



Gulf of Mexico
OIL SPILL
& ECOSYSTEM
SCIENCE CONFERENCE

2017

Report

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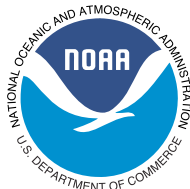


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Gulf of Mexico Research Initiative

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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 support throughout the conference.

NOAA's Coastal Services Center provided pre-conference agenda development.

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

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STUDENT AWARDS & ACTIVITIES

James D. Watkins Student Award for Excellence in Research

For 2017, 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. Given his lifelong pursuit of encouraging and building the next generation of ocean scientists, it is appropriate that the award given in his name recognize excellent research and motivate students to continue to excel in the field of oceanography.

The student recipients are:

Brittany Evans (Eckerd College)

Effects of Salinity on the Toxicity of Oil Dispersants in Eastern Mud Snails

Aprami Jaggi (University of Calgary)

Experimental Simulation of Effect of Dispersants on Oil-Water Partitioning of Low-molecular Weight Compounds during a Deep Submarine Oil Spill

Joseph Seigny (University of New Hampshire)

Genomic Responses to the Deepwater Horizon Event and Development of High-throughput Biological Assays for Oil Spills

Susan Snyder (University of South Florida)

Forming a Gulf-wide Dataset of PAH Exposure and Accumulation in Benthic-dependent Teleosts

Travis Washburn (Texas A&M University - Corpus Christi)

Deep-Sea Ecosystem Services: Out of Sight but Still Invaluable

2017 STUDENT PRESENTER AWARDS

The Gulf of Mexico University Research Collaborative (GOMURC) and Gulf Research Program of the National Academies of Sciences, Engineering and Medicine sponsored Student Presenter Awards, which provided registration fees for all student presenters. Congratulations to the awardees and thank you for presenting your research at the 2017 Gulf of Mexico Oil Spill and Ecosystem Science Conference!



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GULF RESEARCH PROGRAM



EXECUTIVE SUMMARY

CONFERENCE OVERVIEW

The Gulf of Mexico Oil Spill and Ecosystem Science (GoMOSES) Conference provides a platform for the research and management community to assemble, coordinate, exchange, and disseminate Gulf science findings and information across science disciplines, industries, and levels of government. Organized in a collaborative effort of public and private partners, the conference provides an opportunity to reflect on the current state of the Gulf, using recent scientific discoveries to help determine next steps to ensure the ecosystem is healthy, which benefits both marine life and dependent communities. Understanding the impacts of petroleum pollution and related stressors on marine and coastal ecosystems and on coastal communities and then applying that information to response, mitigation, and restoration following spills is essential to Gulf recovery. Each year since the conference's inception in 2013, researchers have gathered together to share what they learned and identify what other work needs to be done. Themes from previous years include:

- Collaboration, integration and synthesis (2014);
- What have we learned, what does it mean, and how can it be used? (2015); and
- One Gulf: healthy ecosystems, healthy communities (2016)

Since scientific research is critical to informing planning, preparedness, response, and recovery for future events, the 2017 Conference theme, "Ecosystem Approaches to Gulf Response and Restoration," promoted dialogue about how research will impact response, restoration, conservation, policy, and management and how it will enhance public understanding of the Gulf of Mexico ecosystem.

Sessions encouraged researchers to consider the application of their results to practical use. Looking across a broad range of disciplines, what have we learned about oil spills and their impacts that can reduce uncertainty; mitigate ecological, social, and health impacts of a future spill; advance response strategies; and improve how we approach restoration?

The conference was planned by an Executive Committee of 12 partners from academia, federal agencies, and non-governmental organizations, with the generous support of eight sponsors.

An overview of the conference schedule is available in Appendix I (page 48). Program highlights include:

- Keynote address by Dave Westerholm, Director of National Oceanic and Atmospheric Administration (NOAA)'s Office of Response and Restoration;
- Panel addressing how scientific research fits into the continuum of planning, preparedness, response, and restoration;
- 23 conference sessions offering 337 oral and 260 poster presentations;
- Closing plenary panel of restoration practitioners discussing the challenges of integrating science into restoration; and
- Presentation of session summaries, with particular emphasis on how the research presented informs response, management, and restoration activities.

The conference also hosted 12 associated meetings and events during the week, offering attendees the opportunity to learn about and discuss interdisciplinary topics not covered during the breakout sessions, such as international research in the Gulf, marine protected species assessments, development of decision support tools, and the challenges of oil spill science informing response. A summary of each meeting and its outcomes is provided in Appendix II (page 52).

SCIENTIFIC SESSIONS

Sessions emphasized applications of recent oil spill science to restoration, resource management, and oil spill response. In keeping with the integrative theme for this year's conference, the Conference Executive Committee selected 23 sessions to reflect a balance of the following topics:

- Breakdown, transport, and long-term fate;
- Ecological impacts;
- Human dimensions and science communications;
- Data, models and decision-making tools; and
- Research to application.

Highlighted findings based on sessions and plenaries include:

- Impacts at the molecular level of a species can have population level consequences, stressing the importance of working across scales to examine drivers of population, community, and ecosystem changes.
- New findings on pathways of oil to the coast indicate that they are highly variable in time (seasonal, winds, discharge), localized, and three-dimensional.
- Large freshwater input events into the environment (natural or engineered) can have strong and complex impacts to currents, extent of oiling alongshore, salinity levels, and even the continental shelf ecosystem.
- Recently-developed genomics tools provide effective molecular markers that can be used as indicators of biodegradation, response and recovery of organisms (microbes to humans), and ecosystems.
- Improved oil analysis methods allow for a better understanding of breakdown [e.g., marine oil snow sedimentation and flocculent accumulation (MOSSFA), oxyhydrocarbons, and photo-oxidation], toxicity effects, environmental impacts, and degradation rates.
- All mitigation decisions involve tradeoffs, e.g., increasing hydrocarbon concentrations in the water column to decrease surface and shoreline oiling.
- Efficacy and effects of mitigation agents are influenced by a variety of natural factors, and differences in chemical composition of mitigation agents will drive hydrocarbon bioavailability.
- Changes in the microbial community could be used as a surrogate for oil bioavailability.
- Recovery of many Gulf populations, including marine mammals and deep-sea organisms, has been slow. Coastal marshes continue to experience ongoing exposure to Macondo oil.
- Indicators can serve as a way for resource managers to track the recovery of a specific habitat and identify system-wide events across a large geography.
- We are still learning about oil in the environment, how broad the stakeholder community is, and how best to integrate external sources of information (e.g., academic research) to inform decision making, as well as to share information with those who may be affected and those who are keenly interested in learning about an oil spill.
- Real-world observations of oil and gas through field experiments and/or chronic releases provide results that improve sensor and modelling capabilities. This exchange goes in both directions -- models identify sensitive variables and evaluate congruence between data sets.
 - Technology advances, e.g., satellite and emergent drone applications, acoustics, and optical approaches, could inform mitigation efforts for future oil spills and other threats and become part of restoration.
- With the right data access tools, applications and models can be created and used in conjunction with each other to answer important questions; to inform predictions, scenarios, and management strategies that minimize risks to sensitive habitats; and to guide response without the need for a great deal of costly primary research and duplication of effort.
- Multiple opportunities exist for science to inform oil spill response decision making, which emphasizes the necessity to enhance communication and collaboration among government, industry, and the scientific community.
- Trust is key to effective risk communications, community interactions, and developing resilience. Risk communication requires two-way dialogue with constituencies, preferably prior to disasters, and good information that doesn't always follow the same rapid time-scale.

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

- Although new baselines are being generated for several communities and habitats, the Gulf scientific and research community still lacks basic understanding of some components of the Gulf ecosystem, including the functional connectivity of response and recovery between trophic levels (micro to mega).
- The community is still evaluating the long-term behavior of oil, especially in marshes and anaerobic environments, as well as the association of microbial community expression and composition with oil chemistry and oil degradation.
- Response research challenges include access to mitigation products and oils for testing. How are experiments scaled from laboratory to real world conditions, and how are new technologies transitioned from the research and development stage to become options for use in spill response?
- Challenges to restoration include maintaining the ability to adapt to new information and unknown conditions during the restoration process, especially for deepwater ecosystems along the continental shelf. Integrating the Deepwater Horizon (DWH) restoration plan with the many other state and regional funding streams and restoration planning frameworks also present a challenge.
- Massive data sets will take time to analyze. How are large data efforts organizing and collaborating to avoid duplication of effort, to encourage cross platform/organization communication, and to facilitate more open-source programming so that applications can be utilized across platforms?
- The DWH injury assessment highlighted the importance of data collection in short-lived conditions, oil-on-water measurements for response and assessment, development of non-lethal methods for documenting exposure and injury, and better techniques for integrating more chronic and sublethal effects into the injury determination.
- Models continue to improve, but their development still faces many challenges, such as scaling issues and sparse data.
- Is the community producing what responders need? Excellent science is being generated, but how do responders ingest this information more easily at the time of an event? Differing scientific expertise and experience can result in biased interpretations of the situation, advice, and recommendations.
- How are responders using the data generated to inform their planning scenarios? How can the Gulf science community get its science in their hands? Integrating oil spill science into Gulf management faces process challenges, institutional challenges, and financial challenges.
- How can the community institutionalize early interactions of outreach and education professionals with responders and researchers to inform the public? How does the response community better communicate the science-based decision making regarding trade-offs?

Abstracts for [oral](#) and [poster](#) sessions are archived online. Full session summaries and more detailed synthesis are available in the report (pages 10-46).

INTRODUCTION

The unprecedented amount of research following the Deepwater Horizon (DWH) event has resulted in a broad range of scientific findings, including insights about how oil breaks down in marine habitats, where currents might take it, and how it affects ecosystems and communities. As the Gulf of Mexico research community continues to answer questions posed since 2010, the focus of this year's conference shifted to the application of these findings and discoveries to spill response and restoration. Effective application of resultant science will better position the national and international response communities to respond to and mitigate future disasters and their impacts. The 2017 conference theme, "Ecosystem Approaches to Gulf Response and Restoration," also provided an opportunity to reflect on the current state of the Gulf and to determine which questions remain unanswered while considering the practical application of those that have been addressed. How do responders and resource managers use new scientific discoveries to ensure that impacts are understood and that the ecosystem is properly restored? What have we learned about oil spills and their impacts that can reduce uncertainty; mitigate ecological, social, and health impacts of a future spill; advance response strategies; and improve how we approach restoration?

OPENING PLENARY

THE ROLE OF SCIENCE IN OIL SPILL RESPONSE AND MANAGEMENT DECISIONS

Keynote

"Oil Spill Science and Response: Putting the Puzzle Pieces Together"

Dave Westerholm, Director of NOAA's Office of Response and Restoration

After stressing how unfortunate it would be to not incorporate into response the unprecedented amount of oil spill research conducted since the DWH event, Mr. Westerholm explained the process for such integration and the many challenges. Science plays a role in every step of the oil response continuum (planning, preparedness, response, damage assessment, and restoration and recovery) by informing response and recovery plans, training, on-the-ground decision making, and potential legal action. There are many challenges to getting science to the forefront, including 1) public and administrative understanding of the oil spill planning process (or lack thereof) and the role of federal, industry, and academic science; 2) the intersection of interests (e.g., media, academics, politicians, responders, lawyers), which influences actions and relationships during an event; and 3) the coordination of scientific input from multiple (and sometimes conflicting) sources.

Discussion Panelists:

- Dave Westerholm (moderator), NOAA
- Capt. Joe Loring, U.S. Coast Guard
- Steve Buschang, Texas General Land Office
- David Moore, Bureau of Safety and Environmental Enforcement
- Greg DeMarco, ExxonMobil
- Nancy Kinner, Coastal Response Research Center for Spills and Environmental Hazards
- Scott Lundgren, NOAA

Following the DWH event, there has been an unprecedented amount of oil spill research, with more discoveries yet to come. In the event of another spill, how might responders handle new science on the ground? How does oil spill research influence policy, planning, preparedness, and response? What efforts are being made to bring academics into the oil spill decision-making process or to allow them access to a spill site during the emergency?

