council (1990-2002) on "A Legacy of Knowledge," followed by "Bridging Science and Restoration Decision-Making," by Buck Sutter, Deputy Executive Director of the Gulf Coast Ecosystem Restoration Council;
- Opening plenary discussion on the next phase of Gulf research, featuring both keynote speakers and panelists Chuck Wilson (Chief Scientist, GoMRI), Alyssa Dausman (Vice President for Science, The Water Institute of the Gulf), Pamela Plotkin (Director, Texas Sea Grant College Program), and Evonne Tang (Associate Executive Director, Gulf Research Program);
- Twenty-three conference sessions offering approximately 250 oral and 240 poster presentations; and
- Closing plenary honoring Dr. Chris D'Elia as the first recipient of the Wes Tunnell Lifetime Recognition for Gulf Science and Conservation, presented by the Gulf of Mexico University Research Collaborative.

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 list of meetings, with descriptions as available, is provided in Appendix II (Page 34).

The GoMOSES Conference was pleased to host the third annual Gulf of Mexico Data Tools Café, which offered attendees a hands-on opportunity to learn about several data management and analysis tools currently available. The nine featured tools are listed in Appendix III (Page 37).

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. Searches through Meltwater, a media monitoring service, returned 149 examples of coverage before, during, and after the conference with a total reach of 22.0 million people. A full report of communications activities is available in Appendix IV (Page 40).

SCIENTIFIC SESSIONS

The 2019 conference was pleased to offer 23 concurrent sessions over three days, highlighting research advances and their applicability to oil spill response, restoration, and recovery, along with resource management. In keeping with the 2019 theme, extra emphasis was placed on identifying remaining questions and topics for future research endeavors.

HIGHLIGHTS

OIL DYNAMICS

- Many chemical analysis approaches and analytical tools are available that enable identification and/or quantification of oil spill constituents, transformation products, and dispersants that were previously inaccessible. Additionally, advanced analytical and genetic "omics" methods are allowing more comprehensive understanding of how oil is weathered and transported.
- We are moving towards a better understanding of deep-water blowouts, the role photochemistry plays on the fate of surface oil prior to shoreline stranding, and MOSSFA formation, with implications for the use of remediation techniques during response.

ECOLOGY

- The offshore Gulf, a highly diverse, interconnected habitat, provides important linkages between the faunae inhabiting the ocean surface, deep-pelagic, and coastal domains. *Sargassum* spp. are the base of pelagic food webs in the Gulf, forming highly biodiverse and productive habitats that serve as nursery grounds for numerous recreationally and commercially important fishes. The Gulf is one of the world's four "hyperdiverse" deep-pelagic ecoregions. Deep-pelagic fishes and oceanic juvenile stages of coastal fishes are prey to offshore apex predator species (e.g., yellowfin tuna, swordfish, and lancetfish), creating a mechanism by which oil contaminants could be incorporated into these predators, and thus humans.
- Continuity of existing time series (collections, analyses) is essential for the construction of baselines and quantitative characterization of species, especially seabirds and large marine vertebrates, and for the disentanglement of multiple stressors. Research is ongoing to better understand the trophic ecology and habitat use of these species.
- The benthos of the Gulf has not fully recovered following the Deepwater Horizon oil spill; in fact, the health of the deepest coral sites is worsening. Coral symbionts (both microbes and ophiuroids) provide protection from stressors, particularly marine oil snow. Natural seeps were found to provide nutritional carbon and nitrogen which is important to the health of nearby corals.
- There is a consistent pattern of emerging impacted physiological pathways being identified across a wide array of species, generations, and taxa, but these only represent the first steps of this work. Natural environmental stressors including low oxygen, changing salinity, and ultraviolet light can act additively or synergistically with oil exposure to exacerbate organismal effects.

HUMAN DIMENSIONS

- Disaster "exposure" is multidimensional, including both direct (e.g., physical contact) and indirect pathways (e.g., financial loss). Exposure and perceived risk are important flags for illness anxiety and other mental health outcomes, in part because of the social disruption caused by disasters. The concept of "allostatic load" helps to explain the multiple sources of disaster-related stress on individuals and communities and how this stress may lead to poor outcomes.
- Fishers are an invaluable and perhaps underutilized resource in fisheries or marine research. Mechanisms facilitating information exchange to and from fishers can help increase awareness of fisheries management challenges in this community and flag issues for further study. Anthropogenic stressors and their synergistic effects have implications for fisheries management and restoration.

DATA AND MODELS

- It is important collect all the extra, detailed information that makes data useful and gives it context, such as why one was collecting the data. Common standards are the way forward for this level of specifics to move with the data itself and be included with the metadata.
- Visual tools are critical for better communication and collaboration between large groups with distinct specialties. The ability to synthesize data in images, maps, and 4-D animations allows people to see, think about, and connect ideas more easily.
- Oil spill modeling, both operational and for research, is expanding in scales, from extensive integrated regional models to high resolution models of a single droplet and models of aerosolized oil droplets. Calculation of the migration of oil within the Gulf is possible with much higher accuracy and reliability, enabling more effective response strategies. Numerical modeling suggests diversion of the Mississippi River (and other rivers) will affect nutrient and freshwater transport pathways over the Louisiana Shelf and to the Loop Current, with implications for hypoxia dynamics.
- Many coupled models exist that address the natural sciences, however, few couple the natural sciences to economics, social sciences and humanities. A self-assembled modeling community of practice is currently in the process of consolidating a list of models used to evaluate natural processes in the Gulf of Mexico.

RESPONSE

- Oil spill response and impact assessment strategies are guided by data provided by three main toolkits: simulations/models, empirical observations, and extrapolations. Success comes in optimizing the use of these toolkits to reach a "reasonable degree of scientific certainty." A multiple-lines-of-evidence approach, where fit-for-purpose models generate hypotheses that are validated by empirical data and balanced by extrapolation, is recommended.
- Adequate characterization of exposures is necessary to understand the degree to which a test can be applied to the field. Much scientific work, though perhaps scientifically accurate and precise, has little or no relationship to what would be found in a real response scenario. However, the results are widely reported by media, potentially influencing public perception, and the ultimate tradeoff decision making process, away from the best available response option.

RESTORATION

- Relationship building is a long-term investment, and researchers should recognize and prepare for a significant lag time (five to seven years) between when the science is produced and applied. Engagement with stakeholders is often most effective when initiated during the research planning stage and when maintained throughout the entire research process.

GAPS

OIL DYNAMICS

- The degree to which oil weathering (e.g., photo-oxidation) reduces the effectiveness of response options (e.g., dispersant) is not well predicted by lab tests. Moving forward, there is a need for research to focus on understanding those compounds that pose a risk to ecological receptors under realistic exposure conditions. Protein/carbohydrate ratios should be investigated further for the utility to predict MOSSFA formation.
- Understanding the implications of GoMRI research on oil spill mitigation and response efforts needs to be fully appreciated and understood.

ECOLOGY

- Identification of multitaxa hotspots in the Gulf (e.g., overlap of marine mammals, sea turtles, and seabirds) would be useful for determining critical habitats and prioritizing habitat restoration efforts. Pristine reference sites including multiple taxa need to be established for the Gulf. Definitions of resilience and recovery need to be established between multiple trophic levels. Connectivity of inshore-offshore environments is understudied and important for quantification of the inputs/impact from stressors (e.g., hypoxia, heavy metals, hydrocarbons, plastics).
- Gulf-wide surveys and tracking in the southern Gulf of Mexico are essential for understanding the distribution, abundance, and habitat use of marine mammals and seabirds on the scale of the Gulf ecosystem. Impacts of climate change on distribution, abundance, and foraging ecology of large marine vertebrates in the Gulf is an important area of study moving forward. Funding sources for international, collaborative, Gulf-wide survey efforts need to be identified for the United States, Mexico, and Cuba.
- Important toxicological impairments to organisms have been historically overlooked and should be incorporated into oil spill response research going forward. While the general patterns of emerging effected pathways appear to span multiple species and taxa, there is also clear interspecies variability related to magnitude of injury, and the longevity of many of the observed effects has yet to be determined. Whether many of the emergent pathways are extensions of the classical cardiorespiratory impairments of oil, or if they have novel cellular origins, is also unclear. This question is also relevant to oil weathering, as the same chemical constituents that drive classical oil toxicity endpoints may not drive the emergent toxicity endpoints.

HUMAN DIMENSIONS

- Toxicity measures for many oil spill compounds are missing or incomplete to be able to estimate health risks. Chronic exposures and multiple chemical exposures remain challenging for human health risk assessments; they may be difficult to determine and quantify using existing research methods.
- There is a need for more research on the impact of disasters from an intersectional perspective (e.g., gender, race, age, and other components). The impacts of disasters on specific ethnic communities and women and children are also understudied.

DATA AND MODELS

- Organizations managing large volumes of information need to package it so that is readily discoverable, however, knowing the granularity for consumption is difficult to fathom. Where possible, data should be linked to publications, with grantees required to provide rich metadata records that expand upon the “who, what, where, when, and (especially) why.”
- Champions are needed to tell stories of interdisciplinary success and better share the message of exactly how important data are so that resource managers, policy makers, corporations, and communities see and hear how valuable the data generated really are.
- Software development goes hand-in-hand with progress in hardware to facilitate access to, and handling of, increasing amounts of data that can now be transferred almost instantly between groups of people, in particular the public and the decision makers. Access to software and hardware able to handle large amounts of various types of data limits the creation and development of visualization products.
- The anthropogenic (humanities, socioeconomic, social science) models lag behind the natural science models in maturity. The integration of natural and anthropogenic models needs further development, and possibly new methods. More data are needed on indicators and metrics for socioeconomic and social science models, including overall socioeconomic factors and both physical and mental aspects of human well-being. The units of analysis need to be reconciled between the different disciplines. Spatial and temporal units will also need to be consistent between modeling systems; scientists, models, and data must be able to speak to each other.

- Challenges remain for modeling the coastal environment, particularly transport and mixing, as well as phytoplankton and microbial community dynamics. With oil spill modeling, there is the need for ocean circulation and wind models, with research focusing on scaling necessary to provide the best information. River fronts, where freshwater overlays marine water, is a complex issue for oil spills, as the freshwater can block the oil transport, and better understanding will assist in forecasting the movement of oil.

RESPONSE

- Industry and academic researchers should work closely together to enable deeper understanding of oil spill dynamics, identify the data necessary for timely decisions during a spill, and support more effective response strategies.
- Community members should be viewed as collaborators and partners rather than "recipients" of hazard planning. Response plans should include more attention to stress reduction, relief, and treatment. Disaster response and relief should be expanded to provide comprehensive language/translation tools for responders and better incorporate a wider geographic scope of affected people (e.g., displaced communities). Opportunities for strengthening public health preparedness, including for stress-related impacts, in disaster laws, policies, and regulations need to be identified.

RESTORATION/MANAGEMENT

- Not much information exists about the coproduction between researchers and resource managers of science and knowledge; many times, research and funding agencies operate based off "lessons learned." More could be done to scale "lessons learned" and make progress beyond the individual researcher and funder.

IN SHORT

As the session highlights demonstrate, Gulf science has come a long way in understanding oil dynamics, weathering, and migration, and the impact of oil on ecosystems and communities. Effective communication and relationships are essential to integrating these advances and discoveries into updated policies and management plans, whether for oil spill response, community resilience, or ecosystem restoration. Increased discourse and collaboration between academia, industry, government, and the general public can help bridge differences between sectors, fill in the research gaps identified in each session, and further inform decision makers and stakeholders.

Greater detail and explanation of these points are available in the full session summaries (Pages 4-27). Abstracts for *oral* and *poster* sessions are archived online.

INTRODUCTION

In its seventh year, the Gulf of Mexico Oil Spill and Ecosystem Science (GoMOSES) Conference sought to connect science and application to policy, practice, and management. As usual, the conference was a time to come together and discuss what has been learned. Unlike other years, more weight was placed on what questions either remain unanswered or have arisen from nearly 10 years of research. This comes in preparation for the conclusion of the Gulf of Mexico Research Initiative and a shift in focus from oil spill response to restoration and recovery. In other words, the Gulf scientific and management community is preparing for the next phase in Gulf research. Anchoring these changes was an interdisciplinary approach to thinking about science, ecosystems, and communities, which was championed by Chris Elfring, who represented the Gulf Research Program on the conference Executive Committee and passed away in 2018.

The 2019 program, "Minding the Gaps: Research Priorities for Response, Restoration, and Resilience," aimed to forward these goals through four days of meetings, presentations, and discussion. The program opened with a discussion of what support will be needed as the Gulf science and management community begins the transition from an emphasis on oil spill response to recovery and restoration. Twenty-three scientific sessions honed in on what is currently known and identified what questions remain. In closing, attendees took a moment to remember the late Wes Tunnell and his many contributions to Gulf science, and honored Chris D'Elia with the inaugural Wes Tunnell Lifetime Recognition for Gulf Science and Conservation.

OPENING PLENARY

CHANGING FOCUS: FROM OIL SPILL RESPONSE TO RESTORATION

Deepwater Horizon is not the first time a wealth of scientific research has resulted from a major oil spill; similar research activities under the Exxon Valdez Oil Spill Trustee Council informed federal legislation, spill response, and, later, restoration efforts in Alaska. Keynote speakers set the stage with lessons learned from the Exxon Valdez spill and an assessment of the current state of Gulf science versus pre-Deepwater Horizon.

KEYNOTES

Robert Spies, Chief Scientist, Exxon Valdez Oil Spill Trustee Council (1990-2002)

A Legacy of Knowledge

Initially, research related to the Exxon Valdez oil spill sought to quantify the extent of damage caused to Alaskan ecosystems. Years later, as species such as pink salmon showed few signs of recovery, the questions changed from "What is extent of injury?" to "Why are species not recovering?" This shift of focus from impact to recovery also drove a change of scientific management and objectives, including a pivot from studies of injury of single species to ecosystem constraints and recovery. Dr. Spies concluded with some lessons learned from this transition, such as the advantage of supporting large multi-institutional ecosystem studies and the importance of communicating results to inform the status of resources and adaptive management measures. Many of these lessons were later *summarized in a related blog post*.

Buck Sutter, Deputy Executive Director, Gulf Coast Ecosystem Restoration Council

Bridging the Gap of Gulf Science and Decision-Makers

There are broad science needs as the Gulf transitions to restoration. Because science and policy "speak" different languages, there is often tension between these two groups. Opportunities for restoration/synthesis discussions, as well as organizations which synthesize science for policy needs, help diffuse this tension. There are consequences if we fail to communicate our mutual challenges— we don't want to settle for "what could have been" in this unique time of funding and opportunity. We need to effectively convey the benefits of doing things like oyster reef restoration—WHY is that important? Adaptive management won't work without robust monitoring; are we monitoring or investing the right resources into monitoring? Because science can help decision makers manage risk, impacts of climate change in the Gulf should be incorporated in adaptive management as well. Mr. Sutter also offered some lessons learned, including never underestimating the importance of working together collaboratively; keeping smart, young people around you; acknowledging the many challenges to data management; and how having champions makes a big difference.

PANEL DISCUSSION: THE NEXT PHASE IN GULF RESEARCH

Following their keynotes, both speakers joined a panel to discuss the next phase of Gulf research in response to shifting priorities and funding sources. What can the Gulf research and management communities learn from the Alaskan experience to help make their own transition from response to recovery and restoration? Does the Gulf region have the administrative and financial support necessary to address any knowledge gaps and maintain the current momentum for Gulf science?

PANELISTS

Moderator: Chuck Wilson, Chief Scientist, GoMRI
Alyssa Dausman, Vice President for Science, The Water Institute of the Gulf
Pamela Plotkin, Director, Texas Sea Grant College Program
Evonne Tang, Associate Executive Director, Gulf Research Program

Science became a more lasting legacy post-Valdez; the event demonstrated that long-term studies are necessary for monitoring long-term impacts. It is important to invest in baseline data and longitudinal research that provide decision makers with big-picture explanations, for example how an ecosystem functions, so they may make more informed policy and management decisions.

Some activities are so big that no one organization can take them on alone, requiring collaboration and coordination. For example, approaching the Gulf of Mexico as a Large Marine Ecosystem for research and management purposes means building relationships between institutions in the United States, Mexico, and Cuba. There are many funding streams; the question is how to make connections for cross-institutional collaboration and coordination to maximize funding? The Centers of Excellence are looking for creative approaches toward this but face statutory challenges; they recognize the value in research conducted to date and are seeking approaches to incorporate.

The Gulf research community has an opportunity to move from building tools to integrating these tools into decision making. There is now lots of scientific information that could inform discussions; the question is how to get science into those discussions, encourage dialogue between interest groups, and shift away from political conversations in order to figure out how to translate goals and objectives into actionable ideas.

Most research programs require data sharing and archiving, either via funding agreements or per federal regulations. Although open data is not yet standard practice in the research community, the trend is shifting towards discoverability as well as accessibility. Can researchers and end users find what they need?

Regarding communicating research results to stakeholders and end users, context is important so that the information presented makes sense and is relatable to stakeholders, including people impacted by decisions. As the Gulf science community seeks to continually improve outreach efforts to key stakeholders, they can look at key programs as models. Sea Grant involves communities in strategic plans, research priorities, and funding; research proposals for Sea Grant funding must identify outcomes and end users. The Gulf Research Program asks, “Who are your end users and how do you plan to reach them?” as part of research solicitations and funds networking workshops between funded scientists and end users. Although the Centers of Excellence face limitations by the U.S. Department of the Treasury on funding outreach, they are working hard to ensure the research can be utilized by end users (often states), and their requests for proposals include applicability to end users.

The Gulf science and resource management community needs champions who can drive science forward by cultivating financial and political support for research. Conveying to different audiences WHY science is needed to inform decisions and policy at each level of government is essential. The Gulf delegation in Congress were once such champions of Gulf research; current representatives should be enlisted to promote ongoing research and encourage support for future science needs.

CLOSING PLENARY

GULF OF MEXICO UNIVERSITY RESEARCH COLLABORATIVE (GOMURC) PRESENTATION OF THE WES TUNNELL LIFETIME RECOGNITION FOR GULF SCIENCE AND CONSERVATION

The Gulf of Mexico University Research Collaborative (GOMURC) has recognized marine science and education leaders in the Gulf for many years. In 2017, the GOMURC Board decided to establish a regular recognition, honoring lifetime dedication and achievement in support of a healthy and sustainable Gulf of Mexico environment and economy. The Board further agreed to name this recognition to honor Dr. Wes Tunnell, who passed away in 2018.

Dr. Tunnell's friends and colleagues commemorated his contributions in advancing Gulf science and recognized the first recipient of the Wes Tunnell Lifetime Recognition for Gulf Science and Conservation, Dr. Christopher D'Elia, Dean of the College of the Coast and Environment and Professor at Louisiana State University. Presenting the award was GOMURC Chair Dr. Kelly Lucas, Director of the Thad Cochran Marine Aquaculture Center.

SESSION ORGANIZERS, SESSIONS, AND SUMMARIES

Over three days, approximately 250 oral and 240 poster presentations discussed recent findings and advances in oil spill research, including 52 oral and 103 poster presentations by students. The Executive Committee thanks the 2019 session organizers for their time, expertise, and dedication in reviewing and arranging abstracts and in moderating this year's sessions.

SESSION 001: SYNTHESIS, INTEGRATION, COLLABORATION, AND LINKAGES: MOVING COMPLEX DATA INTO THE RIGHT HANDS

Dave Reed (Florida Fish & Wildlife Conservation Commission), Elizabeth Fetherston-Resch (Florida Institute of Oceanography), Emily Frost (Smithsonian Institute), Jessica Henkel (Gulf Coast Ecosystem Restoration Council)

SESSION OVERVIEW

This session was designed to emphasize work that has been done to foster a more cooperative, transdisciplinary approach to decision making, communication, and community engagement by highlighting notable data synthesis, data integration, and data display efforts. These efforts will be necessary to bridge the gap between researchers and the response, restoration, resiliency, and management communities who can and do use this data to shape the future of the Gulf region. The session concluded with a panel discussion of data management leaders from across the Gulf discussing opportunities to break through "silos" of excellence to integration and interdisciplinary work.

SESSION HIGHLIGHTS

It's becoming clear how important it is to collect all the extra, detailed information that makes data useful and gives it context, such as why one was collecting the data. The details matter. There is a need for this level of specifics to move with the data itself and be included with the metadata. Common standards are the way forward and have been the topic of many discussions. As we move towards common standards, we better position ourselves to be able to weave multiple information streams together into citable packages of data to support restoration. There is a need to tell stories of interdisciplinary success to better share the message of exactly how important data are.

RESEARCH GAPS IDENTIFIED

In order to overcome the "silos of data excellence" and make data more accessible, organizations managing large volumes of information need to package it so that is readily discoverable, however, knowing the granularity for consumption is difficult to fathom. Where possible, we should be linking our data to publications, requiring grantees provide rich metadata records that expand upon the "who, what, where, when, and (especially) why" and compelling grantees to archive data in well documented systems. We need to identify champions that support the gold standard for data and metadata creation and encourage the "story telling" through all channels of communication. In doing so, not only do researchers benefit from getting their data out to the population at large, resource managers, policy makers, corporations, and communities see and hear how valuable the data generated really are.

SESSION 002: TURBULENT BEHAVIOR OF DEEPWATER BLOWOUTS

Zach Aman (University of Western Australia), Claire Paris (University of Miami), Michael Schlüter (Hamburg University of Technology)

SESSION OVERVIEW

This session focuses on experimental, multi-physics computational fluid dynamics (CFD); multi-phase hydrocarbon modeling-based studies, and their coupling to far-field models necessary to predict the distribution of crude oil in deepwater blowout environments. Presentations seek to address a critical outstanding knowledge gap as to whether subsea dispersant addition significantly affected the dispersing potential of the subsea plume, considering effects on oil biodegradation, dissolution, flocculation, sedimentation, and sequestration. Building on the conference theme, related physical and geochemical processes represent critical building blocks for the next generation of 4-D models used to describe oil transport and fate under high-pressure and low-temperature conditions, with a particular focus on assessing risk and injury, planning response, and quantitatively informing trade-offs between response options.

SESSION HIGHLIGHTS

We are moving towards a better understanding of deep-water blowouts, including the effects of turbulence and degassing process on the droplet size distribution (DSD). With new insights and new methods (e.g., population balance model, large eddy simulation, and Eulerian-Eulerian and Eulerian-Lagrangian frameworks), the calculation of the migration of oil within the Gulf is possible with much higher accuracy and reliability.

- Deep-sea blowouts are always associated with large amounts of gas.
- Saturated oil and free gas released under high pressure and cold water drive the formation of gas hydrates (physically reversible).
- When gas bubbles separate from the plume, the plume becomes more dormant and forms an intrusion so-called “deep plume,” moving in the mid- and far-fields (MF and FF).
- The geometry of the flow, gas to oil ratio (GOR), local turbulence, and degassing processes are affecting DSD from the NF to the FF.
- New lab experiments for DSD:
  - For dead oil without dispersants: DSD can be predicted as input for FF models.
  - For gas saturated “live oil” with pressure drop in the blowout preventer (BOP): DSD can be estimated by taking into account the turbulent kinetic energy (TKE); micro-droplets are expected to form.
  - Chemical dispersants generate micro-droplets by tip streaming — unrelated to turbulence.
  - When a pressure drop in the BOP causes emulsification of live oil and entrained water, chemical dispersants do not have additional effect on DSD.
- New scientific method based on TKE and energy of dissipation rate at the wellhead predicts the DSD as input parameters for further modeling (NF and FF).
- Obstacles within the damaged riser pipe are causing additional turbulence and a larger opening angle of the jet.
- Gas bubbles: dissolution is fundamental to simulate gas bubbles; smaller bubbles dissolve faster than large ones; larger bubbles travel < 200 m and may never reach the surface.
- A hydrate volume fraction of at least 0.5% is necessary to create hydrate on methane bubbles. While large bubbles are flexible and able to destroy a thin shell of hydrate, smaller bubbles are rigid and tend to be covered fully by a hydrate shell.
- Response teams will benefit from the research presented because a better prediction of migration of the oil is possible to enable more effective response strategies.
- Changing the Rossby number and slip velocity alters the number and thickness of intrusion layers.

RESEARCH GAPS IDENTIFIED

- Only 22 years of research on deep-sea blowout.
- The critical importance of droplet size distribution (DSD) for accuracy of oil spill models is off debate. However how to obtain accurate DSD still under debate — BUT trends of decreasing DSD over the years.
- Oil companies have to work together more closely with GoMRI to enable deeper understanding and more effective response strategies. Data should be identified that is necessary for fast decisions in the case of a new oil spill (e.g., gas saturation, volume flow rate, pressure drop, etc.).

SESSION 003: ANALYTICAL ADVANCES IN CHEMICAL ANALYSIS FOR OIL SPILLS: RECENT GAINS AND GAPS IN KNOWLEDGE FACILITATED BY GOMRI-FUNDED RESEARCH

Ryan P. Rodgers (National High Magnetic Field Laboratory), Elizabeth B. Kujawinski (Woods Hole Oceanographic Institution), Terry L. Wade (Texas A&M University), Stephen A. Wise (National Institute of Standards and Technology)

SESSION OVERVIEW

Since the 2010 Deepwater Horizon oil spill, GoMRI-funded research has fueled the advancement of analytical methods for chemical analysis of petroleum, petroleum photochemical and biological transformation products, and dispersants and their biodegradation products. The focus of this session was to discuss the chemical analysis approaches and analytical tools now available that enable identification and/or quantification of oil spill constituents, transformation products, and dispersants that were previously inaccessible. The session consisted of six 30-minute keynote lectures highlighting significant findings in GoMRI-sponsored research facilitated by advances in analytical techniques.

The session opened with the state of oil spill chemical analysis prior to Deepwater Horizon using foundational analytical methodologies (e.g., gas chromatography with flame ionization detection (GC-FID), GC with mass spectrometry (GC-MS), and fluorescence spectroscopy) to identify and quantify oil spill constituents (Edward Overton, LSU). Advances in the use of comprehensive 2-D gas chromatography (GCxGC) analysis and ultrahigh-resolution MS were described by Chris Reddy (WHOI) and Ryan Rodgers (National High Magnetic Field Laboratory), respectively. Elizabeth Kujawinski (WHOI) reviewed advances in analytical methods for monitoring dispersants to assess their fate after use in oil spills. New analytical methods for the characterization of oil spill photo-products were reviewed by Christoph Aeppli (Bigelow Laboratory for Ocean Sciences). Finally, Helen White (Haverford College) discussed the combination of chemical and genomics information to gain a better understanding of oil degradation. The half-day session was well attended, and many participants commented positively on the all-keynote format for the session.

SESSION HIGHLIGHTS

- The use of GCxGC analysis provides a greater understanding at the molecular-level of the composition and complexity of oil and weathering changes.
- Better utilization of the capabilities of ultrahigh-resolution MS has extended the analytical characterization window beyond conventional GC-based methods to include polar and high molecular mass components and provides new opportunities for discovery and investigation of photooxidation and biotransformation products.
- Even though nonionic surfactant dispersants are structurally complex (multiple isomers present), analytical advances provide new insights into their fate and transport in seawater.
- Using high-resolution LC-MS techniques, it is now possible to track multiple components of dispersants in seawater to develop molecular proxies for future spills and remediation efforts.
- Diversity of chemical compounds, microbes, and genes was state-of-the-art at the time of DWH; now we can start to link the chemical and biological “omics” to understand the mechanisms of oil degradation.

SESSION 004: ENVIRONMENTAL SETTING, STRESSORS, AND THEIR INFLUENCE ON RESILIENCE OF BENTHIC FAUNA IN THE GULF OF MEXICO

Patrick Schwing (University of South Florida), Sarah Davies (Boston University), Arne Diercks (University of Southern Mississippi), Adrienne Correa (Rice University), Isabel Romero (University of South Florida), Jason Sylvan (Texas A&M University)

SESSION OVERVIEW

Benthic systems in the Gulf are experiencing several large-scale stressors including changes in oceanic current patterns that can modify dispersal capacities of benthic and reef organisms; increases in sea surface temperatures; and storm runoff, which can lead to seawater stratification and seasonal hypoxia. Coupled with these global stressors, Gulf benthic systems also experience more local pressures related to oil and gas activity, terrestrial runoff, storm impacts, and fishing pressure. This session highlighted research across several disciplines targeted at integrated understanding of the marine benthic system throughout the Gulf of Mexico.

SESSION HIGHLIGHTS

- The Gulf benthos has not fully recovered following Deepwater Horizon. Deepest coral sites' health is worsening, likely due to low food availability, but also may be caused by redeposition of marine oil snow. Highest sediment PAH concentration is in the Cantarell exclusion zone and in the deep sea in the southern Gulf of Mexico.
- Continuity of existing time series (collections, analyses) are essential for the construction of ecological baselines and quantitative characterization of ecosystems, and the disentanglement of multiple stressors. No baselines existed for Flower Garden Banks microbial communities prior to 2016; required a mortality event to provide these measurements. Gulf-wide benthic marine biotic indices are currently in development to provide decision support tools for operationalization by resource managers.
- Connectivity of deep-sea coral communities is primarily limited by vertical water depth distribution, while larvae are distributed widely horizontally. Hard-bottom (coral) microbial communities are distinct from surrounding soft-bottom (sediment) microbial communities.
- Coral symbionts (both microbes and ophiuroids) provide protection from stressors, particularly marine oil snow. *Thioglobus* spp., a coral symbiont may provide a hydrogen sulfide metabolic pathway allowing corals to utilize natural seeps.
- Fish muscle hydrocarbon concentrations are high in areas of natural seeps, near oil and gas infrastructure, and in Campeche (potentially loop current related). Sublethal effects of hydrocarbon concentration are higher in deep-water fishes. Liver hydrocarbon concentrations and hepatic lesions are a better indicator of episodic impact than other tissues (gonads, etc.).
- Combination of hydrocarbon stress with other stressors affects population resiliency; fishing effort is the dominant stressor at the population level.
- Hypoxia and freshwater exposure were primary stressors related to reproductive impairment in groundfish and survival rates, suppressed metabolism, and slower feeding response in shrimp. Implications for freshwater management Mississippi River and marshes.