The expert panel provided an in-depth discussion on issues such as how planning and response decisions are made by federal, state, and industry responders with focus on the opportunities and challenges of using academic research. They highlighted the differences between peer-reviewed published research and that done by the government, oil companies, or organizations hired during a response or damage assessment. The panel also discussed incentives for more academic participation in the response continuum and the "cultural" differences, such as reward systems, between the response and scientific communities. They talked about the cyclical nature of oil spill research funding and stressed the importance of building relationships for improved collaborations. Panelists also emphasized that academic partners who want to be part of the response should have the necessary credentials and training and, if

possible, should provide synthesized data before an oil spill occurs (given the challenges of analyzing data during an emergency), and should include science communications for various stakeholders as part of their research activities. They talked about the potential for academic researchers, during a response, to help evaluate technologies that are independently offered during the event, as well as legal issues and liabilities that occur during a response and damage assessment. In conclusion, the panel agreed that science can and should continue to be used as a tool to drive interagency cooperation and the decision-making process.

CLOSING PLENARY

LINKING SCIENCE & RESTORATION: NOW AND IN THE FUTURE

Discussion Panelists:

- William (Monty) Graham (moderator), University of Southern Mississippi
- Becky Prado, Florida Department of Environmental Protection
- Amy Hunter, Alabama Department of Conservation and Natural Resources
- George Ramseur, Mississippi Department of Marine Resources
- Jim Pahl, Louisiana Coastal Protection and Restoration Authority
- Robin Riechers, Texas Parks and Wildlife Department

Because restoration occurs in – and perhaps in response to – a changing world, these projects also serve as real-world, real-time science experiments. Who is responsible for documenting the success of projects over time? Restoration practitioners from the Gulf States provided insight into novel techniques and approaches, connecting restoration projects on a larger landscape and guarding against unintended consequences. They also accountability for project success in the face of changing ocean conditions. While approaches to restoration planning and implementation vary by state, the panel also discussed examples of interstate cooperation, such as the collaboration between Alabama and Mississippi to reduce sourced dredging.

SESSION DESCRIPTIONS & SUMMARIES

Over three days, 337 oral and 260 poster presentations (including 60 oral and 121 poster presentations given by students) discussed recent findings and advances in oil spill research. Following an introduction by Michael Celata, Gulf of Mexico Regional Director for the Bureau of Ocean Energy Management, session organizers presented highlights of the research discussed in their respective sessions as part of the closing plenary.

These summaries are included in one of five overarching tracks:

- Oil breakdown, transport, and long-term fate
- Ecological impacts
- Human dimensions and science communications
- Data, models, and decision-making tools
- Research to application

Each track highlights key messages, as well as research gaps and challenges, and emphasizes application and/or relevance to the conference theme. Thank you to the session organizers for providing these summaries.

OIL BREAKDOWN, TRANSPORT, AND LONG-TERM FATE

Sessions

- Processes in the Near Field of a Blowout
- Fate and Transport of Oil in the Open Ocean: Water-Sediment Connectivity
- Deepwater Horizon Oil in Coastal Environments: Observations, Experiments and Predictive Modeling
- Marine Oil Pollution Monitoring Methods: New and Emerging Techniques for Obtaining and Analysing in-situ Observations and Laboratory Data
- Circulation, Mixing, and Ecosystem Responses to River Discharge Patterns
- Understanding Ocean Surface Currents in Relation to Oil Spill Response

Overarching Highlights

- We now have new predictive skills that could be utilized by responders.
 - Model framework for particle transport (e.g., MOSSFA) in the Gulf is critical for predicting where oil will be deposited.
- New findings on pathways of oil to the coast indicate that they are highly variable (depending on seasons, winds, and/or discharge), localized, and three-dimensional.
 - Measurements obtained in large-scale expeditions indicate that ocean surface currents change in extremely short scales of time (minutes and hours) and space (a few kilometers).
 - 3-D currents associated with surface convergence zones are found to be extremely effective in sucking material down into the deep ocean.
 - Large freshwater input events into the environment (natural or engineered) can have strong and complex impacts on flow field pathways, hydrographic conditions, and biological community responses and can significantly modulate biological characteristics, such as properties (e.g., nutrient availability, vertical structuring) and behavior (e.g., altered vertical zooplankton migration patterns).
- Real-world observations of oil and gas through field experiments and/or chronic releases provide results that improve sensor and modelling capabilities.
 - Satellite and emergent drone applications promise better assessment and quantification of pollution magnitudes and surface distribution.
 - Acoustics and optical approaches offer large-scale detection and detailed structural components of pollution in the water column and seafloor.
 - Biological tracers and chemical techniques inform environmental impacts.
- Contingency plans could be prepared based on the conditions of a blowout, including the predicted size of the release, droplet size distribution, gas to oil ratio, and dissolution. These determine the trapping height of oil and could guide in selecting the response strategy, including dispersant dosage.
 - Methods and numerical models have been developed in the last year to fill the gaps of knowledge regarding oil and bubble dispersion from blowouts.

- Local phenomena such as the interaction of bubbles and droplets, degassing of “live oil,” effectiveness of dispersant, and turbulence from large-scale orifices need further experimental investigations to validate the models.
- Algorithms developed to dynamically couple near and far field models simulate the partition of hydrocarbon fractions, which facilitates validation with experimental and in situ data.
- Improved methods for oil analysis allow for a better understanding of toxicity effects, environmental impacts, and degradation rates.
 - About 40 percent of the oil was trapped in marine snow. Massive deposition of marine oil snow can slow oil biodegradation and prolong the presence of toxic compounds in marine sediment. The apparent role of dispersants on MOSSFA formation and composition is important for understanding potential impacts to benthic systems.
 - Oil was rapidly oxidized in the environment, producing a complex pool of oxidized hydrocarbons (oxyhydrocarbons) with different toxicities and degradation rates. Oxygenated products make up greater than 50 percent of the mass of most weathered samples.
 - Photodegradation affects the biomarker diagnostic ratios of hopanes and steranes and leads to the formation of more toxic components during oil degradation.
- Changes in the microbial community could be used as a surrogate for oil bioavailability.
 - Microbial strains *Altererythrobacter* and *Neptuniibacter*, as well as some from the order Rhodobacterales, increased in relative abundance with growing oil concentration.
 - First microbial responders degrade alkanes, e.g., *Parvibaculum* (known as long chain alkane degraders); second responders (*Pseudomonas*, *Mycobacterium*) degrade PAHs.
 - Deposition of oil had a significant impact on nitrogen cycling in the sediment. Nitrification activity was blocked in submerged oiled sediments but enhanced in exposed salt marsh sediment.
 - Elevated oxygen consumption and respiration suggest application of dispersant facilitates biodegradation.
- Identification of indicator species, such as the marsh periwinkle, *Littoria irrorata*, allows a better assessment of the contamination and ensuing recovery process.

Identified Gaps and Challenges

- Massive data sets will take time to analyze.
- There are complex spatial gradients in impacts in near-shore estuaries, bays, and marshes.
 - Turbulence and mixing impacts are still poorly understood with regard to coastal riverine systems.
- Limited data on ecosystems properties during extreme events lead to reduced ability to predict biological behavior in response to physical processes.
- Bench-scale experiments have inherent scaling issues, such as limits in model grid resolution and data to capture small-scale patterns and process and the lack of large-scale experimental data for the validation of scale-up rules.
- Sensitive volatile organic compound measures during response are difficult to collect due to interferences from atmospheric conditions, such as humidity and wind.
- Image projection and analysis presents challenges for determining explosive gas within bubble plumes.
 - Gas bubbles and oily droplets have different rise times, making understanding rates challenging.
- There is a need to evaluate the long-term behavior of oil, especially in marshes.
 - Associating microbial community expression and composition with oil chemistry and oil degradation needs further development.
 - Long-term fate of oil buried in anaerobic environments is poorly understood.
- What is the extent of large oil constituents being transformed rather than being fully degraded and ultimately contributing to highly oxidized dissolved organic matter in the ocean? What are the effects of these transformed species on the marine ecosystem and what is their toxicity?
- What happens to particles and sediment after deposition? Are there hotspots for deposition in the Gulf? Have they been targeted in previous surveys?
- What is the contribution of specific water-column layers (e.g., surface, deep-plume depth) to total organic carbon and oiled-particles deposition on the seafloor?

Processes in the Near Field of a Blowout

Michael Schlüter, Hamburg University of Technology

Michel Boufadel, New Jersey Institute of Technology

Claire Paris, University of Miami

Zachary Aman, University of Western Australia

Session Overview

- Experiments and numerical modeling of the formation of oil droplets and gas bubbles from blowouts. Particular attention paid to high pressure and low temperature conditions, along with the role of dispersant in the presence of bubbles.
- Coupling between the bubbles and droplet, between the nearfield and farfield.
- Through sensitivity analyses, models are setting bounds on the uncertainty of the release.

Session Highlights

- Integrated modeling from the wellhead to the nearfield.
- Methods and numerical models have been developed in the last year to fill the gaps of knowledge regarding oil and bubble dispersion from blowouts.
- Local phenomena such as the interaction of bubbles and droplets, degassing of “live oil,” effectiveness of dispersant, and turbulence from large scale orifice need further experimental investigations to validate the models.
- Algorithm developed to dynamically couple near and far field models simulate the partition of hydrocarbon fractions, which facilitates validation with experimental and in situ data.

Application

- Based on the conditions of a blowout contingency plans could be prepared based on the predicted size of the release, droplet size distribution, gas to oil ratio, and dissolution. These determine the trapping height of oil, and could guide in selecting the response strategy including dispersant dosage.
- Size of droplets and dissolution could inform about potential damage to ecosystem.

Challenges and research/data gaps:

- Large scale experimental data for the validation of scale-up rules
- Taking into account physico-chemical processes at the microscale at the oil/water/gas interfaces: nucleation and dispersants.
- Droplet size distribution of live oil under high pressure and/or from large diameters is still unresolved.

Fate and Transport of Oil in the Open Ocean: Water-Sediment connectivity

Isabel Romero, University of South Florida

Thomas Oldenburg, University of Calgary

Beizhan Yan, Lamont-Doherty Earth Observatory of Columbia University

Jeff Chanton, Florida State University

Sara Lincoln, Pennsylvania State University

Session Overview

- Integration of studies from the water column to the sedimentary environment in the open ocean: water-sediment connectivity
- To improve our understanding of the breakdown of the spilled oil (e.g., transformations, chemical partitioning, biodegradation) during transport, deposition, and post-deposition in open ocean sediments
- To determine baseline condition for the Gulf's present state
- To generate conceptual and numerical models as tools to guide risk and impact assessments before, during and after an oil spill at depth.
- Topics included in 36 studies: e.g., biodegradation, droplet formation, marine oil snow sedimentation and flocculent accumulation (MOSSFA) events, marine particles, impact of dispersants on processes, Gulf-wide surveys

Session Highlights

- Model framework for particle transport (e.g., MOSSFA) in the GoM, critical for predicting where oil will be deposited
- Apparent role of dispersants on MOSSFA formation and composition, important for potential impact to benthic systems
- Sedimentation dynamics and time-series studies revealed main organic matter sources in the GoM (land, oil & methane, marine/natural), essential for understanding baseline conditions
- Potential contribution and interconnectivity between the northern and southern GoM via the particulate organic carbon pool, fundamental for establishing Gulf-wide predictions in the water-column and sediments

Application

- Establishing current baseline in the GoM [e.g., total organic carbon (TOC) deposition, microbial communities, hydrocarbon spatial distributions]
- Implementation of mechanistic models:
 - For predicting oil dispersion through the water column
 - For predicting particle transport and deposition (MOSSFA)

Challenges and research/data gaps:

- Hydrocarbon transformation products and rates
- Particulate organic carbon particle size distribution
- Baseline for petrocarbon and molecular signatures
- Relative importance of Gulf carbon sources (seeps, terrestrial, marine/natural primary producers)
- Important questions for fully understanding water-sediment connectivity:
 - What is the extent of large oil constituents being transformed rather than fully being degraded and ultimately contribute to highly oxidized dissolved organic matter (DOM) in the ocean? What are the effects of these transformed species on the marine ecosystem and what is their toxicity?
 - What about particles/sediment transport after deposition? Are there hotspots for deposition in the Gulf? Have been targeted in previous surveys?
 - What is the contribution of specific water-column layers (e.g., surface, deep-plume depth) to total organic carbon/oiled-particles deposition on the seafloor?