RESEARCH GAPS IDENTIFIED

- When/how do we deny or limit further development of Gulf resources despite increasing (potentially devastating) risks to natural resources and ecosystem services? Can we utilize benthic ecological quality statuses/indices to provide thresholds for this purpose?
- Reference sites (pristine) including multiple taxa need to be established for the Gulf. Definition of resilience and recovery need to be established between multiple trophic levels. Specific analyses needed to identify and disentangle specific impacts of each stressor for different trophic levels; measuring abiotic factors (e.g., salinity, temperature, etc.) is essential for this purpose. Funding sources for international, collaborative, Gulf-wide survey efforts are needed.
- Connectivity of inshore-offshore environments is understudied and important for quantification of the inputs/impact from stressors. Integrate understanding across seminal hard- and soft-bottom benthic communities. Are offshore communities just "catching up" to near shore communities? What are the impacts of resuspension/redeposition of marine oil snow on the benthos? How does the chemical environment (seep/non-seep) affect the microbiome of deep-sea corals? Is transplantation a viable restoration method for deep-water corals? Is increase in hydrocarbon concentration in offshore fish due to oil spill or gradual, long-term trend in contaminant loads?

SESSION 005: FILLING LONG-TERM RESEARCH AND MONITORING GAPS ACROSS MULTIPLE TAXA OF LARGE MARINE VERTEBRATES: MARINE MAMMALS, SEA TURTLES, SEABIRDS, AND BEYOND

Jenny Litz (National Oceanic and Atmospheric Administration (NOAA)), Margaret Lamont (U.S. Geological Survey), Patrick Jodice (Clemson University), Vicki Cornish (Marine Mammal Commission)

SESSION OVERVIEW

This session included a range of presentations focused on the distribution, abundance, behavior, health, and population trends of marine mammals, seabirds, and sea turtles. All of the research presented during this session has applications for resource managers, response teams, and/or decision-makers. Data presented improves our understanding of individual behavior as well as the distribution and abundance of populations and will enhance our ability to predict exposure of individuals and populations to anthropogenic and natural stressors at both acute and chronic scales.

SESSION HIGHLIGHTS

The Gulf has been historically undervalued and undersampled with respect to seabirds, particularly when compared to marine regions of similar size and with similar levels of oil and gas activity (Haney). The Gulf of Mexico Marine Assessment Program for Protected Species (*GoMMAPPS*) is filling many of these gaps with aerial surveys conducted in nearshore waters (Wilson) and vessel-based surveys in pelagic waters (Michael). Preliminary data are already improving our understanding of the distribution and abundance of seabirds, and in some cases refining the geographic range previously known for the species (Haney, Wilson, Michael). Spatial distribution models for seabirds are being developed for the northern Gulf (Michael, Wilson).

Although sea turtles are a common focus of research and monitoring in the Gulf, their distribution and movements are poorly understood during the juvenile stage. New simulation models are being used to define essential habitat during the juvenile stage and have demonstrated the importance of western boundary currents to initial movements off beaches and dispersal into pelagic waters (Harrison).

Marine mammals can serve as sentinels for ecosystem health and provide important baseline data for comparisons following events such as oil spills. Long-term population and health monitoring (multi-decadal, year-round studies) with repeated sampling and concurrent environmental monitoring are important for establishing reference populations and putting data into an ecological context (Wells). Multiple presentations focused on new data from offshore and continental shelf species. During the marine mammal portion of GoMMAPPS, three vessel and three aerial surveys were completed, including the first winter vessel survey since the early 1990s. These data will provide for updated abundance estimates and spatial distribution models for marine mammals in the northern Gulf (Ortega-Ortiz). The Gulf of Mexico Bryde's whale population is a small and genetically distinct population that has been petitioned for listing under the Endangered Species Act. Research is ongoing to better understand their trophic ecology and habitat use. Tag data indicate Bryde's whales dive to depths between 200-280 m and execute feeding lunges near the bottom during the day while remaining near the surface during the night (Garrison). There were multiple presentations on sperm whale distribution using passive acoustic monitoring (PAM) and genetics (Li, Solsona-Berga, Vollmer). Overall, sperm whales are present year-round in the Gulf with little seasonal variation. Density estimates from PAM show decreasing annual densities at the Mississippi Canyon and Green Canyon sites and increasing annual densities near the Dry Tortugas site. Genetic analyses from biopsy samples provided evidence for multiple sperm whale populations in the Gulf. The genetic differentiation was much higher in the maternally inherited mitochondrial DNA than the biparentally inherited nuclear DNA, indicating female philopatry is driving population structure and that dispersal of males tempers differentiation.

Two presentations focused on coastal and bay, sound, and estuarine (BSE) bottlenose dolphin stocks. Data were analyzed to identify hot spots of potential overlap between the northern coastal stock (NCS) of bottlenose dolphins and the BSE stocks. Remote biopsy samples analyzed for contaminants showed that the BSE animals had higher contaminants in blubber than the animals sampled along the coast with more extended movements (potential NCS dolphins), indicating differences in exposure to stressors (Balmer). The session ended with a focus on health changes in bottlenose dolphins affected by the Deepwater Horizon spill. Studies of dolphins in Barataria Bay, Louisiana, showed immune function changes which appeared to be improving between 2013 and 2016; however, new data presented for 2017 and 2018 showed a recurrence of the immune changes which could lead to increased susceptibility to pathogens. Preliminary assessments show this trend could be driven by dolphins born after the spill or may possibly be due to transgenerational effects (DeGuise).

RESEARCH GAPS IDENTIFIED

Multi-taxa:

- Gulf-wide surveys and tracking in the southern Gulf of Mexico are essential for understanding the distribution, abundance, and habitat use of marine mammals and seabirds on the scale of the Gulf ecosystem.
- Identification of multi taxa hotspots in the Gulf (i.e., overlap of marine mammals, sea turtles, seabirds) would be useful for determining critical habitats and prioritizing habitat restoration efforts.
- Impacts of climate change on distribution, abundance, and foraging ecology on large marine vertebrates in the Gulf is an important area of study moving forward.

Seabirds:

- Individual tracking efforts are needed to elucidate the link between areas of use by birds in pelagic waters of the Gulf and their colonies of origin. Tracking efforts would also provide important information on the time of residency in and fidelity to pelagic waters (or habitats) by seabirds.
- Feeding ecology and interactions with bottom-up processes – requires modeling, surveys, individual tracking to elucidate.

Marine Mammals:

- Continued vessel and aerial surveys, including more winter surveys, would be helpful to improve the precision of the spatial distribution models being developed under GoMMAPPS.
- There is a need to further understand Bryde's whale distribution in the Gulf. Additional studies are planned to continue investigating foraging behavior and prey composition.
- New tools are being developed to further understand the stock range for the northern coastal stock (NCS) of bottlenose dolphins and their overlap with the bay, sound and estuarine stocks. These include remote deployment of satellite tags on dolphins off the coast which could improve knowledge of NCS movement patterns. Incorporating genetics and stable isotope analyses with the current data from photo ID studies would also be beneficial.
- Further analyses of sperm whale stock structure are needed and additional sampling of sperm whales in the deeper waters (central Gulf) and the southern Gulf of Mexico (in Mexican and Cuban waters) would help to fill gaps in knowledge of sperm whale stock structure in the Gulf.
- The potential transgenerational health effects of the oil spill on marine mammals should continue to be studied (e.g., changes in intracelluar immune response in bottlenose dolphins) and consideration should be given to developing methods that account for these effects within restoration strategies.

SESSION 006: SCIENCE TO ACTION: BUILDING PARTNERSHIPS AND DEVELOPING COLLABORATIONS TO SUPPORT LIVING COASTAL AND MARINE RESOURCE MANAGEMENT

Julien Lartigue (NOAA), John Tirpak (U.S. Fish and Wildlife Service), Kassie Ernst (NOAA)

SESSION OVERVIEW

The session highlighted collaborations between researchers and resource managers that demonstrated strategies for ensuring that research findings and products are actionable, applicable, and used by managers and decision makers working with living coastal and marine resources. The session explored 1) how researchers can build and strengthen partnerships with resource managers or users; 2) how these collaborative partnerships are resulting in relevant knowledge or decision-support tools; and 3) how information gaps and new directions for research are being identified through these types of partnerships.

SESSION HIGHLIGHTS

- Tangible benefits to researchers and resource managers working together to generate actionable science include more informed management decisions and new directions for scientific inquiry.
- Pairing researchers with resource managers to co-produce knowledge can be challenging because of an academic reward system that prioritizes publications over relationships and lacks incentives for co-production or even interdisciplinary research, and government barriers, including the short-term nature of funding cycles. Funders can mitigate these issues with explicit requests for co-production and by providing greater budget flexibility so projects can adjust to input from managers. Funders can also support projects that solely focus on the application of science and emphasize metrics beyond peer-reviewed journal articles.
- Conceptual models and decision-support frameworks provide a way for large groups to understand a set of issues and be strategic in how they address them (e.g., form subgroups).
- Engagement with stakeholders is often most effective when initiated during the research planning stage and when maintained throughout the entire research process through the use of mechanisms such as an expert advisory panel composed of resource managers and other stakeholders. There are creative ways of avoiding partnership fatigue (e.g., cohort recruitment), but ensuring the relevance of science to decisions is the best approach.
- Relationship building is a long-term investment, and researchers should recognize and prepare for a significant lag time (five to seven years) between when the science is produced and applied.
- The relevance, need, and use of decision-support tools is likely overstated unless a tool has specific implementation plans in place.
- Follow through, coordination, and knowing where relevant information can be found are key to connecting decision-makers to actionable information.
- Building trust, a diversity of perspectives and skill sets, patience, intentionality, ability to leverage projects, and creating equal dialogue are all important for delivering actionable information.
- In order for researchers to engage in co-production work, they need to understand its value, have the time to engage in it, and have the skills to do it. Sometimes it is helpful to embed someone into the project with the skills to do co-production, but the researchers still need to be an engaged part of the co-production process for it to be successful.
- Not much information exists about how to do co-production, so many times research and funding agencies operate based off of lessons learned. More could be done to scale lessons learned and make progress beyond the individual researcher and funder.

SESSION 007: ORGANISMAL RESPONSES TO OIL EXPOSURE: FROM INDIVIDUALS TO ECOSYSTEMS

Andrew Esbaugh (University of Texas at Austin), Ed Mager (University of North Texas)

SESSION OVERVIEW

This session was dedicated to exploring organismal responses to oil exposure, with a specific focus on emergent pathways and multi-stressor experimental designs that span from cellular effects to whole animal performance.

SESSION HIGHLIGHTS

- There is a consistent pattern of emerging impacted physiological pathways that are being identified across a wide array of species and taxa. These include reproductive effects, immune responses, oxidative stress, visual and cognitive impairment, and cholesterol biosynthesis impairment, in addition to the classical cardiorespiratory impairment. The sum total of this work highlights that important toxicological impairments have been historically overlooked and should be incorporated into oil spill response research going forward.
- Emergent technologies have been developed and utilized to further the study of organismal responses to oil exposure. This was particularly apparent in the use of ultrasound techniques to diagnose reproductive effects on dolphins *in utero*, as well as the numerous uses of transcriptomics and integrated pathway analyses to identify novel impairments in fish related to immune function, visual function, cholesterol biosynthesis, HPI axis, and cognitive function.
- There is increasing evidence that natural environmental stressors including low oxygen, changing salinity, and ultraviolet light can act additively or synergistically with oil exposure to exacerbate organismal effects. It is also clear that these effects can span generations, presumably through epigenetic mechanisms related to global methylation patterns on the exposed parental genome.

RESEARCH GAPS IDENTIFIED

- While the general patterns of emerging affected pathways appear to span multiple species and taxa, there is also clear interspecies variability related to magnitude of injury, and in some cases the direction of the observed effect. This is most apparent in the work related to cholesterol biosynthesis and immune function; however, it can also be extended to other emerging pathways of oil toxicity.
- The emerging pathways of oil toxicity are exciting, but only represent the first steps of this work. The ultimate goal will be to evaluate the role of these responses in lethal and sublethal toxicity and ascertain their value in the context of organismal adverse outcome pathways. This will require concerted effort in the exploration of cellular effects and the role of particular proteins and organelles. This should also be complemented by organismal studies that attempt to place these emerging toxicity pathways in an ecological context through the study of whole organism performance measures.
- The longevity of many of the observed effects remains unclear. Specific exploration of the duration of injury upon returning to a clean environment should be performed with the intent of clarifying the ultimate ecological outcomes for exposed individuals.
- With the identification of new pathways of oil toxicity and attempts to develop field-worthy biomarkers, it is important to understand the relative sensitivity of the respective observations. Similarly, it remains a matter of debate whether many of the emergent pathways are extensions of the classical cardiorespiratory impairments of oil, or if they have novel cellular origins. This latter point is also relevant in the question of oil weathering, as the same chemical constituents that drive classical oil toxicity endpoints may not drive the emergent toxicity endpoints.

SESSION 008: RESTORE ACT CENTERS OF EXCELLENCE RESEARCH GRANT PROGRAMS – GULF RESEARCH TO INFORM POLICY AND MANAGEMENT

Alyssa Dausman and Melissa Baustian (The Water Institute of the Gulf), Elizabeth Fetherston-Resch (Florida RESTORE Act Centers of Excellence Program)

SESSION OVERVIEW

This session highlighted the Centers of Excellence Research Grant Program's work that represents each of the Gulf Coast states and provided an overview on how each Center is addressing state needs through the five eligible RESTORE Act disciplines. Since the 2019 host state for GoMOSES is Louisiana, two researchers funded through the RESTORE Act Center of Excellence for Louisiana provided updates on their work and what it means for coastal Louisiana, and a speaker from Louisiana's Coastal Protection and Restoration Authority discussed coastal management goals and how research supports Louisiana's Coastal Master Plan planning and implementation. The session closed with a panel of Centers of Excellence Research Grant Program's personnel fielding audience questions and discussing their vision for the future of intra- and interstate research and management collaborations.