Deepwater Horizon Oil in Coastal Environments: Observations, Experiments and Predictive Modeling

Michel Boufadel, New Jersey Institute of Technology
Charles Greer, National Research Council, Canada
Markus Huettel, Florida State University
Kostas Konstantinidis, Georgia Institute of Technology
Joel Kostka, Georgia Institute of Technology
Christoph Aepli, Bigelow Laboratory for Ocean Sciences

Session Overview

- Transformation of oil as it travels in coastal environments, the “last mile.”
- Photo-oxidation, biodegradation, and formation of oil particle aggregates (OPAs).
- Oil decomposition in exposed, intertidal and submerged sediments.
- Impact of cleanup and restoration efforts on the fate of oil deposited on coast.
- Products of oil degradation, oxyhydrocarbons, and toxicity.
- Microbial oil decomposition and persistence of oil in marshes and beaches.
- Sediment community response and indicator species.
- Modeling of the oil degradation process in coastal environments.

Session Highlights

- Sediment resuspension led to the formation of OPAs in the shallow nearshore zone that coagulated to produce oil mats. This process may have scavenged substantial amounts of oil prior to deposition on the shore.
- The oil spill caused large variations in chlorophyll-a in the Gulf of Mexico.
- About 40% of the oil was trapped in marine snow. Massive deposition of marine oil snow can slow oil biodegradation and prolong the presence of toxic compounds in marine sediment.
- Waves and wave breaking affects oil droplet size distribution.
- Degradation of oil buried in beaches was enhanced by tidal pumping.
- Tropical weather events caused erosion and forced oil residues farther into the marshes.
- Heat, sediment compression and tidal pumping can bring the buried oil in the marshes back to the surface.
- Oil was rapidly oxidized in the environment, producing a complex pool of oxidized hydrocarbons (oxyhydrocarbons) with different toxicities and degradation rates. Oxygenated products make up >50% of the mass of most weathered samples.
- PAH weathering found to be highly dependent on the vertical position of the oil in beach sands.
- Long-chain carboxylic acids appeared during oil weathering.
- Water-soluble photo-oxidation products are more toxic than the unaltered oil.
- Weathered oil persisting in beaches no longer appears to be acutely toxic.
- The longest wavelength of light is responsible for the formation of more toxic components during oil degradation.
- Photodegradation affects the biomarker diagnostic ratios of hopanes and steranes.
- Microbial response to crude oil water accommodated fractions shows maximal inhibition during warmer summer months and lower inhibition levels during winter.
- A novel approach allows screening crude oil degrading bacteria consortia in sediments and soil.
- Microbial strains *Altererythrobacter* and *Neptuniibacter*, as well as some from the order Rhodobacterales, increased in relative abundance with increasing oil concentration.

- First microbial responders degrade alkanes, e.g., *Parvibaculum* (known as long chain alkane degraders). Second responders (PAH degraders): *Pseudomonas*, *Mycobacterium*.
- Deposition of oil had significant impact on nitrogen cycling in the sediment. Nitrification activity was blocked in submerged oiled sediments but enhanced in exposed salt marsh sediment.
- Surface residue balls buried in beach sand caused a sequence of microbial community composition changes with time but relatively little change with sediment depth.
- Elevated oxygen consumption and respiration suggest application of dispersant facilitates biodegradation.
- Petroleum hydrocarbon exposure affects burrowing activity of fiddler crabs and widgeon grass.
- The marsh periwinkle, *Littoraria irrorata*, as an indicator of DWH oil spill effects
- The mineralogical x-ray diffraction signature of SW GoM volcanic ash layers was investigated as an alternative method for constraining the Ixtoc-I event

Application

- Changes in the microbial community could be used as a surrogate for oil bioavailability.
- Predictive models for OPAs could be used to estimate the extent and location of oil mats, which could be used to estimate the extent of oil balls on beaches following hurricanes.
- Improved methods for oil analysis allow an improved understanding of toxicity effects, environmental impacts and degradation rates.
- Identification of indicator species allows a better assessment of the contamination and ensuing recovery process.
- Development of rapid microbial screening methods allows a faster identification of microbial community response and key oil degraders.

Challenges and research/data gaps:

- Interaction of oil with sediments, formation of OPAs and the subsequent formation of oil mats are still unresolved issues.
- Associating microbial community expression and composition with oil chemistry and oil degradation needs further development.
- Long-term fate of oil buried in anaerobic environments is poorly understood.
- Integrating processes in the last mile near the shore.
- Evaluating the long-term behavior of oil, especially in marshes.
- Problem-driven research tends to immediately affect policy and to be used by responders. Not so much for curiosity-driven research.

Marine Oil Pollution Monitoring Methods: New and Emerging Techniques for Obtaining and Analysing in-situ Observations and Laboratory Data

Emlyn Davies, SINTEF Materials and Chemistry

Ian MacDonald, Florida State University

Robyn Conmy, U.S. EPA

Session Overview

This session brought together a holistic variety of measurement techniques relevant for oil spill response and assessment.

- Satellite and emergent drone oil slick mapping (DWH, Ixtoc, Taylor)
- Field experiments of gas leaks to determine zone of explosive gas
- Shadowgraph imagers and multibeam acoustics for oil droplet size and plankton
- Toxicity experiments under high hydrostatic pressure
- Natural seep flux quantification via acoustic backscatter
- 3D acoustics for gas plume geometry
- Acoustic mapping of oil in sediments
- Surfactant-associated bacteria detection with synthetic aperture radar imagery
- Luminescence detection of toxic high molecular weight polycyclic aromatic hydrocarbons (HMW-PAH) and transformation products

Improved detection methods and technology enhances the ability to address key questions during spill response – how much, where is it, where is it going, what state? – all to mitigate and/or predict the impacts of spilled oil.

Session Highlights

Real-world observations of oil and gas through field experiments and/or chronic releases provide results that improve sensor and modelling capabilities.

- Satellite and emergent drone applications promise better assessment and quantification of pollution magnitudes and distribution at the surface.
- Acoustics and optical approaches offer large scale detection and detailed structural components of pollution in the water column and seafloor.
- Biological tracers and chemical techniques inform environmental impacts.

Challenges and research/data gaps

- Slick heterogeneity, rapid weathering, emulsion formation
- Sensitive volatile organic compound measures during response (interferences with humidity, wind, etc.)
- Gas bubbles and oily droplets have different rise times, making understanding rates challenging
- Image projection / analysis challenges for determining explosive gas within bubble plumes
- Remote oil slick thickness estimates and weathering state (influence of sea state, etc.)
- Experiments have inherent scaling issue – how to translate bench-scale experiments to spills
- Influence of hydrostatic pressure (stress factor) on toxicity of deepwater organisms
- Need to better resolve highly-toxic HMW-PAH compounds

Understanding Ocean Surface Currents in Relation to Oil Spill Response

Tamay Ozgokmen, University of Miami

Eric D'Asaro, University of Washington

Session Overview

Much of the oil during spills collects in the upper few meters, even centimeters of the ocean, yet ocean currents here are extremely challenging to measure and model and have not been a research area in traditional oceanography. The objective of the session was to highlight recent progress in measuring and modeling these currents that are at the interface between winds, waves and deeper ocean currents.

Session Highlights

- There have been a range of new observational tools developed under GoMRI funding: these include biodegradable compact inexpensive drifters (patented) for massive-scale sampling of the ocean, real-time aircraft imaging and processing systems, high-resolution X-band radar and polarimetric cameras for tracking of frontal features from vessels as well as software of images taken from cameras installed at aerostats and drones to derive surface currents from oil-following plates and wave properties.
- Measurements obtained in large-scale expeditions, such as the LAGRANGIAN Submesoscale Experiment (LASER), using these instruments indicate that ocean surface currents change in extremely short time scales on the order of minutes and hours and extremely short space scales on the order of few km.
- 3D currents associated with surface convergence zones are found to be extremely effective in sucking material down into deep ocean.

Application

- All of the instruments listed in the previous slide are approaching to become products that can be purchased through companies spinning off from consortia, such as greenwaveinstruments.com to facilitate access.
- The collected data will be studied in great detail and published in peer-reviewed scientific journals to ensure that high-quality conclusions are disseminated.

Challenges and research/data gaps

- Massive data sets collected under generous GoMRI support will take time to analyze. New theories will be developed, feeding into new parameterizations and predictive model improvements.

Circulation, Mixing, and Ecosystem Responses to River Discharge Patterns

Jeffrey Book, Naval Research Laboratory

Zhankun Wang, NOAA

Brian Dzwonkowski, University of South Alabama

Session Overview

- Major concentration of oil and gas operations occurs in regions heavily influenced by freshwater discharge
- Important to improve the understanding of freshwater discharge on:
 - Physical processes (i.e., circulation and stratification)
 - Biological patterns (i.e., nutrients, light, community structure)
- How do these physical and biological dynamics influence the risks of oil release into the environment and affect the recovery from such exposures?

Session Highlights

- New findings on pathways of oil to the coast
 - Highly variable in time (seasonal, winds, discharge)
 - Localized
 - 3D
 - We now have new predictive skill that could be utilized by responders.
- Physical processes associated by freshwater pulses can significantly modulate biological characteristics such as:
 - Properties (e.g., nutrient availability, vertical structuring)
 - Behavior (e.g., altered vertical zooplankton migration patterns)
- Large freshwater input events into the environment (natural or engineered) can have strong and complex impacts
 - Flow field pathways
 - Hydrographic conditions
 - Biological community responses

Challenges and research/data gaps

- Limits in model grid resolution and data to capture small scale patterns and process
- Forecasting biophysical connectivity: Limits in ability to predict biological behavior in response to physical processes
- Turbulence and mixing impacts are still poorly understood with regard to coastal riverine systems
- Limited data on ecosystems properties during extreme events
- Complex spatial gradients in impacts in near-shore estuaries, bays, and marshes

ECOLOGICAL IMPACTS

Sessions

- Ecosystem Structure, Function, and Services: Legacies of the Deepwater Horizon Oil Spill
- Recovery from the Bottom Up: Rates, Processes, and Connectivity in the Deep Gulf of Mexico
- Understanding Population Status, Trends and Connectivity of Gulf of Mexico Large Marine Vertebrates as Sentinels for Ecosystem Health in the Context of Restoration
- Genomics and Modeling of Biological Communities to Improve Predictions of Ecosystem Response to and Mitigation of Spilled Oil
- Impacts and Recovery of Benthic Marine Environments in the Aftermath of the DWH Event
- Multi-year Signatures of the DWH Oil Spill in Coastal Systems

Overarching Highlights

- Studies have developed a systematic understanding of marine oil snow and marine dispersant snow formation pathways and the relative contributions of phytoplankton, bacteria, photic processes, and exopolymeric substance.
 - These studies stress the importance of good stratigraphy and chronology, as well as using time-series studies and pairing multiple tracers of sedimentary oil and marine oil snow preservation in sediments.
- There is improved understanding of benthos with the generation of baseline measurements, Gulf-wide benthic maps, and benthic recovery rates.
 - Trophic relationships exist between benthic microbial, meiofauna, macrofauna, and megafauna relationships, response, and recovery rates (some benthic abiotic and biotic factors recovered in three to four years after DWH spill)
 - Responders and policy makers should now have a much greater appreciation for what lives deep in the Gulf, and protecting this unique pool of diversity should factor into all plans for oil dispersal and/or containment.
 - Impacted corals in the deep benthos have not recovered after six years; even ‘healthy’ branches showed delayed negative effects, and impacted mesophotic reefs show no signs of recovery. Coral-associated sediment community diversity was lower, and interannual variability higher, at impacted sites.
 - Deep-demersal fish assemblage composition varies greatly at different sites on the northern Gulf outer slope. Many deep-demersal taxa take decades to reach maturity, and therefore have the lowest rebound potential.
 - o The highest levels of oil contamination markers occurred 30-40 months after the oil spill.
 - The Gulf appears to be one of the four highest diversity deep-pelagic ecosystems known in the world ocean, with over 1,200 species of deep-pelagic organisms recorded by GoMRI scientists.
 - o Pelagic communities are highly connected, from the surface to great depths.
 - o Elevated polycyclic aromatic hydrocarbon levels are still being observed in deep-pelagic organisms.
- Mature ecosystem models are being employed to examine DWH effects on Gulf ecosystem structure, function, and services.
 - New baselines, critical to examine impacts and plan restoration, are being generated for several communities and habitats. Space can sometimes be traded for time to reconstruct baseline conditions.
 - Impacts at the molecular level can have population-level consequences, highlighting the importance of working across scales to examine drivers of population, community, and ecosystem changes.
- Nuances of multi-year impacts are subtle, illuminated in the details, and embedded within a system whose complexities may overwhelm discovery of impacts and restoration.
 - It is critical to use prevention to protect resources: once a marsh is gone, it is lost forever.
 - The oil spill is one of many multiple stressors affecting coastal habitats and resources but is a definite signal in the landscape. Coastal marshes continue to experience on-going exposure to Macondo oil.
 - 2010 Mississippi River diversions will likely affect the gyre in the Louisiana bight and the Louisiana Coastal Current and extend oiling further alongshore, reducing salinities and impacting the continental shelf ecosystem.
- Genomics tools provide effective molecular markers for fate and transport of oil as well as response and recovery of organisms (microbes to humans).
 - Effective molecular markers have been developed that can be used as indicators of biodegradation and ecosystem response and recovery.

- Understanding the spatial distribution, movements, and habitat use of some large marine vertebrates (LMVs) can help to determine high risk areas and/or identify vulnerabilities.
 - Since the DWH spill, much has been learned about movement and habitat use of LMVs that could inform mitigation efforts for future events and/or resource management efforts
 - There is evidence of potential indirect effects of the DWH spill on LMVs through loss or shifts in prey (bottom-up) AND on prey species through the loss of LMVs (top-down cascade).
 - Recovery of well-studied marine mammal populations has been slow, such as the continued poor reproductive success of bottlenose dolphins in Barataria Bay.
 - Advances in acoustic technology could provide for real-time detection of species in an area, which could inform mitigation efforts for future oil spills and other threats and become part of restoration.

Identified Gaps and Challenges

- Do dispersants inhibit or enhance marine oil snow sedimentation and flocculent accumulation formation?
- We still lack basic understanding of biodiversity, sources of carbon and energy, biogeochemical cycling, population dynamics, or community structure for some components of the Gulf ecosystem.
 - Long-term studies are needed to aid ecological work.
 - Functional connectivity of response and recovery between trophic levels (micro to mega) is needed.
 - More research is needed on oil spill effects on lower trophic species and how this is affecting LMVs; little has been reported on potential indirect effects on health of LMVs resulting from the loss of or shifts in distribution of lower trophic species.
 - Lack of high resolution bathymetry from the continental shelf limits our ability to assess the extent of mesophotic coral habitats and to monitor the recovery of these areas that were potentially impacted by the DWH oil.
 - Besides the logistical challenges of studying the deep ocean, the biggest challenge may be that the deep Gulf ecosystem complex is routinely neglected by resource managers and restoration planners.
- Consistency of resources is needed to gain greater understanding and to making restoration decisions without uncertainty.
 - Funding in amount and duration is limited.
 - There is the potential for loss of institutional memory as researchers move to other programs or retirement.
- More sensitive monitoring approaches are needed to detect changes in population abundance of LMVs, particularly oceanic marine mammals.
- It is important to understand the impact of the baseline shift in buried oil content and constituents.
- Few have synthesized environmental genomic data into models, from the molecular and metabolic to population scales.
- We need robust and continued monitoring of LMV populations affected by DWH spill to understand recovery. Recovery of some populations (e.g., Barataria Bay dolphins) has been surprisingly slow, but it is helping to understand recovery process.

Ecosystem Structure, Function, and Services: Legacies of the Deepwater Horizon Oil Spill

Will Patterson, University of Florida

Dave Portnoy, Texas A&M University - Corpus Christi

Steve Murawski, University of South Florida

Session Overview

Session Focus on DWH and GOMRI Legacies:

- 1) Report recent findings and further quantification of acute and chronic DWH impacts on the Gulf ecosystem
- 2) Present novel information on ecosystem structure and function
- 3) Place new information on Gulf ecosystem structure and function in the context of potential restoration activities, as well as development of baseline data in the event of a future offshore spill

Session Highlights

- Mature ecosystem models being employed to examine DWH effects on Gulf ecosystem structure, function, and services
- Innovative technologies brought to bear to examine ecosystem processes, some of which were previously intractable
- Baseline data critical to examine impacts and plan restoration; can sometimes trade space for time for baseline conditions

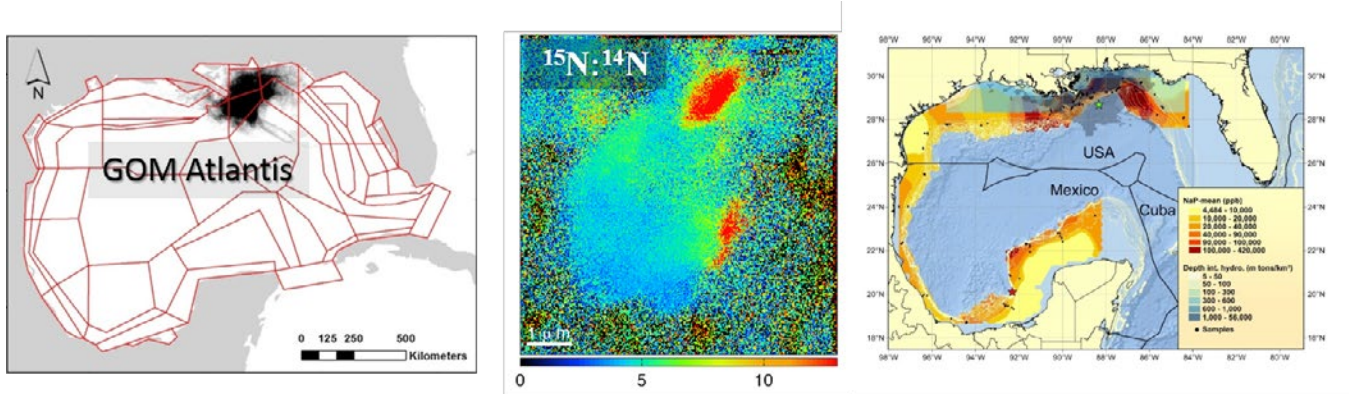


Figure 1. Examples of advanced technology or comprehensive ecosystem models parameterized to examine oil spill impacts include A) the Gulf-wide Atlantis model constructed by Ainsworth et al. to examine oil spill impacts on the northern Gulf ecosystem; B) secondary ionization mass spectrometry analysis conducted by Montoya et al. to examine bacterial nitrogen fixation; and C) Gulf-wide spatial distribution in reef fish bile metabolites analyzed by Pulster et al. with gas chromatography-mass spectrometry.

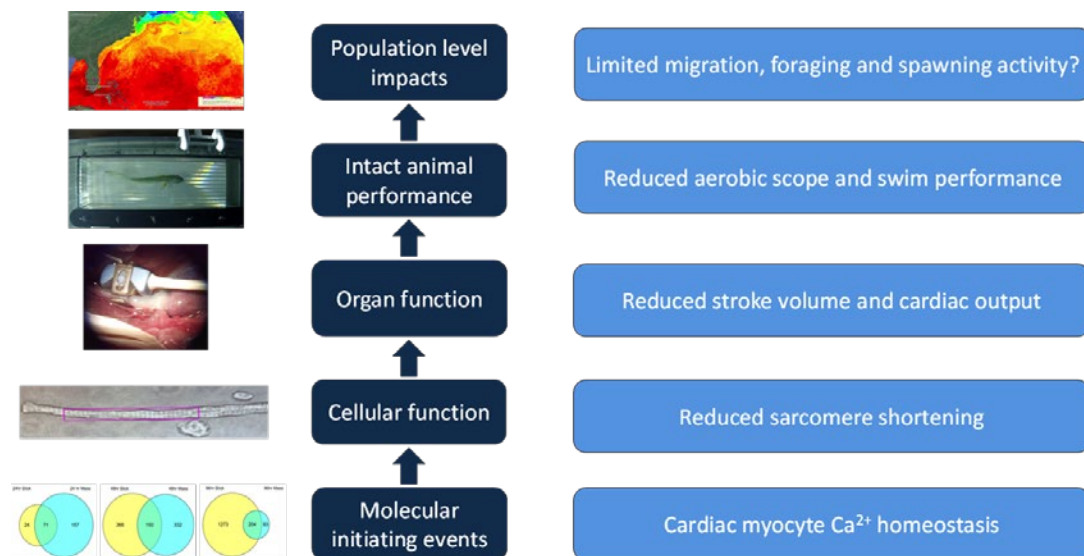


Figure 2. Schematic diagram presented by Grosell et al. depicting cascading effects from molecular and cellular to population level impacts in fishes exposed to oil compounds.

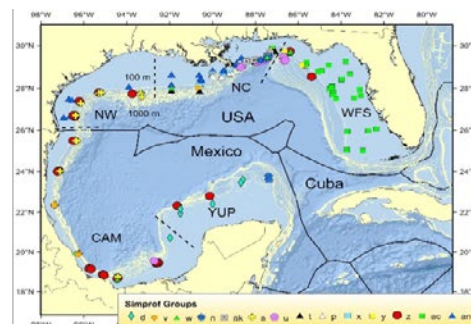
- Importance of working across scales to examine drivers of population, community, and ecosystem changes; impacts at molecular level can have population level consequences



Hartland et al.



Dahl et al.



Murawski et al.

- Many different legacies of DWH and GOMRI funding presented in this session
- Discoveries: subcellular processes to large-scale ecosystem drivers
- New baselines being generated for several communities and habitats

Figure 3. Important new baseline data on Gulf taxa include A) species diversity of deepwater crustaceans and fishes reported by Hartland et al.; B) trends in invasive lionfish populations and potential for confounding effects of lionfish and DWH on native reef fishes reported by Dahl et al.; and C) the spatial distributions of reef fish communities that Murawski et al. have inferred from bottom longline sampling across the Gulf shelf.

Challenges and research/data gaps:

- Lack basic understanding of biodiversity, sources of carbon/energy, biogeochemical cycling, population dynamics, or community structure for some components of the Gulf ecosystem
- Resources to gain greater understanding; making restoration decisions under uncertainty

Recovery from the Bottom Up: Rates, Processes and Connectivity in the Deep Gulf of Mexico

Tracey Sutton, Nova Southeastern University
 Ian MacDonald, Florida State University
 Iliana Baums, Pennsylvania State University
 Erik Cordes, Temple University
 Amanda Demopoulos, U.S. Geological Survey
 Gilbert Rowe, Texas A&M University at Galveston

Session Overview

- Understanding impacts of DWH oil spill on the deep Gulf ecosystems is particularly complex due to the wide ranges of biophysical rates of its ecosystem components.
- This session featured presentations on deep-benthic, deep-demersal and deep-pelagic assemblages, with focus on exposure, recovery, active and passive flux, and ecosystem connectivity (within the deep Gulf and with the broader Gulf-wide ecosystem).