SESSION HIGHLIGHTS

- This was the first gathering of the RESTORE Act Centers of Excellence in a conference session setting; representatives from Florida, Mississippi, Louisiana, and Texas participated.
- Each center is structured slightly different, but they all have to adhere to the U.S. Department of the Treasury's policies while also fulfilling the needs of their respective state agency.
- Each center has released at least one request for proposal and has funded research projects.
- Each center typically has a slightly different focus area (e.g., to date, Florida focuses on marine fisheries; Mississippi focuses on oysters; Louisiana focuses on coastal protection and restoration; Texas OneGulf focuses on a healthy and sustainable Gulf of Mexico).
- Centers typically release funds through a competitive request for proposal.
- Most of the centers have some type of external review panels and a research needs/strategy that helps guide the research they fund.
- Timelines can be challenging for the centers, since U.S. Department of the Treasury grants are a maximum of five years and funded research projects should be a maximum of two years.
- Incorporating research about human health has been difficult for many of the centers.
- There is a challenge for the centers to collaborate with each other, because they are each mandated to focus on their state's priority needs but future opportunities are of interest to the centers.
- The centers are in favor of continuing a conference like GoMOSES beyond 2020.
- The Coastal Protection and Restoration Authority of Louisiana uses research results to help implement the Coastal Master Plan.
- Two RESTORE Act Centers of Excellence for Louisiana projects provided updates on their research projects: adaptive migration in south Louisiana; faulting in Holocene Mississippi River Delta strata.

SESSION 009: HUMAN RISK ASSESSMENT ASSOCIATED WITH OIL SPILL CHEMICALS (OSCs): APPROACHES AND ANALYSES

Alesia C. Ferguson (North Carolina A&T University), Helena Solo-Gabriele (University of Miami) and Kristina Mena (University of Texas Health Science Center School of Public Health)

SESSION OVERVIEW

When coastlines are impacted by oil spills, officials and the public are unclear as to the true human health risk. It is imperative to use robust scientific methods to estimate risk and, in particular, to protect vulnerable groups such as children, the elderly, and others who are immunocompromised. Immediately following a spill, volatile compounds found in oil spill chemicals may play a greater role in inhalation exposure for first responders and clean-up crews. Dermal and ingestion exposures are also important to address in nearshore environments where children may play following spill events. Health risk estimations rely on determining oil spill chemicals in time and space, along with human activity patterns and toxicity values for compounds. This session opened with an introduction to the mechanics and challenges of conducting risk assessments. The session then had three presentations that addressed the toxicity of oil spill chemicals through *in vitro* methods, while one presentation showcased the results from a fate and transport model to look at oil spill chemical (OSC) concentrations in the nearshore. Three other presentations focused on collecting family and children play behaviors at beaches, while the last presentation demonstrated a health risk estimate for one OSC. One presentation addressed the low presence of OSCs measured at the time of the spill. The information presented are beginning to fill the gap needed to conduct human health risk assessments for OSCs, but more work is needed. Although the Deepwater Horizon oil spill can be used for discovery and development of tools and techniques for risk assessment, the public health field needs the technology and science methods to estimate human health risk for various populations in the event of future spills. Researchers must find ways to merge their various fields to better estimate associated human health risks.

SESSION HIGHLIGHTS

- Some OSCs, such as chrysenes, may pose more harm than others.
- Research groups are using *in vitro* methods to look at the toxicity of oil spill chemicals (e.g., Tulane University, Louisiana State University, and John Hopkins University).
- Research groups are beginning to look at children's unique activity patterns in the nearshore environment (e.g., BEACHES funded through GOMRI-University of Miami, University of North Carolina A&T, University of Texas School of Public Health).
- NOAA and other researchers (e.g., University of Miami) have existing fate and transport tools developed or under development that can look at concentration of chemicals in the nearshore environment (beach sediment and water) where the general public plays.

RESEARCH GAPS IDENTIFIED

- Toxicity measures for many oil spill compounds are missing or incomplete, making them unable to estimate health risks.
- Chronic exposures may be difficult to determine and quantify with existing research information.
- Multiple chemical exposures remain challenging for human health risk assessments.
- Determining whether reported physical outcomes are a result of chemical exposures versus mental health outcomes is a challenge.
- Low measured OSC concentrations (including dispersants) at the time of the BP spill may not reflect reported physical outcomes.

SESSION 10: PROGRESSIVE VISUALIZATION TECHNIQUES FOR OPTIMIZED DATA SYNTHESIS AND EFFECTIVE GRAPHIC COMMUNICATION

Natalie Perlin (University of Miami), Dana Wetzel (Mote Marine Laboratory), Sherryl Gilbert (University of South Florida), Guillaume Novelli (University of Miami)

SESSION OVERVIEW

This session had one invited keynote speaker and eight additional presenters (nine selected speakers but one withdrawn). It was followed by a discussion and the audience was invited to fill out a short questionnaire. The audience varied between 40 and 60 attendees per talk.

SESSION HIGHLIGHTS

The topic of the session was very transdisciplinary and featured high quality talks covering a variety of scientific topics, including: oyster gaps, rainfall during tropical cyclones, deep sea blowouts, collaborative visualization tools, NOAA common operational picture tool for oil spill response, visualization of simultaneous multi-scale ocean physical processes (2 m to 200 km), visualization of genomics in the context of broader research, and ensemble models for the prediction of oil spill pathways. The keynote talk made clear that visual tools are critical for better communication and collaboration between large groups with distinct specialties. A few key points: There are algorithms that help calculate readability; labels and context images help convey messages more clearly; “concept mapping” is a technique to develop a better communication around complex ideas.

The questionnaire on visualization tools was answered by a variety of people representing the interest in this session from a broad audience coming from fields such as physics, government, engineering, ecology, genomics, and climatology.

All scientists are also speakers, teachers, and writers. They use a variety of tools to explain their research to funding agencies, contractors, students, and the general public. In the digital era, most information is now published online and has to be adapted to screens — our survey showed that all data is stored and displayed digitally. The ability to synthesize data in images, maps, and 4-D animations allows people to see, think, and connect ideas more easily. Software development goes hand-in-hand with progress in hardware to facilitate the access to and handling of increasing amounts of data that can now be transferred almost instantly between groups of people, particularly the public and decision makers.

RESEARCH GAPS IDENTIFIED

The bottleneck in visualization is access to software and hardware to handle large amounts of data of various types, as well as informing scientists to use these new tools for increase readability of their work.

SESSION 011: BRIDGING FIELD AND LABORATORY OBSERVATIONS OF THE FATE AND EFFECTS OF WEATHERED OIL TO INFORM OIL SPILL RISK ASSESSMENT, PLANNING, AND RESPONSE

Amanda Bess (Chevron), Brandi Echols (Environmental Toxicology Associates LLC), Osman Karatum (Exponent), Tim Nedwed (ExxonMobil Upstream Research)

SESSION OVERVIEW

The focus of this session was to 1) connect field and laboratory observations to improve the application of research to oil spill planning and response by decision-makers and 2) identify appropriate experimental and analytical tools to understand the fate and environmental toxicology of oil.

SESSION HIGHLIGHTS

- Oil spill response and impact assessment strategies are guided by data provided by three main toolkits: simulations/models (e.g., fate and transport, ecosystem, exposure models; laboratory tests), empirical observations, and extrapolations. Success comes in optimizing the use of these toolkits to reach a "reasonable degree of scientific certainty." When one tool dominates, the risk is either that decisions are based on too little data (extrapolation dominates) or that decisions are paralyzed and overworked by analysis (models/simulations dominate). Dr. Paul Boehm recommended a multiple-lines-of-evidence approach where fit-for-purpose models generate hypotheses that are validated by empirical data and balanced by extrapolation.
- Lab toxicology studies often have multiday, constant, and high exposure concentrations in contained systems with the presence of oil droplets. Field data show that oil dilutes in the water column in hours, except possibly in rare cases immediately adjacent to a continuous source. Oil droplets buffer losses due to biodegradation and volatilization such that dissolved hydrocarbon concentration and composition in tests are not reflective of field conditions.
- Most toxicology testing makes key assumptions (e.g., maintain constant concentration/composition, all constituents are dissolved, exposure scenarios match the scenarios of actual oil spills). If any of these are violated, experimenters should recognize these uncertainties/limitations in extrapolating results to field conditions (*Hodson, Adams, and Brown 2019*). Adequate characterization of exposures is necessary to understand the degree to which a test can be applied to the field.
- Lab biodegradation studies often use abnormally high nutrient concentrations, microbial cultures non-representative of the field or tested under conditions significantly different from their natural environmental, and/or high concentrations (greater than a few parts per million) of oil.
- Deepwater Horizon oil on shorelines and in slicks demonstrated a high degree of oxidized hydrocarbons. Use of FT-ICR-MS support photo-oxidation rather than biodegradation as the cause.
- Results showed that dispersants are effective on weathered oil or in low energy systems. Large-scale wave tank and the baffled flask test were used to show that five-day photo-oxidized HOOPS oil readily disperses despite an increase in oxidative species and viscosity.
- Results showed that benchtop and larger-scale wave tank tests do not mimic field spreading of oil thus they underestimate oil dispersion due to containment and residual presence of surfactants.

RESEARCH GAPS IDENTIFIED

- The degree to which oil weathering (e.g., photo-oxidation) reduces the effectiveness of response options (e.g., dispersant) is not well predicted by lab tests. Further large-scale studies are needed.
- Ecological relevance of the thousands of polar compounds produced by photo-oxidation is not clear. Moving forward, there is a need for research to focus on understanding those compounds that pose a risk to ecological receptors under realistic exposure conditions.

SESSION 012: TOWARDS UNDERSTANDING THE PHYSICAL, PHOTOCHEMICAL, AND BIOLOGICAL PROCESSES THAT DETERMINED THE FATE AND EFFECT OF OIL AND OIL-DISPERSANT MIXTURES DURING THE DEEPWATER HORIZON OIL SPILL

Ed Overton (Louisiana State University), Uta Passow (University California, Santa Barbara), Colin Ward (Woods Hole Oceanographic Institute), Christoph Aeppli (Bigelow Laboratory for Ocean Sciences)

SESSION OVERVIEW

The goal of Session 012 was to get an overview of the different fates of spilled and dispersed oil in seawater and along the coast as one of the initial steps towards synthesis of GoMRI Core 2: Towards establishing a Synthesis for the Physical, Photochemical, and Biological Fates of Oil and Oil-Dispersant Mixtures during the Deepwater Horizon Oil Spill: Dissecting Disciplinary Views of Oil. The session was introduced by presenting a schematic on the various fate movement and transformation processes that oil and dispersed oil underwent for use by disciplinary scientists in describing their respective results. This was followed by a first-hand description of the oil's fate from the NRDA program by invited speaker Dr. Jim Payne. Other presentations focused on the oil's composition, photochemistry, biodegradations, associations with marine particles, and the MOSSFA event. There were 22 oral presentations and 17 posters, all of which were well attended.

SESSION HIGHLIGHTS

The role and significance of photochemistry on the fate of surface oil prior to shoreline stranding was highlighted, with implications associated with use of remedial techniques use during the response. Also, the role of oil associated with marine particles, and this as a transport mechanism for oil residue sinking was highlighted. Additionally, advanced analytical and genetic "omics" methods are allowing more comprehensive understanding of how oil is weathered and transported.

RESEARCH GAPS IDENTIFIED

Understanding the implication of GoMRI research on oil spill mitigation and response efforts needs to be fully appreciated and understood.

SESSION 013: CONNECTING THE RELEVANT SCIENTIFIC RESEARCH AND FINDINGS TO ACTIONABLE RESPONSE DECISION MAKING

Steven Buschang (Texas General Land Office) with introduction and perspective from Dana Tulis (U.S. Coast Guard)

SESSION OVERVIEW

The session's aim was to highlight how practitioners, such as those from industry, private environmental support-scientific contractors, and scientific advisors to state and federal agencies, could convey response needs to the academic community and how these researchers could, from conception, think about research to study specific questions that may lead to tangible and relevant conclusions that may be useful in real-world response decision making. Related was a series of talks from researchers who have developed research ideas with potentially actionable results for the beginning.

SESSION HIGHLIGHTS

- The primary objective of NOAA and others is to identify researchers who have the expertise and willingness to perform response-related research. NOAA is funding a meeting with the Coastal Response Research Center to help facilitate. Also, Canada is funding work that will build a network of scientific oil spill expertise and the validation of and subsequent regulatory approval of alternative response options.
- Industry representatives as well as other speakers shared examples of scientific work that is and has been done, though perhaps scientifically accurate and precise, has little or no relationship to what would be found in a real response scenario. Yet, the results of these studies are presented in a way that is notorious, and as such are widely reported by media and may influence public perception and the ultimate tradeoff decision making process negatively away from the best available response option. Examples include how standard LC50 tests have a difficult time projecting into *in-situ* situational response situations, or how confined laboratory testing may overlook how open ocean conditions exist and how oil behaves there (e.g., limited spreading and unrealistic thickness of oil in a confined test container).
- Researchers discussed scientific tools developed such as fate and effect models and hydrodynamic operational models that were studied and resulted in decision-making science resources.
- Researchers discussed how other counties are learning from existing science and building response plans for their emerging industries from the onset. They also discussed how extinction models may benefit best management practices.
- We learned how research into new remote sensing capabilities are resulting in faster, better, more thorough data acquisition and a better response by collection and dissemination of information from throughout the water column using APEX Floats, gas leak detection technologies, and satellite imagery to find the location of unreported oil spills in the environment.
- Researchers discussed the work they were doing in little-studied areas, such as how transport occurs in non-natural passes and how these influences can affect the movement of contaminants in and out of sensitive areas. This includes eddy simulations and forecasting using bay models such as SUNTANS as a decision-making tool.

RESEARCH GAPS IDENTIFIED

- Potential data gaps and nonapplicable scientific studies that don't yield information that is relevant or perhaps even acts as a hinderance to response actions were the focus of our session. The session organizers' hope was that newer researchers to this field would listen to the presentations and perhaps use these to guide future research formulation of ideas and proposals. The response and restoration community would be the beneficiaries of this focus with the environment as a whole being the ultimate beneficiary as then we would have the ability to make the best decisions from relevant science to guide the response.

SESSION 014: IDENTIFYING GAPS AT THE INTERSECTION OF SPIRITUAL DISPLACEMENT, ENVIRONMENTAL JUSTICE, AND COMMUNITY POWER

Sarah E. DeYoung, Denise C. Lewis, Desiree M. Seponski (University of Georgia)

SESSION OVERVIEW

Our session focused on identifying key social factors that facilitate or hinder resilience in Gulf communities, particularly aspects of spirituality, religion, and beliefs.