Session Highlights

- The deep Gulf is a complex, highly diverse, and highly interconnected system.
- Of all habitats impacted, the deep Gulf was the least known prior to DWH.
- Impacts to the deep ecosystems were massive and still ongoing.
- Highlights from the deep benthos:
 - Impacted corals have not recovered after 6 years, and even 'healthy' branches showed delayed negative effects.
 - Impacted mesophotic reefs show no signs of recovery.
 - Coral-associated sediment community diversity was lower, and interannual variability higher, at impacted sites.
- Highlights from deep-demersal communities:
 - Fish assemblage composition varies greatly at different sites on the northern Gulf outer slope.
 - Many deep-demersal taxa take decades to reach maturity; ergo have the lowest rebound potential.
 - The highest levels of oil contamination markers occurred 30-40 months after the oil spill.
- Highlights from deep-pelagic communities:
 - The Gulf appears to be one of the four highest diversity deep-pelagic ecosystems known in the world ocean.
 - Over 1200 species of deep-pelagic organisms have been recorded by GoMRI scientists.
 - Pelagic communities are highly connected, from the surface to great depths.
 - Elevated PAHs are still being observed in deep-pelagic organisms, putatively from DWH.

Application

- Responders and policy makers should now have a much greater appreciation for what lives deep in the Gulf, and protecting this unique pool of diversity should factor into any and all plans for oil dispersal and/or containment.

Challenges and research/data gaps

- Deep-sea data gaps are still massive, but the key missing element is information on the rates of biological processes in the deep [e.g., production, cycling, mortality, roles in the biological pump (i.e., carbon sequestration)].
- Lack of high resolution bathymetry from the continental shelf limits our ability to assess the extent of mesophotic coral habitats and to monitor the recovery of such areas that were potentially impacted by the DWH oil.
- Besides the logistical challenges of studying the deep ocean, the biggest challenge may be that the deep Gulf ecosystem complex is routinely neglected by resource managers and restoration planners.

Understanding Population Status, Trends and Connectivity of Gulf of Mexico Large Marine Vertebrates as Sentinels for Ecosystem Health in the Context of Restoration

Natalia Sidorovskaia, University of Louisiana at Lafayette
Alexis Baldera, Ocean Conservancy
Elizabeth Fetherston-Resch, Florida Institute of Oceanography
David Mellinger, Oregon State University
Lori Schwacke, National Marine Mammal Foundation
Mark Baumgartner, Woods Hole Oceanographic Institution*

Session Overview

Focus: Examine what we know about oil spill impacts on large marine vertebrates, and how environmental variables and ecosystem conditions influence population status and trends.

Goal: Foster a dialogue as to how environmental factors influence large marine vertebrate populations, which will inform and support more effective restoration strategies.

Session Highlights

- Good News: Since the DWH spill, much has been learned about movement and habitat use of some LMV (e.g., turtles, fish, marine mammals) that could inform mitigation efforts for future events and/or resource management efforts
- Bad News: There is evidence of potential indirect effects of the DWH spill on LMV through loss or shifts in prey (e.g., B. Mate's presentation suggesting effects on benthic community and shifts in sperm whale distribution as a result), AND on prey species through the loss of LMV (top-down cascade as suggested by J. Short's presentation).
 - Recovery of well-studied marine mammal populations has been slow, as demonstrated by C. Smith's presentation on the continued poor reproductive success of bottlenose dolphins in Barataria Bay.

Application

- Understanding LMV spatial distribution and movements, and habitat use can help to determine high risk areas and/or identify vulnerabilities, as suggested by K.M. Hart's presentation on sea turtle habitat use.
- Advances in acoustic technology could provide for real-time detection of species in an area as suggested by the invited presentation by M. Baumgartner, and by the presentation of one of the session hosts, D. Mellinger.
- This could inform mitigation efforts for future oil spills and other threats; could become part of restoration.

Challenges and research/data gaps

- Oil spill effects on lower trophic species and how this is affecting LMVs. Aside from the hypothesis of B. Mate on a bottom-up effect on oceanic sperm whales, little has been reported on potential indirect effects on health of LMVs from loss/shifts in lower trophic species.
- Understanding of LMV population trends, including oceanic species. Changes in population abundance of LMVs, particularly oceanic marine mammals, are difficult to detect. More sensitive monitoring approaches are needed. GoMMAPPS effort may help to assess trends since the DWH spill using established assessment techniques (observational surveys), and also may advance monitoring approaches (e.g., augmenting visual observations with passive acoustic approaches).
- Interpretation of acoustic detection data for long-term trends following spill.
- Need robust and continued monitoring of LMV populations affected by DWH spill to understand recovery. Recovery of some populations (e.g., Barataria Bay dolphins) has been surprisingly slow, but is helping to understand recovery process. But, need monitoring of more populations, including oceanic species that are difficult to observe.
- Advances are being made in acoustic technology for detecting marine mammal species, particularly important for deep-divers which cannot be easily observed.
- Acoustic data are providing info on presence of marine mammal species, and patterns of acoustic detection across seasons and over time. Acoustic sensors have limited detection range (~4 km) and there was debate about the interpretation of "local density" that is estimated based on detection rates and whether it was appropriate to estimate abundance from current detection data.
- A research gap is on oil spill effects on lower trophic species and how this is affecting LMVs.

Genomics and Modeling of Biological Communities to Improve Predictions of Ecosystem Response to and Mitigation of Spilled Oil

Joel Kostka, Georgia Institute of Technology
 Kostas Konstantinidis, Georgia Institute of Technology
 David Portnoy, Texas A&M University - Corpus Christi

Session Focus

- Recent advances in genome-enabled approaches that provide insights on biodegradation and the response/ recovery of ecosystems.
- Engaged researchers studying organisms covering whole food web, microbes to megafauna
- Science has not matured yet to the stage where it may be directly employed by responders and resource managers.

Session Highlights

- Large amount of sequence data has been collected:
 - Seafloor microbial communities mapped throughout the Gulf
 - Genomes of commercially important fish have been sequenced
- Effective molecular markers developed that can be used as indicators of biodegradation and ecosystem response/ recovery
- Emergence of transcriptomic approaches to quantify changes in gene expression under different conditions
- Metatranscriptomics revealed adverse impacts of dispersant on biodegradation and stress in deepwater corals

Application

- Genomics tools provide effective molecular markers for fate/ transport as well as response/ recovery of organisms (microbes to humans)
- Potential for rapid, high throughput, lower cost indicators

Challenges and research/data gaps

- Few have synthesized environmental genomic data into models, from the molecular/ metabolic to population scales
 - Predictive understanding of oil fate, controls on biodegradation, metabolic pathways affected by oil exposure
- Lack of reference genomes for some organisms like meiofauna or fungi
- Link gene abundance or expression to spill response and recovery outcomes
- Develop inputs for modeling

Impacts and Recovery of Benthic Marine Environments in the Aftermath of the DWH Event

Patrick Schwing, University of South Florida

David Hollander, University of South Florida

Paul Montagna, Texas A&M University- Corpus Christi

Peter Santschi, Texas A&M University at Galveston

Session Overview

The goal of this session was to synthesize time-series and laboratory studies detailing:

1. Abiotic and biotic marine oil snow formation
2. Characterization of marine oil snow sedimentation and flocculent accumulation
3. Benthic environment (e.g., chemical, physical)
4. Ecological (biological) assessments of impact and long-term recovery into meaningful baseline data products to be utilized in the event of a future marine petrochemical release.

Session Highlights:

- Systematic understanding of marine oil snow and marine dispersant snow formation pathways and relative contribution of phytoplankton, bacteria, photic processes, role of exopolymeric substance (EPS)
- Importance of good stratigraphy, good chronology, time-series studies and pairing multiple tracers of sedimentary oil and marine oil snow preservation in sediments
- Trophic relationships between benthic microbial, meiofauna, macrofauna and megafauna relationships, response, recovery rates (some benthic abiotic and biotic factors recover in 3-4 years after DWH spill)

Application

- Systematic understanding of formation of marine oil snow: inhibition/enhancement with dispersant use
- Benthic baseline measurements: physical, chemical, biological
- Gulf-wide benthic maps: physical, chemical, biological
- Benthic recovery rates

Data Gaps and Challenges

- Dispersant effects on MOSSFA formation (inhibit or enhance?)
- Disentangling multiple sedimentary inputs (volcanoes, natural seeps) from oil spill events in sedimentary record
- Functional connectivity of response and recovery between trophic levels (micro to mega)

Multi-year Signatures of the DWH Oil Spill in Coastal Systems

R. Eugene Turner, Louisiana State University

Sabrina Taylor, Louisiana State University

Nancy Rabalais, Louisiana Universities Marine Consortium

Session Overview

- From Archaea to bull sharks.
- From genomes to individuals, communities, processes, and ecosystems.
- Immediate acute harm transitions to slow or rapid recovery, with lingering effects still in 2016, and possibly new baseline conditions.
- The more we learn, the greater the understanding and ability to predict future responses.
- Much better understanding of coastal marshes and processes.
- Models can inform the trajectory to the present and into the future with continued multiple stressors, including oil spills.

Session Highlights

- Coastal marshes continue to experience on-going exposure to Macondo oil.
- The oil spill is one of many multiple stressors affecting coastal habitats and resources, but is a definite signal in the landscape.
- Mississippi River diversions were opened to attempt preventing oil entering marshes in 2010, but were not effective; the planned diversions amounting to as much as 25% of the discharge of the river will likely affect the gyre in the Louisiana bight and the Louisiana Coastal Current, extend oiling further alongshore, reducing salinities and impacting the continental shelf ecosystem.

Application

- Prevention, prevention, prevention - to protect the resource; once the marsh is gone, it is gone forever.
- Experimental treatments with or without planting will inform marsh cleanup in the future.
- Nuances of multi-year impacts are subtle, illuminated in the details, and embedded within a system whose complexities may overwhelm discovery of impacts and restoration. "Every oil spill is different" J. Michel.
- Long-term studies are needed for ecological work.

Challenges and research/data gaps:

- Continuation of long-term sampling scheme.
- Non-linear responses.
- Impact of the baseline shift in buried oil content and constituents.
- Controlled exposures of oil (mesocosms).
- Funding in amount and duration is limited.
- Potential for loss of institutional memory with researchers moving on to other programs or coming close to retirement.
 - Litigious environment sometimes hampers social transparency and engagement.

HUMAN DIMENSIONS AND SCIENCE COMMUNICATIONS

Sessions

- Human Dimensions and Activity of Oil Spill Response, Restoration, and Future Preparedness: Interdisciplinary Communications and Community Resilience from a Social Ecological and Systems Approach
- Bridging Research and Response: Science Discoveries from DWH to Inform Future Oil Spill Response Decision Making and Engage Stakeholders

Overarching Highlights

- Decision science is useful for managing risks. It begins with learning about risk perceptions through discussion and bridges the sciences across issues.
 - Response decisions are made in a rapid and cyclic process.
- Community resilience is important to behavioral health and well-being.
 - Resilience can be promoted through protective factors including social support, religion, increased resources, and community connectedness.
 - Vulnerable groups, e.g., fishers, children, and adolescents and those with a history of trauma or alcohol misuse, are at increased risk from major oil spills.
 - We need to engage these stakeholder groups through different strategies that are practical for the decision makers and relevant to the stakeholders.
- Risk communication is critical and requires two-way communication with constituencies, preferably prior to disasters. Building trust is key to having risk communications accepted.
 - Institutionalize a way for responders to engage a broader range of stakeholder groups and communities.
 - Engage community stakeholders to integrate connections into U.S. Coast Guard Area Contingency Plans – define opportunities to better mitigate adverse outcomes and improve resilience.
 - Trust is key to effective risk communications, community interactions, and resiliency development.
- Take the time during response (when possible) to learn more about relevant science from the area to inform interpretations about the situation.
 - Also important is the need to provide good information that doesn't always follow the same rapid time-scale. Especially during a hazardous substance spill, some science must be methodical and not rushed or people could be put at significant risk.
 - We are still learning about oil in the environment, how broad the stakeholder community is, how best to integrate external sources of information (e.g., academic research, to inform decision making), and how to share information with those who may be affected, (e.g., fishermen) and those who are keenly interested in learning about an oil spill (e.g., students).