SESSION HIGHLIGHTS

One interesting big picture message from the session was that community members should be viewed as collaborators and partners rather than "recipients" of hazard planning. Another interesting takeaway from our session was that longitudinal impacts of disasters are understudied, specifically among Cambodian and Laotian people. The impacts of disasters on women and children are also understudied.

- New science that was presented included GIS mapping of Laotians and Cambodians outside of Mobile County, Alabama.
- New analytical methods include multidisciplinary research teams (social scientists from anthropology, psychology, and other fields) working with hazard planners and geologists.
- Healthcare entities, community planners, and researchers benefit from the aggregated data that were presented in this session.
- New methods for integrating projects across teams might be helpful for meta-analyses (e.g., on preparedness across states and counties).

RESEARCH GAPS IDENTIFIED:

One challenge is that in emergency response groups that are volunteer-based (such as firefighters), rural counties will experience greater challenges in maintaining response capacity for hazard events. Some data gaps we identified include the need for more research on the impact of disasters from an intersectional perspective (gender, race, age, and other components). Another challenge is understanding and reporting the limitations of self-report data, data from snowball sampling, and other commonly used survey techniques. Finally, another major challenge in implementing healthcare and disaster response is the lack of comprehensive language/translation tools used by responders.

SESSION 015: MODELING FOR SYNTHESIS - PROGRESS IN LINKING THE NATURAL SCIENCES AND CONNECTING TO POLITICS, ECONOMICS, HEALTH, PSYCHOLOGY, AND FURTHER

Cecilie Mauritzen (Norwegian Meteorological Institute), Eric Chassignet (Florida State University), Elizabeth Fetherston-Resch (Florida Institute of Oceanography), Helena Solo-Gabriele (University of Miami), Katya Wowk (Harte Research Institute)

SESSION OVERVIEW

This session set out to assess how models can be coupled to answer questions like “How serious was the spill?”, “What is the overall societal impact of an oil spill?”, or “How can we be better prepared?” Such models should be quantitative and include measures of uncertainty. This session highlighted integrated modeling of natural and anthropogenic systems from various disciplines and scales, including a description of a model-sharing platform.

SESSION HIGHLIGHTS

- Many coupled models exist that address the natural sciences. Few couple the natural sciences to economics, social sciences, and humanities. The conference speakers presented a wide variety of modeling approaches to address interdisciplinary questions. These include:
  - Dr. Busalacchi presented UCAR’s vision for an Earth system prediction model, which builds on Earth system models used in climate simulations (which are forced by scenarios of human developments) to include modeling of the human developments themselves.
  - Dr. Kourafalou presented models that coupled hydrodynamics, nutrients and ecosystem responses (GoM-HYCOM), and hydrodynamics and larval transport (FKEYS-HYCOM-CMS).
  - Dr. Berenshtein presented a linked model that coupled hydrodynamics, fishery impacts, revenue loss, and social vulnerability measures for coastal counties.
  - Dr. Morey presented a model that simulates the hydrodynamics, waves, and atmosphere and couples this information with oil, microbe, and sediment transformation including a module that accounts for marine snow and transformation of gene functions that permit for evolution of microbes.
  - Dr. Saul presented an alternative approach, an agent-based model, capable of integrating the effects of toxicological data to build scenarios about fish mortality.
  - Dr. Solo-Gabriele described a risk assessment approach that coupled oil spill trajectory information with human physical health impacts.
  - Dr. Ross presented a societal “preparedness” model that includes considerations of subsistence needs, knowledge, loss minimization, social integration, technological integration, and mental/physical capacity of the human population.
- A group of researchers has self-assembled to establish a modeling community of practice (Dr. Steyer). This group is currently in the process of consolidating a list of models used to evaluate natural processes in the Gulf of Mexico.

DATA GAPS AND CHALLENGES

- The anthropogenic (humanities, socioeconomic, social science) models lag behind the natural science models in maturity.
- The integration of natural and anthropogenic models needs further development, and possibly new methods. Need to go farther to the right in the modeling spectrum to include overall socioeconomic factors and both physical and mental aspects of human well-being.
- Observing systems are needed for all aspects to be modeled. More data are needed on indicators and metrics for socioeconomic and social science models. There is an effort to develop these indicators and metrics with the Gulf of Mexico National Estuarine Research Reserves. Another important contribution would be the Human Health Observing System discussed in GoMRI Synthesis and Legacy Core Area 4.
- The units of analysis need to be reconciled between the different disciplines. Spatial and temporal units will also need to be consistent between modeling systems; scientists, models, and data must be able to speak to each other.
- The funding structure in the United States limits the development of interdisciplinary model systems – the silo structure makes it hard. Examples are available in other parts of the world including the Copernicus Program in the EU.
- There is a lack of funding resources to develop coupled modeling systems. One opportunity is the NASEM funding of $500 million over 30 years.

SESSION 016: BRIDGING RECENT ADVANCES IN MARSH ECOLOGY WITH THE FUTURE OF GULF OF MEXICO ECOSYSTEMS

Paola Lopez-Duarte (University of North Carolina at Charlotte), Charles Martin (University of Florida), Jill Olin (Michigan Technological University)

SESSION OVERVIEW

This session focused on long-term marsh studies, especially ones with insights into time scales over which the impact of several stressors persists. Over the course of these assessments, we have captured ecosystem-level responses to other stressors, including how these disturbances influence organisms and their habitats at many levels. Concomitant with these assessments is the generation of large spatial and temporal datasets documenting abiotic conditions such as temperature, salinity, dissolved oxygen, and nutrient fluxes. The overarching goal of this session was to link long-term, comprehensive assessments of Gulf of Mexico marsh ecology with impending and predicted environmental challenges, thereby providing scientists and management practitioners with a roadmap for future directives and studies that will contribute to the conservation of these coastal ecosystems for decades to come.

A summary for this session was not provided.

SESSION 017: OUT OF THE BLUE: WHAT HAVE WE LEARNED ABOUT THE PELAGIC GULF OF MEXICO, WHAT REMAINS UNKNOWN, AND HOW CAN WE USE THE INFORMATION?

Rosanna Milligan (Nova Southeastern University), Estrella Malca (University of Miami), Tracey Sutton (Nova Southeastern University)

SESSION OVERVIEW

Overall, our session concerned fauna and ecological processes unique to the offshore habitat of the Gulf of Mexico, the impacts of the Deepwater Horizon oil spill on these attributes, and new tools for assessing offshore ecosystem health.

SESSION HIGHLIGHTS

The talks in this session highlighted the importance of the offshore Gulf as a highly diverse, interconnected habitat, in which important linkages exist between the faunae inhabiting the ocean surface, deep-pelagic, and coastal domains. Sutton and Eytan highlighted the high taxonomic and genetic diversity of the offshore Gulf, noting that 186 new occurrences and 68 genetic records of fishes have been documented since the Deepwater Horizon oil spill. These findings emphasized the Gulf's standing as one of the world's four "hyperdiverse" deep-pelagic ecoregions. The highly connected nature of the Gulf of Mexico was also a key theme throughout the session and was emphasized by several speakers. Sutton noted that over 50% of all known Gulf fishes live all or part of their lives in the oceanic domain, while Li presented evidence that red tide blooms likely begin offshore, then are transported onshore when oceanographic conditions are suitable. Several speakers considered trophic linkages between fish species in the Gulf, again highlighting the extent to which the region appears to be a continuum as opposed to differentiated by zones. Murawski demonstrated the importance of deep-pelagic fishes and oceanic juvenile stages of coastal fishes in the diets of offshore apex predator species, such as yellowfin tuna, swordfish, and lancetfish. This is of particular importance as a mechanism by which oil contaminants could be incorporated into these predators, and thus humans.

Economically valuable oceanic fishes, such as common dolphinfish and tunas, were the foci for several speakers. Pruzinsky (invited speaker) presented novel information on the dynamics of juvenile tunas in the Gulf and their relationships to environmental drivers. Malca presented a new method for calibrating age and growth estimates of larval Atlantic bluefin tuna by combining data from both the Gulf and Mediterranean stocks. Laiz-Carrion presented a novel method for using stable isotope analysis of larval tuna to identify the trophic status of the maternal fish (based on larval consumption in the yolk sac). In a sequence of three talks, Schlenker, Pasparakis, and Faillettaz described a series of aquarium- and field-based experiments to examine the early life history dynamics of dolphinfish (*Coryphaena hippurus*). After calibration data were presented using tagged captive fishes, they reported that spawning *C. hippurus* occur deeper in the water column (~ 30 m) than non-spawners, and they highlighted how embryonic behavior (via buoyancy control) provides a mechanism to avoid harmful near-surface conditions (e.g., high UV light and oil).

Two speakers focused on the base of pelagic food webs in the Gulf. Dillon discussed *Sargassum* spp. as highly biodiverse, highly productive habitats that serve as nursery grounds for numerous recreationally and commercially important fishes. The trophic structuring of these habitats was found to vary spatially across the northern Gulf, suggesting a dynamism that should be captured in ecosystem models. Knapp showed for the first time in the offshore Gulf how stable isotope analyses can be used quantify the relative contributions of nitrogen fixation and nitrate as sources of nitrogen, and the surprising lack of importance of nitrogen fixation within the pelagic Gulf (contrasted to other oligotrophic systems).

Finally, the diverse posters complimented the speakers and provided further insights into the fauna, ecological linkages, distribution, prey field, and new geochemical measurements for the dynamic Gulf ecosystem.

SESSION 018: CROSS-DISASTER LESSONS IN COMMUNITY RESILIENCE: DEEPWATER HORIZON AND OTHER DISASTER EVENTS ALONG THE GULF OF MEXICO

Andrew Parker (RAND Gulf States Policy Institute), Melissa Finucane and Rajeev Ramchand (RAND Corporation)

SESSION OVERVIEW

The goal of this session was to examine diverse disaster experiences by communities along the Gulf of Mexico and extract lessons learned for resilience research and practice.

Overall, the session addressed multiple disaster contexts using diverse research methods and suggested that contextual and temporal factors matter greatly but are under-researched. Social science contributes important insights into public reactions to disasters, but more effort is needed to modify disaster plans, processes, and policies according to the knowledge gleaned. In addition, longitudinal and multidimensional approaches are needed to better understand the complex interactions of factors affecting immediate disaster impacts and long-term resilience.

SESSION HIGHLIGHTS

- Disaster "exposure" is multidimensional, including both direct (e.g., physical contact) and indirect pathways (e.g., financial loss) by which a disaster might impact an individual or community's health, economic, and social functioning.
- Exposure to disasters was associated with perceived greater likelihood of another disaster, but the role of exposure on protective actions and resilience was hard to separate from various sociodemographic and contextual variables.
- Exposure and perceived risk are important flags for illness anxiety and other mental health outcomes, in part because of the social disruption caused by disasters.
- Some groups, such as fishers, seem more vulnerable than others.
- The concept of "allostatic load" helps to explain the multiple sources of disaster-related stress on individuals and communities and how this stress may lead to poor outcomes.
- The role of social capital and sense of place in post-disaster decision making (e.g., whether to relocate) is complex.
- Multimodal outreach is effective for retaining participants in longitudinal social survey research.

RESEARCH GAPS IDENTIFIED

- Baseline data are needed to permit pre- versus post-disaster changes in physical health, mental health, socioeconomic functioning, preparedness, and other risk-related behaviors.
- More study of how best to conceptualize and measure "exposure" is needed.
- Response plans should include more attention to stress reduction, relief, and treatment.
- Need to enhance the capacity of science and public health (early responders) in disaster contexts.
- Natural infrastructure could be better utilized to minimize damage and help alleviate stress effects on health.
- Need to expand disaster response and relief to better incorporate wider geographic scope of affected people (e.g., displaced communities).
- Need to identify opportunities in disaster laws, policies, and regulations for strengthening public health preparedness, including for stress-related impacts.
- With community participation, develop and implement equitable processes prior to disasters for dealing with damage assessments, litigation, payments, housing, etc.
- Multi-level modeling is needed to account for individual and contextual factors affecting public reactions to disasters and longer-term community resilience.

SESSION 019: CLOGGED PIPELINES: EXAMINING GAPS IN THE USE OF NEW SCIENCE FOR FISHERIES MANAGEMENT AND RESTORATION IN THE GULF OF MEXICO

Chris Robbins (Ocean Conservancy), Elizabeth Fetherston-Resch (Florida RESTORE Act Centers of Excellence Program)

SESSION OVERVIEW

This session discussed how anthropogenic stressors and scientific uncertainties can be better understood and mitigated through more effectively integrating science into fisheries management and restoration planning in the Gulf of Mexico. Speakers representing the fishing, scientific, management, and funding communities provided different perspectives on a range of topics related to improving the collection and use of information for fisheries management and restoration. Individual talks addressed the synergistic effects of multiple stressors, such as the Deepwater Horizon oil spill and lionfish invasion on the decline and recovery of reef fish, the importance of incorporating ecosystem processes into stock status assessments, combining on-the-water knowledge of fishers with the expertise of trained scientists through cooperative research, and introducing new technologies to more efficiently collect and transmit fisheries data. The session concluded with a panel discussion around these questions: How do we integrate key uncertainties into fisheries restoration and management, what stressors can be mitigated, what information do we need to address them, and where do they fit within a decision-making process?

SESSION HIGHLIGHTS

- Anthropogenic stressors and their synergistic effects have implications for fisheries management and restoration. For example, native reef fish and their prey base declined following the Deepwater Horizon oil spill, coinciding with a dramatic increase in invasive lionfish.
- Fishers are an invaluable and perhaps underutilized resource in fisheries or marine research.
- Spawning behavior and life history traits are good predictors of fish stock status and can be used to understand the extrinsic vulnerability of fish species to fishing during spawning season.
- Single species assessments have been effective, but they have been done to the exclusion of other ecosystem factors. Modeling the ecosystem and fisher behavior can help identify the reasons behind status and trends, reduce uncertainty and help inform decision making.
- Mechanisms facilitating information exchange to and from fishers can help increase awareness of fisheries management challenges in this community and flag issues for further study.
- Funders are identifying science and research gaps/needs for resource types in the Gulf of Mexico, but important questions remain: What determines a priority? Is a gap necessarily a need? And who should make these decisions?

SESSION 020: UNDERSTANDING THE SHELF ECOSYSTEM – A CRITICAL INTERMEDIARY BETWEEN OPEN WATER AND THE COAST – BY COMBINING IN-SITU MEASUREMENTS, MODELING, AND REMOTE SENSING

Adam Greer, Kemal Cambazoglu, Virginie Sanial (University of Southern Mississippi)

SESSION OVERVIEW

The shelf ecosystem is subject to numerous anthropogenic activities, from industry to tourism, and serves as a critical intermediary between the land and the open ocean. Many ecological properties of the shelf ecosystem are the result of the complex interactions among physical, biological, and geochemical processes. Because many of these interactions occur on fine spatiotemporal scales, the mechanisms influencing the shelf are poorly understood. Low oxygen bottom waters (i.e., hypoxia) is a major concern to the shelf ecosystem in the northern Gulf of Mexico, and an understanding of the causes and consequences of widespread hypoxia requires interdisciplinary thinking. This session aimed to bring together people from different research backgrounds all focusing on improving our understanding of the coupling of oceanographic and biogeochemical processes in the shelf ecosystem.