Identified Gaps and Challenges

- Improve real-time data; for example, social media can help with human health and mental health risk assessments.
- Increase collaboration among community stakeholders, industry, and differing scientific disciplines necessary for multi-systemic (micro-, meso-, and macro-) application.
- There are different models with respect to decision making and differing scientific opinions don't always agree.
- Maybe we don't fully understand the science at the time we're expected to make timely decisions.
- Differing scientific expertise and experience can result in biased interpretations of the situation, advice, and recommendations.
- How do we better communicate the science-based decision making for trade-offs?
- How can we institutionalize early interactions of outreach and education professionals with responders and researchers to inform the public?

Human Dimensions and Activity of Oil Spill Response, Restoration, and Future Preparedness: Interdisciplinary Communications and Community Resilience from a Social Ecological and Systems Approach

Howard Osofsky, Louisiana State University Health Sciences Center

Ann Hayward Walker, SEA Consulting Group

Lisanne Brown, Louisiana Public Health Institute

Alesia Ferguson, University of Arkansas for Medical Sciences

Helena Solo-Gabriele, University of Miami

Melissa Finucane, RAND Gulf States Policy Institute

George Hobor, Louisiana Public Health Institute

Session Overview

This session's broad scope included 20 transdisciplinary presentations on decision science, environmental stressors, behavioral and mental health, strategies to build resilience in special populations and communities, media and communications, and US Coast Guard (USCG) oil spill/disaster interactions with communities. Session attendance was standing-room only, e.g., over 100 in the audience during the morning. Presentations prompted questions and discussion from a number of different disciplines. The session's substantial attendance and discussion reinforced the importance of human dimensions in oil spill response, restoration, and the need to adapt the standard preparedness cycle going forward.

Community Health, Communications and Resilience

- Disasters like DWH lead to exposure, risk, social-ecological transitions or impacts on multiple human dimensions yet are seldom addressed in oil spill planning, preparedness and response.
- Insights on ways for response community to connect with communities to strengthen recovery and preparedness.

Session Highlights

- Lessons learned from DWH and other disasters show that community resilience is important to behavioral health and well-being.
- Risk communication is critical and requires two-way communication with constituencies, preferably prior to disasters. Building trust is key to having risk communications accepted.
- Trust is key to effective risk communications, community interactions, and developing resilience.
- Vulnerable groups, e.g., fishers, children and adolescents, history of trauma, alcohol misuse, are at increased risk from major oil spills.
 - Evidence that they recover more slowly than others

Application

- Decision science: useful for managing risks; begins with learning about risk perceptions through discussion; bridges the sciences across issues
- Resilience can be promoted through protective factors including social support, religion, increased resources and community connectedness.
- Engage community stakeholders to integrate connections into USCG Area Contingency Plans – define opportunities to better mitigate adverse outcomes and improve resilience.

Challenges and research/data gaps

- Improve education, outreach, awareness, and methods about managing the incident
- Improve real-time data re: human health and mental health risk assessments—social media can help with this.
- Increase collaboration among community stakeholders, industry and differing scientific disciplines, necessary for multi-systemic (micro-, meso-, and macro-) application
- Allow past events to inform future responses.
- Need personalized solutions for localized response.
- Consider working group at next conference to improve interdisciplinary communications, translations, and applications of human dimension research findings.

Bridging Research and Response: Science Discoveries from DWH to Inform Future Oil Spill Response Decision Making and Engage Stakeholders

Ann Hayward Walker, SEA Consulting Group
Laura Bracken Chaibongsai, University of Miami
Charlie Henry, NOAA
Christopher Reddy, Woods Hole Oceanographic Institution
Daniel DiNicola, University of Miami
Jessica Kastler, University of Southern Mississippi

Session Overview

The eleven presentations in this session were scientific and outreach examples of how science and stakeholders are important in the oil spill preparedness and response decision-making process. The invited speaker for the session, Rear Admiral Meredith Austin (former DWH Federal-On-scene Coordinator in Louisiana, 2010) provided a real-world context for the challenges of response decision-making within the response organization, and externally with academic researchers, the public at large, and other stakeholders. RADM Austin stressed the importance of getting the right information to the right people, both those making the decisions and those affected by response decisions, at the right time, i.e., when it's needed.

Session Highlights

Big picture messages:

- Response decisions are made in a rapid and cyclic process.
 - The Incident Command System, which is the emergency management system used by all government agencies in the US, has (a?) standard, incident planning process for evaluating and determining the course of action in each operational period of a response. Incident Action Plans are developed for each operational period, which are typically 1 day or 1 week, during a marine oil spill response while the oil is still mobile.
- We recognize the “battle rhythm” during response. Also important is the need to provide good information which doesn't always follow the same rapid time-scale. This can be an important factor, especially when response decisions are critical and outcomes can affect human health and sensitive environments... Especially during a hazardous substance spill, some science must be methodical and not rushed or people could be put at significant risk.
- We are still learning about oil in the environment, how broad the stakeholder community is, and how best to integrate external sources of information, e.g., academic research, to inform decision making, as well as to share information with those who may be affected, e.g., fishermen, and those who are keenly interested in learning about an oil spill, e.g., students.
- We need to engage these stakeholder groups through different strategies that are practical for the decision makers and relevant to the stakeholders.
 - Students, fishermen, etc.

Application

- Take the time during response when possible to learn more about relevant science from the area to inform interpretations about the situation
- Institutionalize a way for responders to engage a broader range of stakeholder groups and communities

Challenges and research/data gaps

- There are different models with respect to decision making and differing scientific opinions don't always agree.
- Maybe we don't fully understand the science at the time we're expected to make timely decisions.
- Differing scientific expertise and experience can result in biased interpretations of the situation, advice, and recommendations.
- How do we better communicate the science-based decision making for trade-offs, when some (media) are interested in communicating the extreme, vs. realistic, potential consequences?
- What is being done to export US knowledge and tools to high-risk oil producing countries?
- Regarding the challenge of disseminating oil spill information to the public ... GoMRI has developed a strong, dedicated network of outreach professionals with expertise in communicating with the public at large, as well as subgroups, e.g., students and fishers. How can we institutionalize early interactions of outreach/education professionals with responders and researchers to inform the public?

DATA, MODELS AND DECISION-MAKING TOOLS

Sessions

- Use of Ecological and Socioeconomic Indicators to Demonstrate Ecosystem Recovery
- Decision Support and Integration Tools for Response and Restoration
- Environmental Baseline and Oil Spill Impacts: Utilizing Big Data and Synthesis to Support Decision Making
- Monitoring and Modeling Responses to Oil Spill Injury and Restoration: Integrating Tools for Adaptive Management
- Oil Spill Modeling: Source to Sink

Overarching Highlights

- With the right data access tools, applications and models can be created and used in conjunction with each other to answer important questions, inform predictions scenarios, and guide response without the need for a great deal of costly primary research and duplication of effort. These tools could also serve as a resource for National Environmental Policy Act analysis and restoration.
- The tools and applications being created bring together large quantities of data from different sources and can help make data more easily accessible for response and restoration planners to make more informed decisions.
 - Organizations, both state and federal, are constantly working on making the data available through multiple portals and in various formats that are readily consumable across platforms. Examples include (but are not limited to) the GCOOS Data Portal, Environmental Research Division's Data Access Program (ERDDAP)/THREDDS Data Server (TDS), and NOAA's Data Integration Visualization Exploration and Reporting (DIVER) program.
 - The creation of a "Tools and Products" portal that lists out the different assets available to researchers and responders could help match people with the most appropriate resource for their question.
- Tools can facilitate further collaboration, which improves methods for collecting, analyzing, and presenting data.
 - Academics are working with response agencies to improve data visualization and interpretation and to develop model optimizations for decision making.
 - A lot of collaboration amongst institutions to pool data is already occurring (e.g., GoMMAPPS), but there are opportunities for more.
- Modeling is a key tool that can inform deployment of assets for spill containment, assess long-term (weeks to months) geographic threats, estimate economic impact, and assist long-term (months to years) mitigation strategies.
 - Models are being developed on a variety of spatial and temporal scales. For example, hydrodynamic models show significant progress in understanding how energetic, gaseous plumes develop dynamically.
 - The trend toward model specialization has increased and has led to more comprehensive forecasting models.
 - Tighter integration of oil spill models and the sharing of insights among different approaches are leading to better forecasting tools.
 - With monitoring and models, exchange goes in both directions (models identify sensitive variables & evaluate congruence between data sets).
- Indicators can serve as a way for resource managers to track the recovery of a specific habitat, identify system-wide events across a large geography, and serve as a simpler way to communicate to the public the status of an ecosystem as it responds to restoration activities over time.
 - Developing a conceptual model that considers pressures, drivers, and feedbacks within the ecosystem is a necessary step in selecting appropriate indicators. Examples from the Programmatic Damage Assessment and Restoration Plan provide measurable quantities that relate ecosystem status to either baseline conditions (i.e., pre-disturbance) or to theoretical measures of ecosystem maturity and stability.
 - Ecosystems are not closed systems (e.g., migratory species), and the physics within them in the Gulf of Mexico can be highly variable. These two factors must be taken into account when developing indicators and a framework for applying them.

Identified Gaps and Challenges

- Model development:
 - Obtaining data encompassing ocean dynamics, winds, oil droplet composition and chemistry, and the identification of subsurface oil spills remains a challenge. Continued financial support for the development of oil forecasting tools is also problematic.
 - Other challenges include matching scales between data sources, models, and decisions; developing useful models in a data-sparse environment; and choosing appropriate scales:
 - o Ecosystem injury requires ecosystem-scale restoration.
 - o Complex problems require complex models.
 - o Consistent data collection protocols aid comparability and scalability.
 - There is a need for more opportunity to improve data analysis, combining results of multiple studies to draw broader conclusions.
- Indicators:
 - The measurement of factors that can serve as indicators is not uniform across the Gulf of Mexico.
 - Increasing the use of indicators will require training for end users on their development and application.
- Key Questions:
 - Are we producing what responders need? We are generating a lot of excellent science, but how do responders ingest this information more easily at the time of an event?
 - How are responders using the data generated to inform their planning scenarios? How can we get our science in their hands?
 - Having that list of tools in one location, where does one go to see the options available to them? Not only on what research has been done, but what applications have been developed to synthesize these data?
 - How are large data efforts organizing and collaborating to avoid duplication of effort, encourage cross platform and organization communication, and encourage more open source programming so that applications can be utilized across platforms?

Use of Ecological and Socioeconomic Indicators to Demonstrate Ecosystem Recovery

Rebecca Allee, NOAA

Julien Lartigue, NOAA

Frank Parker, NOAA

Session Overview

- Ecological and socioeconomic indicators can serve as a proxy for the status of an ecosystem.
- Once a set of indicators for an ecosystem, the services it provides, and the human well-being associated with those services has been developed, they can be used to facilitate ecosystem-based management and track ecosystem recovery/restoration.
- Given the scale of planned restoration in the Gulf of Mexico, the development, testing, and use of indicators to support resource management and track recovery is more important than ever.