SESSION HIGHLIGHTS

- Wind and eddies are important physical factors in the transport of the low salinity, nutrient-rich Mississippi River plume. Eddies increase the offshore transport of river water. Strong export of freshwater plumes over the shelf from the source to the deep ocean may be event-driven (e.g., cold fronts, high winds, etc.). The proximity of Loop Current to the Mississippi River Delta and the interactions of freshwater plumes with cyclonic and anti-cyclonic eddies result in different pathways for waters originating from the Mississippi River or additional rivers along the coast of the northern Gulf of Mexico to reach the central Gulf of Mexico and straits of Florida.
- Wind is also a dominant factor in the mixing near the Mobile Bay ebb tidal delta and strong near-inertial oscillations may have important implications on the ecosystem near the coast.
- Complexity of wind-driven and wave-driven effects on the vertical shear in the upper first meter of the water column is shown by drifters. Near-surface currents are strongly wind- and wave-driven with a smaller contribution from regional circulation.
- Region-specific algorithms using satellite imagery more accurately reproduce coastal phytoplankton distributions/communities compared to more general, global algorithms.
- Oil-degrading bacteria grow faster when exposed to crude oil and are sometimes associated with the development of harmful algal blooms. However, the exact mechanisms behind this correlation are still unresolved because phytoplankton growth was not associated with bacteria-derived nutrients.
- Submarine Groundwater Discharge (SGD) likely supplies iron and dissolved organic nitrogen to the western Gulf. SGD also seems to play an important role in the biogeochemistry as well as in the low oxygen concentrations of Mississippi Bight bottom waters.
- Numerical modeling suggests diversion of the Mississippi River will affect nutrient and freshwater transport pathways over the Louisiana Shelf, with implications for hypoxia dynamics.

RESEARCH GAPS IDENTIFIED

- Acquire field data with improved spatiotemporal resolution to constrain physical and biological models.
- Resolve trophic links of shelf food webs to better describe biological responses to physical and biogeochemical changes.
- Challenges remain for modeling the coastal environment, particularly transport and mixing, as well as phytoplankton and microbial community dynamics.
- Use retrospective analyses to constrain models in order to develop scenarios to test ecosystem responses to future oil spills or other stressors.

SESSION 021: MOSSFA EVENTS: MICROBIAL RESPONSES, ECOSYSTEM IMPACTS, PREDICTIONS AND HIGH-PRESSURE IN NAVIGATING FUTURE DEEP OIL SPILLS IN THE GULF OF MEXICO

David Hollander (University of South Florida), Adrian Burd (University of Georgia), Antonietta Quigg (Texas A&M University), Peter Santschi (Texas A&M University at Galveston), Roseanne Ford (University of Virginia)

SESSION OVERVIEW

The focus of this session was mechanisms that control MOSSFA (Marine Oil Snow Sedimentation and Flocculent Accumulation) formation and are leading to the transport of significant amounts of crude oil and other surface water constituents to the sea floor.

SESSION HIGHLIGHTS

- MOSSFA events depend on the presence and composition of:
  - Extracellular polymeric substances (EPS) and transparent exopolymeric particles (TEP), which are the particulate form of EPS;
  - Allochthonous or autochthonous primary (i.e., phytoplankton) produced minerals such as SiO_2 and $CaCO_3$ to overcome the buoyancy provided by oil; and
  - Dispersants.
- For the composition of EPS and TEP, evidence presented showed the importance of proteins in EPS, compounds that are not frequently determined because one mostly assumes TEP is composed mostly of polysaccharides. This assumption is based on the fact that:
  - TEP is determined by Alcian Blue staining of acid polysaccharides (but not neutral polysaccharides or proteins); and
  - The concentration of TEP determines aggregation extent, both of which are not supported by many data.
- Reasons for the importance of proteins that were discussed include that, besides containing hydrophilic moieties on the surface of the molecule, they also contain hydrophobic moieties in their interior (e.g., aromatic side chains) that can interact with oil and amphiphilic compounds, and that proteins can polymerize and form aggregates through the actions of radical oxygen species produced by sunlight or microbial enzymes. Both processes can help to form aggregates that either stay longer in the water when oil/Corexit is present or help with the formation of sinking aggregates when only oil is present. This random chemical crosslinking of proteins is the likely reason why proteins become unrecognizable by bacterial enzymes and thus can be preserved on their transit to the ocean bottom. It was also shown through radiotracer experiments that proteins are predominantly produced by bacteria in response to oil/Corexit. Bacterial synthesis of proteins was also shown in another study that it is only weakly dependent on pressure.
- Thus, evidence from different microfluidic devices, as well as laboratory and mesocosm experiments, was presented for the use of the protein/polysaccharide ratio as a predictor of aggregation extent, or “stickiness,” and surface tension.
- It was also shown that photorespiration and the Krebs cycle play an important role for phytoplankton growth, and these were reduced by the presence of WAF.
- When Corexit is present, EPS preferentially partitioned into the colloidal fraction and formed small microaggregates, likely due to negative effects on phytoplankton (e.g., diatoms or coccolithophores) that are forming minerals (SiO_2 or $CaCO_3$). When Corexit was present, it was shown that diatoms only formed under control or WAF conditions, but under CEWAF or DCEWAF conditions, euglenozoan and other heterotrophs become dominant.

RESEARCH GAPS IDENTIFIED

Protein/carbohydrate ratios should be investigated further for their utility to predict MOSSFA formation. This would require more chemical measurements of proteins, which currently are quite sparse.

SESSION 022: WHERE THE OIL GOES: APPLICATIONS OF MODELING FOR OIL FATE, TRANSPORT, BIOLOGICAL EFFECTS, AND SAFETY

CJ Beegle-Krause (SINTEF Ocean), Christopher Baker (NOAA)

SESSION OVERVIEW

It is one thing to better understand a given process, and another to be able to restructure that understanding enough to provide guidance or assessment of a spill. This session focused on recent developments in the understanding of these processes that can enhance prediction, as well as use cases for improved safety, decision support and/or assessment systems. Since the Deepwater Horizon oil spill, this conversation has widened to include large-scale modeling of oil mineral aggregates and oil marine snow. This session focused on the variety of methodologies used, the application of new understanding to modeling systems, and algorithm development that could be applied to and in such systems.

SESSION HIGHLIGHTS

Oil spill modeling, both operational and for research, is expanding in scales, from extensive integrated regional models to high resolution models of a single droplet and models of aerosolized oil droplets. River fronts, where freshwater overlays marine water, is a complex issue for oil spills, as the freshwater can block the oil transport. Better understanding these systems will assist in forecasting where the oil could go. Integration of nonlocal flux into the upper ocean simulation of oil spills is being developed. Continued research incorporating planetary rotation into well blowout buoyant plume models shows that the development of intrusion layers changes over time, which needs to be better understood for planning in Arctic regions. Researchers are exploring well blowout scenarios that are different from the Deepwater Horizon blowout, which will help in planning and preparedness for future spills. With oil spill modeling, there is the need for ocean circulation and wind models, with research focusing on scaling necessary to provide the best information.

SESSION 023: UNDERSTANDING PROCESSES ASSOCIATED WITH CHRONIC HYDROCARBON RELEASES FROM NATURAL AND ACCIDENTAL SOURCES

Binbin Wang (University of Missouri), Ian MacDonald (Florida State University), Anusha Dissanayake (RPS), Daniela Di Iorio (University of Georgia), Lisa DiPinto (NOAA)

Moderator: Chuck Wilson (GoMRI)

SESSION OVERVIEW

This session summarizes recent developments of physical, chemical, and biological processes associated with chronic hydrocarbon releases from both natural and accidental sources. This session presented new datasets, new methodology, and new results from laboratory, field, and modeling works.

SESSION HIGHLIGHTS

- The depletion of ^{13}C was a tracer for Deepwater Horizon oil in the deep Gulf, but this signal has largely dissipated. At present, 50 to 70% of dissolved inorganic carbon in the deep Gulf of Mexico is from natural hydrocarbon seeps.
- Mass transfer coefficient can be predicted to model the dissolution of hydrocarbon bubbles in the ocean water. Gas hydrate decreases the dissolution rate of hydrocarbons. Horizontal spreading of bubble clouds follows diffusive processes. A majority of the deep-water seep bubbles cannot make to the surface of the ocean.
- Natural seeps were found to provide nutritional carbon and nitrogen which is important to the health of corals. Suspended particulate organic carbon is a good indicator of carbon source feeding the microorganisms.
- Some lines of evidence suggest that hydrocarbon release rates from the MC20 site of a destroyed production platform must be low due to limits on producing wells.
- The oil samples from MC20 are heterogeneous, therefore suggesting the source is probably material dispersed in sediments.
- Some lines of evidence suggest the response efforts at MC20 have removed or otherwise constrained much of the possible oil sources.
- Analysis of gas collected in the water column indicates a likely reservoir source as opposed to a microbial source.
- Acoustic signatures of bubbles in the water column describe a persistent plume rising from a focused source at the base of the fallen platform.
- Drifter studies indicate that the residence time for surface oil detected from satellites at MC20 is on the order of 12 hours and indicates variable discharge rates.
- The acoustic plumes at MC20 were characterized by abundant gas bubbles and oil drops that could be imaged at multiple depths in the water column

ATTENDANCE AND DEMOGRAPHICS

9 COUNTRIES

Australia, Canada, France, Germany, Mexico, Norway, Spain, United Kingdom, and United States

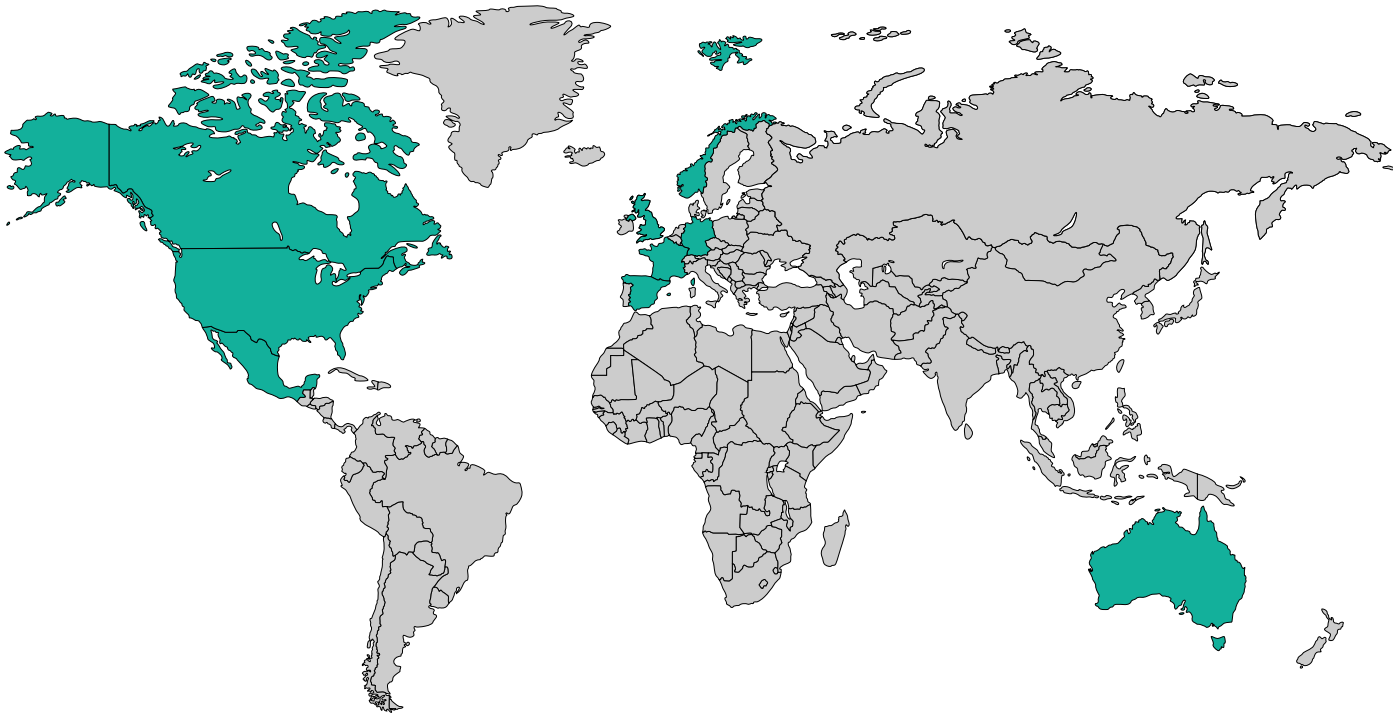
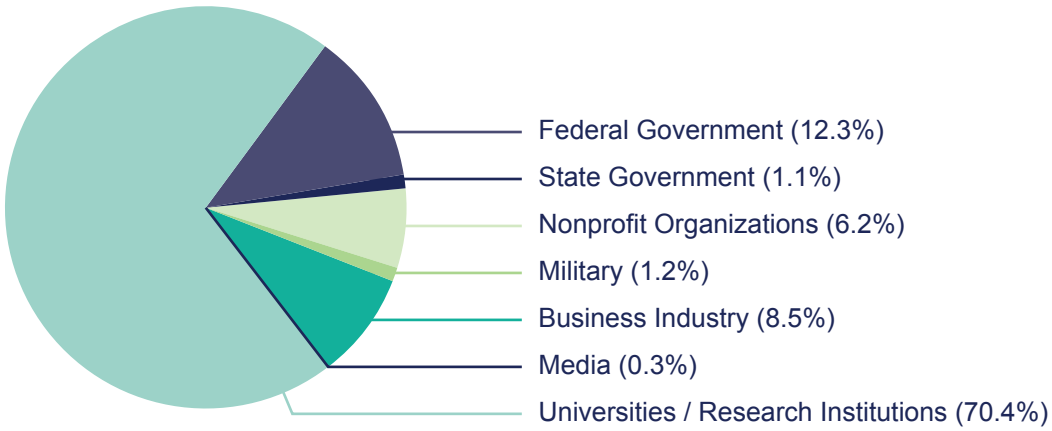
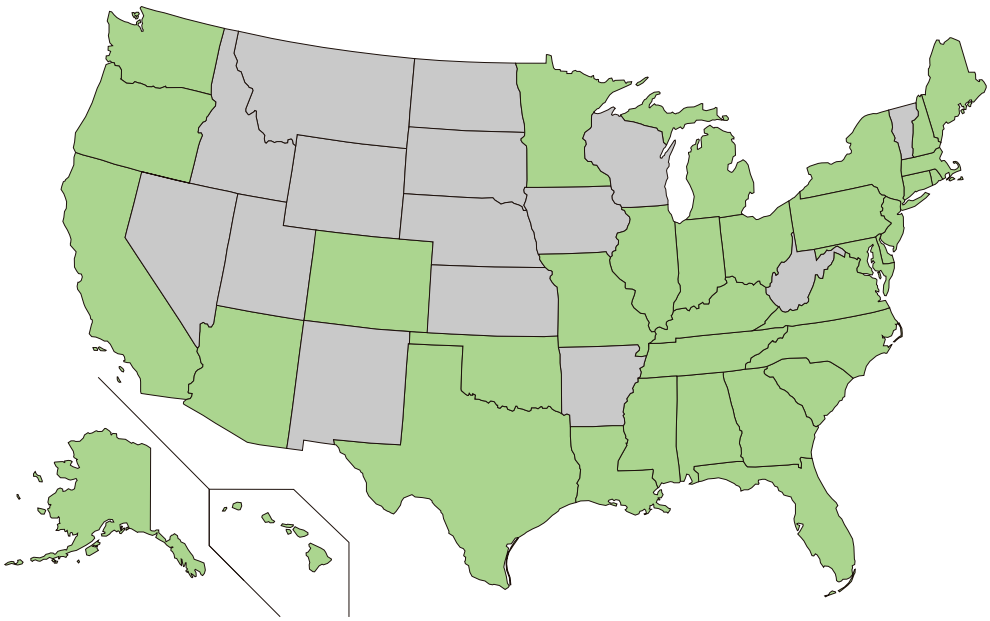


FIGURE 1: ATTENDEES BY SECTOR



35 STATES

Alabama, Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, Washington and Washington, D.C.



MEDIA

A key element to the 2019 GoMOSES Communications/Media Engagement plan was to continue cultivating relationships with local organizations that attended previous GoMOSES conferences in New Orleans. In particular, outreach was done to connect with the "*Coastal Reporting Team*" from The Times-Picayune and an environmental reporter from WWNO who hosts the Coastal News Roundup radio show in advance of the conference. Both reporters attended, were engaged with the conference, and produced pieces after the conference. Dialogue will continue with both reporters in the hopes that they can continue their involvement with GoMOSES and attend the 2020 conference in Tampa, Florida.

Two press releases were distributed through *PRNewswire*, a national press release service, and conference partners, while updates and news were announced via the conference email list, the Consortium for Ocean Leadership e-newsletter, and social media. Searches through *Meltwater*, a media monitoring service, returned 149 examples of coverage before, during, and after the conference with a total reach of 22.0 million people. Social media engagement resulted in 65 uses of the conference hashtag (#GoMOSES) on Twitter, 467 Twitter followers, and 434 Facebook followers.

The full media report is available in Appendix IV (Page 40).

APPENDIX I: CONFERENCE AGENDA

Monday, February 4

Time	Event	Location
8:30a – 5:30p	Registration and check-in open	Celestin Foyer
12:00p – 5:30p	Presentation upload open	Celestin Foyer
2:00p – 6:00p	Exhibit set up	Storyville Hall
2:00p – 6:00p	Poster set up	Storyville Hall

Workshops and Associated Meetings

7:30a – 5:00p	Workshop on the Trophic Effects of Nitrogen Sources and Plankton Food Web Dynamics for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico (Closed)	Imperial 10
7:30a – 5:30p	Oil Spill Preparedness and Response Workshop: Tradeoff Decisions in the Gulf of Mexico (Closed)	Celestin H
9:00a – 12:00p	Monitoring Coordination Committee Meeting (Closed)	Celestin C
9:00a – 5:00p	Responding to Future Deep Water Oil Spills in the Gulf of Mexico	Celestin B
9:00a – 5:00p	BSEE/NOAA Cruise Workshop (Closed)	Celestin D
9:00a – 5:00p	AIBS Science Policy Training (Closed)	Imperial 5 C/D
12:00p – 2:00p	CONCORDE Synthesis Workshop (Closed)	Celestin G
1:00p – 5:00p	Stakeholder Engagement to Identify Monitoring and Adaptive Management Data Needs for the Deepwater Horizon NRDA Open Ocean TIG's Restoration Program	Celestin A
1:00p – 5:00p	Framing Indicators for an Ecosystem Assessment of Barataria Basin, LA	Celestin E
2:00p – 5:00p	NOAA RESTORE Site Visit: Sargassum Project (Closed)	Celestin G
5:30p – 7:30p	GoMRI Synthesis Leaders Meeting (Closed)	Imperial 5 C/D

Tuesday, February 5

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

Opening Plenary Program Schedule

Starting at 7:30a	BREAKFAST	Storyville Hall
9:00a – 10:00a	Welcome and Introduction Changing Focus: From Oil Spill Response to Restoration	Celestin D/E
10:00a – 10:30a	BREAK	Storyville Hall
10:30a – 12:00p	Panel and Discussion	Celestin D/E
12:00p - 2:00p	LUNCH BREAK	

Scientific Program Schedule

2:00p – 3:30p	Session 001	Celestin A
	Session 002	Celestin C
	Session 003	Celestin D
	Session 004	Celestin E
	Session 005	Celestin F
	Session 006	Celestin H
3:30p – 4:00p	BREAK	Storyville Hall
4:00p – 5:30p	Session 001	Celestin A
	Session 002	Celestin C
	Session 003	Celestin D
	Session 004	Celestin E
	Session 005	Celestin F
	Session 006	Celestin H
5:30p – 7:30p	Poster session & reception (featuring Sessions 001 – 012)	Storyville Hall

Workshops and Associated Meetings

8:00a – 9:00a	Gulf of Mexico Restoration and Science Program Coordination Forum (Closed)	Imperial 5 A/B
10:00a – 10:30a	Organizing Data – Best Practices and GRIIDC Submission	Imperial 9
12:00p – 2:00p	GRIIDC Advisory Board Meeting (Closed)	Celestin B
12:15p – 1:45p	The Future of the U.S. Gulf Coast Coupled Natural-Human System: NASEM Report Overview, GRP Funding Opportunity, and Research Funders Discussion	Imperial 5 C/D
3:30p – 4:00p	Submitting Cruise Data to GRIIDC	Imperial 9
5:00p – 6:00p	GoMRI Coordinators Meeting (Closed)	Celestin B
5:30p – 6:30p	What Do We Need to Know? Toward a Response Oil Assay	Imperial 5 C/D
5:30p – 7:30p	Gulf of Mexico Data Tools Café	Storyville Hall

Wednesday, February 6

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

Scientific Program Schedule

Starting at 7:30a	BREAKFAST	Storyville Hall
8:30a – 10:00a	Session 007	Celestin E
	Session 008	Celestin F
	Session 009	Celestin H
	Session 010	Celestin A
	Session 011	Celestin C
	Session 012	Celestin D
10:00a – 10:30a	BREAK	Storyville Hall
10:30a – 12:00p	Session 007	Celestin E
	Session 008	Celestin F
	Session 009	Celestin H
	Session 010	Celestin A
	Session 011	Celestin C
	Session 012	Celestin D
12:00p - 2:00p	LUNCH BREAK	
2:00p – 3:30p	Session 012	Celestin D
	Session 013	Celestin A
	Session 014	Celestin H
	Session 015	Celestin C
	Session 016	Celestin F
	Session 017	Celestin E
3:30p – 4:00p	BREAK	Storyville Hall
4:00p – 5:30p	Session 012	Celestin D
	Session 013	Celestin A
	Session 014	Celestin H
	Session 015	Celestin C
	Session 016	Celestin F
	Session 017	Celestin E
5:30p – 7:30p	Poster session & reception (featuring Sessions 013 – 023)	Storyville Hall

Workshops and Associated Meetings

8:00a – 8:30a	Submitting a Dataset to GRIIDC	Imperial 9
10:00a – 10:30a	Submitting Cruise Data to GRIIDC	Imperial 9
12:00p – 2:00p	GoMRI Scholars Lunch (Closed)	Celestin B
12:15p – 1:15p	Evaluation of the Use of Chemical Dispersants in Oil Spill Response – A Report from the National Academies of Sciences, Engineering, and Medicine	Imperial 5 A/B
12:15p – 1:15p	How to Use Social Media to Meet Your Goals	Celestin G
12:30p – 1:30p	Update on the DWH Long-Term Data Management and Coordination	Imperial 5 C/D
3:30p – 4:00p	Organizing Data–Best Practices and GRIIDC Submission	Imperial 9
4:00p – 5:00p	Exploratory Meeting on Comparing Advances in Oil Slick Thickness	Imperial 5 C/D

Thursday, February 7

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

Scientific Program Schedule

Starting at 7:30a	BREAKFAST	Storyville Hall
8:30a – 10:00a	Session 018	Celestin H
	Session 019	Celestin F
	Session 020	Celestin E
	Session 021	Celestin A
	Session 022	Celestin C
	Session 023	Celestin D
10:00a – 10:30a	BREAK	Storyville Hall
10:30a – 12:00p	Session 018	Celestin H
	Session 019	Celestin F
	Session 020	Celestin E
	Session 021	Celestin A
	Session 022	Celestin C
	Session 023	Celestin D
12:00p - 2:00p	LUNCH BREAK	

Closing Plenary Program Schedule

2:00p – 3:30p	James D. Watkins Awards Gulf of Mexico University Research Collaborative (GOMURC) Presentation of the Wes Tunnell Lifetime Recognition for Gulf Science and Conservation Conference Wrap Up	Celestin D/E

Workshops and Associated Meetings

10:00a – 10:30a	Submitting a Dataset to GRIIDC	Imperial 9
1:00p – 5:00p	Marsh Food Web Working Group (Closed)	Imperial 5 A/B

Appendix II: Associated Workshops and Meetings

Oil Spill Preparedness and Response Workshop: Tradeoff Decisions in the Gulf of Mexico (Closed)

ORGANIZED BY THE COASTAL WATERS CONSORTIUM

American regional policies were developed in the 1990s following the Ixtoc I blowout in the Gulf of Mexico (June 3, 1979 – March 23, 1980), the Exxon Valdez oil spill (March 24, 1989), the passage of the Oil Pollution Act of 1990 (OPA 90), and the 1994 update of the U.S. National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The NCP requires the development of regional policies about the use of dispersants, other chemicals, and *in-situ* burning. In many regional policies, dispersant use was authorized as a viable response option to mitigate the impacts of oil on vulnerable/sensitive/productive coastal environments (especially marshes) and water surface wildlife (especially birds), when applied in open waters with good circulation and potential for rapid dispersed oil dilution (e.g., > 3 miles from shore and > 30 feet).

The goal of this workshop was to begin a conversation between GoMRI researchers and their user community (i.e., oil spill planners and responders) about applying past and recent scientific findings to produce shared knowledge that will help inform tradeoff decisions during oil spill planning and response in the Gulf of Mexico. The scenario involved a blowout that threatens the coast, with choices about response options that include dispersant use.

Objective for the user community (oil spill planners/responders): Provide a mutual learning opportunity for oil spill planners and responders, academic researchers, community stakeholders, and industry to engage about possible use of subsea dispersant injection as a possible response option for a deep-water oil well blowout in the Gulf of Mexico.

Objective for researchers/community representatives: Learn about approaches to address dispersant tradeoff issues and provide feedback to the user community about research findings since Deepwater Horizon which are relevant to considering tradeoffs as well as important factors to consider in decision-making and/or outstanding gaps in understanding.

Objective for all participants: Provide a realistic decision-making discussion context. Specifically explore, consider, and/or discuss the issue of tradeoffs in incident-specific decision-making. Does what we have learned since the Deepwater Horizon oil spill change that view of tradeoffs? If so, how and under what conditions?

Participants were able to hear decision makers from the Region 6 Regional Response Team consider dispersant use for a blowout scenario.

Responding to Future Deep-Water Oil Spills in the Gulf of Mexico

ORGANIZED BY THE CENTER FOR THE INTEGRATED MODELING AND ANALYSIS OF THE GULF ECOSYSTEM (C-IMAGE)

Research stemming from the Deepwater Horizon oil spill has resulted in a considerable body of work specific to ambient conditions at that 1,500 m deep site in the northern Gulf of Mexico. Should another mega-blowout occur in the Gulf of Mexico, it surely will occur at sites deeper and more remote to the coast, as the industry has moved to well locations in depths approaching 3,000 m. Data mined from the BOEM website is used to forecast how exploration and production has and will evolve over time. Using simulations of deep blowout scenarios combined with accumulated information on realistic processes extant at various sites as well as resources potentially at risk, this session considered how future scenarios may differ from Deepwater Horizon. The Deepwater Horizon scenario resulted in a considerable quantity of oil reaching the bottom as a result of marine oil snow aggregation processes. Will the conditions required for such a scenario be achieved farther offshore and away from riverine sources of clay particles and in areas of lower primary productivity? How will future spills impact the exclusive economic zones of the three Gulf countries? In particular, the use of mitigation measures such as traditional clean up technologies (booming, straining, controlled burns, surface-applied dispersants), and mitigation measures novel to Deepwater Horizon (SSDI, berming, freshwater releases) were considered. This workshop also highlighted the relative environmental sensitivity of offshore Gulf regions, critical information gaps, and policy implications of offshore spill scenarios.

Stakeholder Engagement to Identify Monitoring and Adaptive Management Data Needs for the Deepwater Horizon NRDA Open Ocean TIG's Restoration Program

ORGANIZED BY THE NRDA OPEN OCEAN TRUSTEE IMPLEMENTATION GROUP

The Deepwater Horizon Natural Resource Damage Assessment (NRDA) *Open Ocean Trustee Implementation Group* (TIG) is seeking input from stakeholders on the identification and prioritization of information needed to facilitate restoration for injured resources within the Open Ocean TIG. This workshop included an overview of the Open Ocean TIG's restoration goals, current restoration priorities, and potential approaches for evaluating Open Ocean TIG restoration outcomes. Participants were asked to provide input on the data needed to best inform planning, implementation, and evaluation of Open Ocean TIG restoration activities for fish and water column invertebrates, mesophotic and deep benthic communities, sea turtles, marine mammals, birds, and sturgeon injured by the Deepwater Horizon oil spill, as well as data needed to inform restoration at the ecosystem level.