Session Highlights

- The development of a set of indicators should be driven by a clear management objective/goal.
- Developing a conceptual model which considers pressures, drivers, and feedbacks within the ecosystem is a necessary step in selecting appropriate indicators.
- Ecosystems are not closed systems (e.g., migratory species) and the physics within them in the Gulf of Mexico can be highly variable. These two factors must be taken into account when developing indicators and a framework for applying them.

Application

- Indicators can serve as a way for resource managers to track the recovery of a specific habitat.
- When applied across a large geography, indicators can be used to identify system-wide events.
- Indicators can also serve as a simpler way to communicate to the public the status of an ecosystem as it responds to restoration activities over time.

Challenges and research/data gaps

- The measurement of factors that can serve as indicators is not uniform across the Gulf of Mexico.
- Increasing the use of indicators will require training for end users on their development and application.

Decision Support and Integration Tools for Response and Restoration

Lauren Showalter, National Academy of Science Gulf Research Program

Dave Reed, Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute

Amy Merten, NOAA

Session Overview

- Creating models and aggregation tools that allow users to more easily access and use research data in practical ways.
- Using these tools to inform restoration and response activities to increase their efficiency and avoid duplication of efforts.

Session Highlights

- Organizations, both state and federal, are constantly working on making the data available through multiple portals and in various formats that are readily consumable across platforms. Examples include (but are not limited to) the GCOOS (Gulf of Mexico Coastal Ocean Observing System) Data Portal (<http://data.gcoos.org>) that offer a myriad of real-time sensor and buoy data, ERDDAP (Environmental Research Division's Data Access Program)/TDS (THREDDS Data Server) servers that provide fisheries and CDT information and DIVER (Data Integration, Visualization, Exploration, and Reporting), a web based data warehouse and query application that integrates raw data into common formats.
- Academics are working with response agencies to improve data visualization / interpretation and developing model optimizations for decision-making. For example, the work done at the University of South Florida, College of Marine Science demonstrates how the use of a Virtual Buoy System (<http://optics.marine.usf.edu>), an Integrated Red Tide Information System (IRIS: <http://optics.marine.usf.edu/projects/iris.html>) and Sargassum Watch System (SaWS: <http://optics.marine.usf.edu/projects/saws.html>) can inform this process.
- With the right data access tools, applications and models can be created and used in conjunction with each other to answer important questions, inform predictions scenarios and guide response without the need for a great deal of costly primary research and duplication of effort. We were shown how three applications: BLOSUM (BLOWout and Spill Occurrence Model – where might oil go? How much and for how long?), Cumulative Spatial Impact Layers (What could be impacted? Where is response needed?) and SWIM (Spatially Weighted Impact Model – What are some response priorities? Should preparation change for different times of the year?) can be used in conjunction to rank and compare multiple simulated scenarios incorporating social, economic and environmental data.
- The tools and applications being created bring together large quantities of data from different sources and can help make data more easily accessible for response and restoration planners to make more informed decisions. One such example of how GoMRI funded research has improved existing tools is the addition of a Nearshore Marine Environment (NME) component to AQUATOX (<https://www.epa.gov/exposure-assessment-models/aquatox>). This AQUATOX 3.1 NME enhancement to the Environmental Protection Agency's simulation model for aquatic systems is currently under review.
- Creation of a "Tools and Products" portal that lists out the different assets available to researchers and responders could help match people with the most appropriate resource for their question.

Challenges and research/data gaps

- Are we producing what responders need? We are generating TONS of excellent science but how do responders ingest this information more easily at the time of an event.
- How are responders using the data generated to inform their planning scenarios? How can we get our science in their hands?
- Having that list of tools in one location, where does one go to see the options available to them? Not only on what research has been done, but what applications have been developed to synthesize these data.
- How are large data efforts organizing and collaborating to avoid duplication of effort and encourage cross platform/organization communication?
- Encourage more open source programming so that applications can be utilized across platforms.

Environmental Baseline and Oil Spill Impacts: Utilizing Big Data and Synthesis to Support Decision Making

Kimberly Bittler, BOEM

Chris DuFore, BOEM

Jennifer Bucatari, BOEM

Session Overview

Synthesizing, consolidating, and analyzing large body of knowledge to apply to environmental decision making

Session Highlights

- A lot of collaboration amongst institutions (e.g., GoMMAPPS) to pool data is already occurring, but there are opportunities for more.
- Improving methods for collecting data and presenting/analyzing it

Application

- Tools could be resources for National Environmental Policy Act analysis, restoration, and response
- Tools can facilitate further collaboration

Challenges and research/data gaps

- More opportunity for improving data analysis, combining results of multiple studies to draw broader conclusions

Monitoring and Modeling Responses to Oil Spill Injury and Restoration: Integrating Tools for Adaptive Management

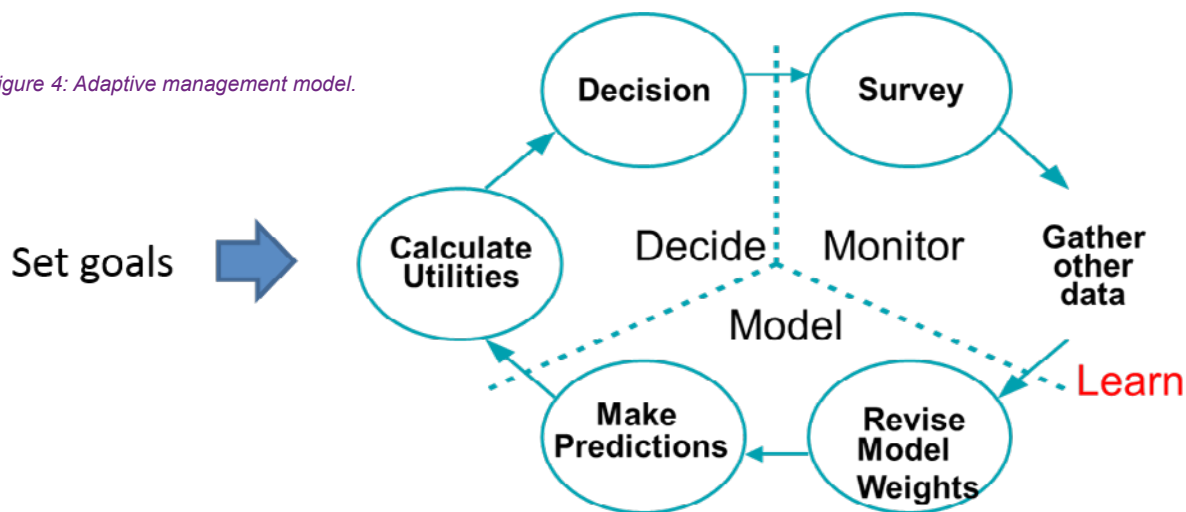
Cameron Ainsworth, University of South Florida
 Michelle Meyers, U.S. Geological Survey
 Deborah French-McCay, RPS ASA
 Claire Paris-Limouzy, University of Miami
 Michael Lee, U.S. Geological Survey
 Stephanie Romañach, U.S. Geological Survey

Session Overview

Focus: Monitoring and modeling work together to support adaptive management

- Implementing restoration in complex and dynamic systems inherently includes many uncertainties, including scientific, technological, engineering, etc.
- In the face of uncertainty, learning under an adaptive management framework becomes very important to inform decisions at various scales (project, program, and region). Adaptive Management includes monitoring and modeling targeted for learning to improve future actions.
- Adaptive management is a mechanism for structuring decisions and formalizing common sense for complex problems leading to greater success towards meeting objectives and learning for wiser future investments.

Figure 4: Adaptive management model.



Session Highlights

- Choose specific metrics of success
 - Greg Steyer: Monitoring a Coastal Wetlands Planning, Protection and Restoration Act project in Louisiana indicated that it is not necessary to plant Spartina as natural colonization resulted in a very similar system.
 - Melissa Carle: examples from Programmatic Damage Assessment and Restoration Plan provide measurable quantities that relate ecosystem status to either baseline conditions (i.e., pre-disturbance) or to theoretical measures of ecosystem maturity and stability. Examples include indices of water quality, fish and invertebrate densities, aquatic vegetation densities, and charismatic animal densities (birds, turtles, mammals).
 - Pamela Plotkin cautioned against goals too broad (e.g., NRDA & NFWF) which could not be easily measured.
- Monitoring and models
 - Exchange goes in both directions (models identify sensitive variables & evaluate congruence between data sets).

Application

- Pamela Plotkin: National Academies of Sciences, Engineering, and Medicine report provided 6 best practices.
- Learning from other areas: JoLynn Carroll showed an example from the Norwegian Sea which used a mechanistic dose-response model similar to what would be needed for the Gulf of Mexico, and integration of hydrodynamic and multispecies stock assessment models similar to what has been done in DWH studies.

Challenges and research/data gaps

- Choosing appropriate scales
 - Melissa Carle (NOAA): Ecosystem injury requires ecosystem-scale restoration. E.g., PDARP considered 13 types of restoration initiatives that covered habitats, ecosystem processes, and species.
- Complex problems require complex models. Oil impacts the ecosystem through many avenues, affecting different species, life history stages, habitats and processes. The net results may be unintuitive. Presenters showed means to estimate net affects through use of multispecies models which incorporated predator-prey dynamics, life history, and habitat use.
 - Ecosystem models (Joel Ortega Ortiz, Cam Ainsworth); example using Atlantis ecosystem model in the Gulf of Mexico.
 - Multispecies life tables (Deborah French-McCay); example showing use of long-term monitoring data sets (e.g., SEAMAP) for estimating lost production of five commercially exploited fish species for injury assessment.
 - Multispecies cod model (JoLynn Carroll); example from Barents Sea cod fishery is able to integrate fish management decisions with oil risks and impacts.
- Pamela Plotkin: The National Academies of Sciences Engineering and Medicine recommend using consistent data collection protocols to aide comparability and scalability.
- Jim Simons showed an example of this in the GOMEXSI trophic database, which uses FWRI sampling protocols. This aids in comparability with previous datasets and meta-analysis.

Oil Spill Modeling: Source to Sink

CJ Beegle-Krause, SINTEF Materials and Chemistry
Juan Restrepo, Oregon State University
Louis Thibodeaux, Louisiana State University
William Dewar, Florida State University
Clint Dawson, University of Texas

Session Overview

Oil spill models are integrated computer systems that simulate the transport, fate and effects of oil spills. Models can be used to help understand such processes and the interplay between processes, as well as being critical to decision makers. Models play key roles in planning for oil development, preparedness for a spill, responding to an oil spill, and in assessment and restoration after an oil spill.

Session Highlights

- Models are being developed on a variety of spatial and temporal scales:
 - Hydrodynamic models continue to diversify in physics, chemistry, dynamics, resolution and applications, thanks to advances in high performance computing, dimension reduction and parametrization strategies, and improved multi-scale strategies.
 - Better understanding has lead us to make inroads in understanding oil processes, from the small scales of marine snow coagulation and droplet dynamics, to the advection/dispersion and mixing processes of large scale oil spills that move across the Gulf of Mexico.
 - Comparison between traditional models and recent advances in the nearfield dynamics of plumes attest to significant progress in understanding how energetic, gaseous plumes develop dynamically.
 - The trend toward model specialization has increased and has led to more comprehensive forecasting models.
 - Tighter integration of oil spill models and the sharing of insights among different approaches are leading to better forecasting tools.
 - Comparisons to data and the process of benchmarking models remains a huge challenge.