An Introduction to the Environmental Unit's Role and Responsibilities During an Oil Spill

ORGANIZED BY OBG

The Environmental Unit (EU) is established within hours of a spill and is responsible for all environmental issues during the response. This course aimed to educate participants on what the EU does and does not do. One of the primary roles of the EU is to minimize inadvertent damage from response activities to natural and cultural resources. During the Deepwater Horizon oil spill response, this minimization was accomplished via the Natural Resource Advisor (NRA) program. The NRA program was managed by the organizers of this course and was discussed thoroughly during this workshop. Additional EU responsibilities include identifying resources at risk; managing the Shoreline Cleanup Assessment Technique (SCAT) program; managing waste streams; and coordinating internal and external environmental stakeholder issues as they pertain to response activities. The main function that the EU does not perform is assessing injury or damage from the release. This is addressed via the Natural Resource Damage Assessment (NRDA) process. The workshop provided an overview of the NRDA process and discussed areas of overlap between response activities and NRDA. This was a discussion-based, four-hour workshop taught by experienced spill response consultants who have worked on the Deepwater Horizon; Texas City Y; LaPorte, TX release of methyl tertiary butyl ether; and Bay Long responses in the Gulf recently along with many other spills.

The Future of the U.S. Gulf Coast Coupled Natural-Human System: NASEM Report Overview, GRP Funding Opportunity, and Research Funders Discussion

ORGANIZED BY THE NASEM GULF RESEARCH PROGRAM

A new National Academies of Sciences, Engineering, and Medicine (NASEM) report, "Understanding the Long-Term Evolution of the Coupled Natural-Human Coastal System: The Future of the U.S. Gulf Coast" identifies critical research areas and knowledge gaps that, if addressed, will significantly improve understanding of the Gulf Coast coupled natural-human system. The report specifically emphasizes the need for understanding interactions and feedbacks between physical processes (e.g., landform migration due to sea level rise), ecological alterations (e.g., wetland loss, tropicalization), and human activities (e.g., coastal development, engineering approaches). This event featured a presentation about the report, a panel discussion of the report with representatives from research funding organizations, and information about a related upcoming Gulf Research Program funding opportunity.

Evaluation of the Use of Chemical Dispersants in Oil Spill Response – A Report from the National Academies of Sciences, Engineering, and Medicine

ORGANIZED BY THE NASEM OCEAN SCIENCES BOARD

This event focused on the recently released report from the National Academies of Sciences, Engineering, and Medicine titled "Evaluation of the Use of Chemical Dispersants in Oil Spill Response." Organizers discussed the report process; big picture conclusions and recommendations; technical details associated with fate and transport, aquatic toxicity, and human health; decision support; and responses to the report from sponsors and others.

How to Use Social Media to Meet Your Goals

ORGANIZED BY THE LOUISIANA UNIVERSITIES MARINE CONSORTIUM

Many scientists feel that they "should" be on social media to tell "the public" about their work. But social media is simply one of many communications tools available for scientists to fulfill their goals. This is not a standard introductory social media workshop. There are many blog posts and how-to advice articles already online that instruct beginners on the technical aspects of using social media. This workshop talked attendees through goal-setting exercises and demonstrated, with real examples, how any social media network is a Swiss Army knife that can be used to fulfill a variety of needs. Participants left with a written profile of themselves and an action plan for how they will use social media to meet their goals, including how to successfully use social media if they want to spend no time on the network at all.

Updates and Exploratory Meetings

ORGANIZED BY THE COASTAL RESPONSE RESEARCH CENTER

Update on the Deepwater Horizon Long-Term Data Management and Coordination

Exploratory Meeting on Comparing Advances in Oil Slick Thickness

What Do We Need to Know? Toward a Response Oil Assay

Gulf of Mexico Research Initiative Information Data Cooperative (GRIIDC) Training Workshops

ORGANIZED BY GRIIDC

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.

Submitting Cruise Data to GRIIDC

GRIIDC submits data generated from research cruises to the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) for long-term archiving. NCEI requires data be submitted with specific documentation and file structure. This workshop provided information about the types of cruise data to submit to GRIIDC, supporting documentation that is required, and the file structure required for data submission to GRIIDC.

Submitting a Dataset 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.

Other meetings:

Workshop on the Trophic Effects of Nitrogen Sources and Plankton Food Web Dynamics for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico (Closed)

Monitoring Coordination Committee Meeting (Closed)

BSEE/NOAA Cruise Workshop (Closed)

AIBS Science Policy Training (Closed)

CONCORDE Synthesis Workshop (Closed)

NOAA RESTORE Site Visit: Sargassum Project (Closed)

Gulf of Mexico Restoration and Science Program Coordination Forum (Closed)

GoMRI Scholars Lunch (Closed)

Marsh Food Web Working Group (Closed)

GRIIDC Advisory Board Meeting (Closed)

Appendix III: Gulf of Mexico Tools Café

Blueways Conservation Decision Support Tool

THE NATURE CONSERVANCY

The "blueways" conservation decision support tool aims at providing knowledge on migratory pathways and important habitats to help planners, resource managers, government officials, marine scientists, and the ocean conservation community understand marine blueways, their threats, and important conservation areas.

Gulf of Mexico Coastal Ocean Observing System (GCOOS): The Data Portal and Products

HARTE RESEARCH INSTITUTE, TEXAS A&M UNIVERSITY - CORPUS CHRISTI

The Gulf of Mexico Coastal Ocean Observing System (GCOOS), a Regional Coastal Ocean Observing System (RCOOS) nested in a National Backbone of coastal observations, developed and maintains a centralized data repository for the Gulf of Mexico. The data portal was designed and deployed to aggregate and disseminate the region's near real-time oceanographic data to provide timely information about the environment of the U.S. portion of the Gulf of Mexico and its estuaries to assist decision-makers, including researchers, government managers, industry, military, educators, emergency responders, and the general public interested in environmental monitoring. The data currently collected are from voluntary local (regional) data providers and federal observing facilities in the Gulf of Mexico.

The deployed and operational version of the data portal and product pages are automated computerized network-accessible data collection and delivery systems. These data sources are maintained under a variety of data standards and archival schemas, and GCOOS serves as the interface to these data, model output, and products via automated standards-based machine-to-machine service interfaces, and through web-based human-accessible graphical user interfaces. The same set of services provide features that facilitate interoperability with other regional data systems, as well as with the federal backbone composed of systems typified by, but not limited to, that of the National Data Buoy Center.

Although it is assumed that data providers follow stringent practices to ensure sensors are calibrated regularly, and data received from sensors are validated prior to data submission, GCOOS re-executes QA/QC tests to all the data received to ensure uniformity of data quality following the Quality Assurance of Real-time Oceanographic Data recommendations. GCOOS maintains data services, including ERDDAP, Comprehensive Knowledge Archive Network, Direct Access and RESTFul, Web Accessible Folders, and Open Geospatial Consortium Sensor Observation Service, to serve data and products. The data and products from GCOOS are licensed under the Creative Commons by Attribution International or CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/legalcode) giving data and products users free access and reuse to the data and products served from GCOOS facilities.

Chemical Aquatic Fate and Effects Database (CAFE)

NOAA, 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 has 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 requires 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, including data related to the Deepwater Horizon oil spill. Interspecies correlation estimation models have also been incorporated in the web-based version of CAFE, allowing the generation of ~800 new SSD curves for chemicals that previously did not have enough data points. 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.

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 GoMRI-funded projects. The data management applications that assist with planning, documenting, and submitting data to GRIIDC are designed for investigators and data managers. GRIIDC also issues a DOI for discrete data packages that provides researchers with a citable reference for their efforts. These tools are available to GoMRI-, Florida RESTORE Act Centers of Excellence Program-, and Mississippi-based RESTORE Act Center of Excellence-funded investigators. The GRIIDC program is also developing 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 and Alabama RESTORE Act Centers of Excellence, the National Academy of Sciences Gulf Research Program, oil and gas industry, 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, nongovernmental organizations, and the general public.

Modeling Oyster Productivity Using AQUATOX: Calibration Using Online Data Sources

MOFFATT & NICHOL

AQUATOX is a mechanistic Ecosystem Model developed by the U.S. EPA (version 3.2 October 2018) that has been used for baseline and injury estimates for the Deepwater Horizon Incident. The application described during the café is for the calibrated oyster reef study for Cedar Point, Alabama, and was presented during a previous tools café for demonstrating baseline ecosystem services (supporting). During this session, we described the following:

- AQUATOX description and previous applications;
- Calibration requires time series of physical/chemical data;
- Available online resources using Google Earth Engine (GEE);
- Demonstrate GEE data - time series downloads;
- Demonstrate AQUATOX data input; and
- Demonstrate oyster reef simulations and restoration application.

Local Sea-Level Rise Data Analysis Helper

NORTHERN GULF OF MEXICO SENTINEL SITE COOPERATIVE/MISSISSIPPI STATE UNIVERSITY/MISSISSIPPI-ALABAMA SEA GRANT CONSORTIUM

As a contribution to the Fourth National Climate Assessment, Sweet *et al*. (2017 & 2018) published regional sea level rise projections and associated projected high-tide flooding. While exceptionally useful, the information is located in technical reports and multiple data files, making it difficult for nontechnical audiences to access the data. This suite of resources enables quick access to the data and presentation of the data in clear and consistent ways. The complete tool includes a Data Analysis Helper, a two-page template, and instructions. The primary intended use is to develop a two-pager to communicate local sea level rise scenarios and the associated high-tide flooding. The two-pager can be shared digitally or in print and is already being commonly used for communication purposes across the Gulf of Mexico. An additional use of the Data Analysis Helper as a stand-alone resource is quickly pulling regional sea level rise projections for uses other than building the two-pager. Many researchers and natural resource managers are using the resource for these kinds of applications.

The Conservation Prioritization Tool: A Prototype Tool of the Strategic Conservation Assessment of Gulf Coast Landscapes Project

MISSISSIPPI STATE UNIVERSITY

The Strategic Conservation Assessment (SCA) project team is developing tools that inform where land conservation can be implemented to maximize benefits to communities, economies, and ecosystems across the Gulf Coast region.

The Conservation Prioritization Tool (CPT) will enable RESTORE Council members and their colleagues to evaluate potential conservation areas of interests. The CPT integrates the shared priorities identified through plan review and stakeholder engagement into a multi-criteria decision analysis framework to construct a flexible evaluation tool. The CPT enables a user to evaluate land conservation projects when provided with a given set of priorities and weights.

The Strategic Conservation Assessment of Gulf Landscapes Project is funded by the RESTORE Council and is being implemented by the U.S. Fish and Wildlife Service and Mississippi State University. The SCA team is working to develop land conservation tools that can be used to inform and identify landscape-scale conservation projects that will:

- Make the greatest contribution to restoring and protecting the natural resources of the Gulf;
- Build upon existing coastal restoration plans or programs, and;
- Provide long-term ecosystem resilience to areas most impacted by the Deepwater Horizon oil spill.

The ultimate product of the SCA project will be a dynamic map-based tool that allows users to weigh ecological and socioeconomic priorities and view the conservation opportunities that meet those criteria. The SCA tool will provide 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 prototype CPT is a complementary tool that will enable users to evaluate existing land conservation projects or areas of conservation interest. We invite feedback on the form and function of this prototype tool so that the SCA team can iterate changes and launch a beta Conservation Prioritization Tool in Spring 2019.

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 these data available to stakeholders, scientists, and the public for querying and download for further analysis. The vast majority of environmental data that support the Programmatic Damage Assessment and Restoration Plan (PDARP) that were 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.

Gulf of Mexico ERMA (Environmental Response Management Application)

NOAA

The Environmental Response Management Application (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 U.S. Coast Guard 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 Deepwater Horizon 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 Deepwater Horizon 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.

Appendix IV: GOMOSES MEDIA REPORT

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. 19): Total Pick-ups = 171, Potential Audience Online = 10,288,420, Twitter = 1,264
    - PR2 (Jan 19): Total Pick-ups = 168, Potential audience = 10,156,851; 1,431 Twitter followers
  - Conference announcements (i.e., session proposals, abstracts, registration, etc.) were distributed, as appropriate, through the Consortium for Ocean Leadership Ocean News Weekly (ONW) e-newsletter with a distribution of more than 7,000 people.
  - Updated information on AP planner website.
  - A key element to the 2019 GoMOSES Communications/Media Engagement plan was to continue to cultivate relationships with local organizations that attended previous GoMOSES conferences in New Orleans. In particular, outreach was done to connect with the "*Coastal Reporting Team*" from The Times-Picayune (Tristan Baurick) and an environmental reporter from WWNO who hosts the Coastal News Roundup radio show (Travis Lux) in advance of the conference. Both reporters attended, were engaged with the conference, and produced pieces after the conference. Dialogue will continue with both reporters in the hopes that they can continue their involvement with GoMOSES and attend the 2020 conference in Tampa, Florida.

INFORM MEDIA OF KEY FINDINGS PRESENTED AT THE CONFERENCE

- Created a media kit for distribution at the conference (at information table).
  - Key message document.
  - "Hot topics" document – Summaries of 10 noteworthy abstracts distributed across tracks.
  - Schedule of events and 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: 65
    - #GoMOSES: 64
    - #gulfscienceconference: 1
- Monitor following on Facebook and Twitter
  - Facebook followers: 399 page "likes"
  - Twitter followers: 472
    - 7,957 impressions from 20 tweets across the 5 days of the conference
    - Gained 26 new followers in February

Press Coverage Summary Report

NEWS MEDIA ATTENDANCE:

- 11 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 149 examples of coverage before, during, and after the meeting with a total reach of 22 million. 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 PRNewswire.

Press Release 1: Gulf of Mexico Oil Spill & Ecosystem Science Conference Explores Future Directions of Response and Restoration in the Gulf

Posted Dec. 19, 2018 9:17 AM ET

Total pick up:

171 Postings
1,555 Release Views & Hits

Total Potential Audience:

10,288,420 visitors/day
75 Engagement Actions (e.g., click throughs)
1,264 Twitter followers

Press Release 2: 2019 Gulf of Mexico Oil Spill & Ecosystem Science Conference Explores Future Directions of Response and Restoration in the Gulf

Posted Jan. 16, 2018 9:17 AM ET

Total pick up

168 Postings
2,158 Release Views & Hits

Total Potential Audience

10,156,851 visitors/day
115 Engagement Actions (e.g., click throughs)
1,431 Twitter followers

BEFORE CONFERENCE ARTICLE TOTALS (MELTWATER)

PR1: 83 Articles, 10,709,248 Reach
PR2: 62 Articles, 9,321,354 Reach

POST/DURING CONFERENCE ARTICLES (MELTWATER)

2/8/2019

Venue: NOLA.com
Mystery marsh birds and oil spill research: Coastal News Roundup
Readership: 891,000

2/8/2019

Venue: WWNO
Coastal News Roundup: New research on dispersants, and the quest for an elusive marsh bird

2/15/2019

Venue: NOLA.com
14-year Taylor Energy oil leak could be two times larger than BP spill, new research says
Readership: 891,000

2/18/2019

Venue: www.DemocraticUnderground.com
14-year Taylor Energy oil leak could prove larger than BP spill, new research says
Readership: 203,000

TOTAL articles with reach of 1,985,000 readers