Application

- Modeling is a key tool. We see advancements from GoMRI research that will improve decision-making:
 - Deployment of assets for spill containment
 - Assessing long term (week to months) geographic threats
 - Estimation of economic impact
 - Assisting long term (months to years) mitigation strategies

Challenges and research/data gaps

- Matching scales between data sources, models and decisions. The challenge of obtaining data encompassing ocean dynamics, winds, oil droplet composition and chemistry, and the identification of subsurface oil spills remains a challenge. Continued financial support for the development of oil forecasting tools is a challenge.
- Developing useful models in a data sparse environment
- Keeping up with the literature
- Significant differences in requirements between planning, emergency response and NRDA

RESEARCH TO APPLICATION

Sessions

- Policy-Relevant Implications of Science Emerging from the Deepwater Horizon Disaster
- Oil Spill Response and Mitigation Agents
- Deepwater Horizon Natural Resource Damage Assessment: What Have We Learned?
- Deepwater Horizon Oil Spill Natural Resource Damage Assessment: Comprehensive Integrated Ecosystem Restoration

Overarching Highlights

- Policy and Decision-making
 - Multiple opportunities exist for science to inform oil spill response decision making.
 - Is there a “gulf” between academic science and industry-sponsored research that hinders new science being incorporated? Significant unresolved questions of great theoretical and practical importance to industry and government (e.g., sub-surface application of dispersants) remain.
 - o Decision makers want information presented in a more accessible and usable format and need to have the science to inform response decisions prior to an oil spill event
 - Case studies emphasize the necessity to enhance communication among government, industry, and academia.
- Prevention
 - Deep water and offshore frontier areas face production risks that are fundamentally distinct from onshore operations; reducing subsurface uncertainty and drilling risk are priorities for prevention.
 - Analyses of time series data can inform management strategies that minimize risks to sensitive habitats.
 - Spill prevention must also address the lifecycle of an aging system.
- Response and Mitigation
 - All mitigation decisions involve tradeoffs, e.g., increasing hydrocarbon concentrations in the water column to decrease surface and shoreline oiling.
 - There are many mitigation agents to pick from, with varying degrees of toxicity, bioeffects, and fate data available. Differences in chemical composition of mitigation agents will drive hydrocarbon bioavailability.
 - Comparative fate and exposure modeling of sub-surface dispersant injection vs. other intervention options may provide an objective way to evaluate response tradeoffs.
 - Efficacy and effects of mitigation agents are influenced by a variety of natural factors (e.g., salinity, UV light, spatial and temporal variations in communities, wave action - aerosolized oil constituents).
 - Promising mitigation technologies presented will need further development and Technology Readiness Level advancement prior to use.
 - MOSSFA events demonstrate the implications of using traditional oil spill response, such as impact trade-offs (either oil coastlines or offshore benthic environments).
 - o Can MOSSFA events be engineered in the offshore region to gradually deposit marine oil snow?
- Injury Assessment
 - A broad range of impacts were observed, across a diverse resource categories covering hundreds of miles, with recovery times ranging from one year to ‘in perpetuity.’
 - Similar effects appeared across taxa (e.g., cardiotoxic effects and reproductive failure), resulting in “conservation of injury” metrics.
 - Some data (e.g., oil on water) have a limited collection window before those conditions disappear. Considerations for ephemeral data collection include working to get out ahead of the spill to collect pre-spill baseline data in real time and early coordination with response efforts to inform injury assessment. Oceanic research equipment staging would help responders and assessors get critical data earlier in or before the event.
 - o The time taken to reach consensus on ephemeral data collection can result in loss of data.
- Restoration
 - DWH Trustees have developed a comprehensive integrated ecosystem restoration plan based on the injury assessment that incorporates monitoring and adaptive management and a commitment to long-term data management.

- The DWH restoration plan is being integrated with existing state and regional frameworks and is informing on-the-ground restoration and planning in all the DWH implementation areas, including the five Gulf States and for open ocean resources in the Gulf region.
- In addition to habitat restoration, Trustees are considering a range of innovative approaches to directly address injuries to open ocean resources, including the use of bycatch reduction as a method of restoring open ocean fish stocks.

Identified Gaps and Challenges

- Integrating oil spill science into Gulf management faces process challenges (peer review, transparency, relevance of science), institutional challenges (e.g., sub-surface blowouts were never anticipated in the Oil Pollution Act of 1990), and financial challenges (e.g., sustaining science seven years after a major incident).
- Baseline data are needed, especially for offshore and deepwater resources and habitats, including those around platforms.
- The DWH injury assessment highlighted the importance of oil-on-water measurements (distribution, patchiness, relative or quantitative thickness) for response and assessment, as well as the needed development of non-lethal methods for documenting exposure and injury (e.g., biomarkers, genomics). Better methods for integrating more chronic and sublethal effects into the injury determination are also missing.
- Response research needs include physicochemical properties of mitigation products; studies with more oil types, abiotic co-stressors, and environmental conditions; analytical chemistry of mitigation agents and oil interactions; and field exposure concentrations. What are the seasonal and temporal variations in bioeffects, particularly in microbial communities?
- Access to mitigation products and oils for testing remains a challenge.
- How do we scale experiments from laboratory to real world conditions and transition new technologies from the research and development stage to options for use in spill response?
- Synthesis of the large volume of data collected in way that will aid future spill response is a challenge.
- Challenges to restoration include maintaining the ability to adapt to new information and unknown conditions during the restoration process, integrating the DWH restoration plan with the many other state and regional funding streams and restoration planning frameworks, managing large amount of diverse data in a way that can effectively inform restoration planning and adaptive management, and understanding stressors on open ocean resources targeted for restoration.

Policy-Relevant Implications of Science Emerging from the Deepwater Horizon Disaster

Steven Murawski, University of South Florida

David Hollander, University of South Florida

Session Overview

- Range of public policy implications in light of new research stemming from the DWH disaster
- Discussion of the public-policy decision making hierarchy related to oil spills (pre-spill risk assessment, real-time response, post-spill resource recovery and post-production decommissioning)
- Examples of each emerging from DWH science
- Extensive discussion of policy implications

Session Highlights

- Multiple opportunities exist for science to inform oil spill response decision-making.
- There are many examples of synergistic effects of employing multiple simultaneous scientific approaches, which provides greater inferential power than single approaches.
- Is there a “gulf” between academic science and industry-sponsored research that hinders new science being incorporated? Significant unresolved questions of great theoretical and practical importance to industry and government (e.g., sub-surface application of dispersants) remain.
 - Decision makers want information presented in a more accessible and usable format.
- Process alternatives assuring that better, more timely research is used for strategic response decision making would be beneficial.
- Analyses of time series of data can inform management strategies which minimize risks to sensitive habitats.
 - Review of data shows that most impacts to deep-sea communities occur within 2000m of platforms; existing mandate of deep Gulf includes 600m buffer zones around seismic anomalies.

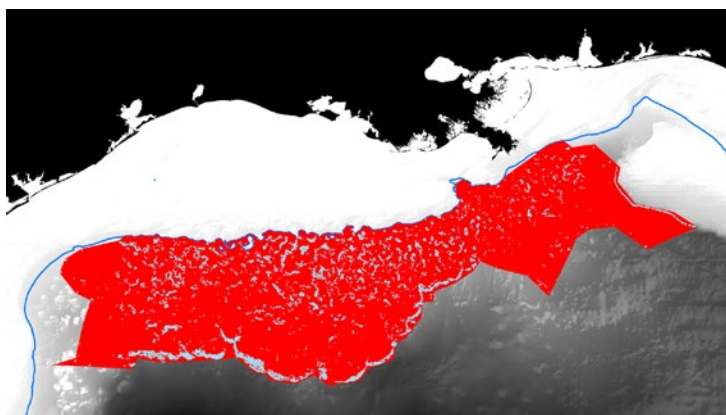


Figure 5: Areas left for drilling (red) if a 2-km buffer zone is added around each of the seismic anomalies.

- NETL's Offshore Risk Model combines GIS and Marine Spatial Planning techniques for oil spill prevention and is adaptable to a range of stakeholder needs and questions.
- Deep water and offshore frontier areas face production risks that are fundamentally distinct from onshore operations; reducing subsurface uncertainty and drilling risk are priorities for prevention.
- Spill prevention must also address the lifecycle of an aging system.
- The increasing number and idle structures and costs require the development of a model which includes stakeholder involvement to analyze a number of criteria and determine the best decommissioning option for a platform.
- Traditional oil spill mitigation strategies (freshwater discharge (clays/nutrients), burning, and dispersant application) led to sedimentary oil deposition during DWH and IXTOC-1 (1979).
- MOSSFA events demonstrate the implications of using traditional oil spill response, such as impact trade-offs (either oil coastlines or offshore benthic environments).

- In light of the discovery of the MOSSFA phenomenon (sedimentary oil deposition), is it time to rethink the policy of “sinking agents” (clays) as a viable tool for deep-water oil spill response and mitigation?
 - Burying sedimentary oil deposits on deepwater slopes may be the best alternative to remove oil from biologically active areas and minimize impacts.
 - Can MOSSFA events be engineered in the offshore region to gradually deposit Marine Oil Snow (MOS)?
 - Now is the time to test adding clay and nutrient mixture to control location of MOS settling.

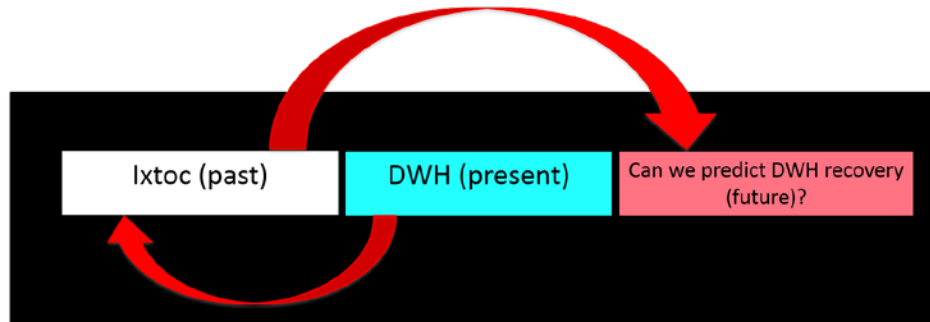


Figure 6: “The present is the key to the past and the past is a window to see into the future.” David Hollander.

Application

- Research presented is highly relevant to responders and policy makers to plan, prepare and respond to oil spills and/or inform future restoration.
- Case studies demonstrate how science can lead to updated prevention and response management strategies and practices.
- Emphasizes the necessity to enhance communication among government, industry and scientists (academic, government and industry).

Challenges and research/data gaps

- Process challenges (peer review, transparency, relevance of science)
- Institutional challenges (e.g., sub-surface blowouts were never anticipated in OPA-90)
- Financial challenges (sustaining science 7 years after a major incident)

Oil Spill Response and Mitigation Agents

Michael Fulton, NOAA
 Scott Lundgren, NOAA
 Marie Delorenzo, NOAA
 Gary Shigenaka, NOAA

Session Overview

The Oil Spill Response and Mitigation Agent session addressed the conference theme of “Application to Response” within two main areas:

- 1) Fate and Effects
- 2) Novel Mitigation Techniques

Session Highlights

- All mitigation decisions involve tradeoffs
 - e.g., increasing hydrocarbon concentrations in water column to decrease surface/shoreline oiling
 - o Advanced modeling of subsea dispersant injection suggests reduced surface water and shoreline impacts, and decreases in soluble & volatile hydrocarbon effects
- Efficacy and effects of mitigation agents influenced by variety of natural factors
 - Salinity, UV light, etc.
 - o Salinity differences affected toxicity of 2 dispersants to eastern mud snails
 - o Dispersing surface washing agent (SWA) (vs. “lift and float” SWA) was significantly more toxic to salt marsh organisms
 - Spatial /temporal variations in communities
 - o 10 ppm chemically-dispersed oil shifted protozoan communities, possible food web implications
 - o In salt marsh mesocosms, dispersed oil adversely affected a range of organisms; benthic impacts were greatest, while fish and snails least affected
 - Wave action - aerosolized oil constituents
 - o Dispersants in the presence of breaking waves increase production of airborne nano-sized particles but reduce concentrations of volatile organic compounds
- Differences in chemical composition of mitigation agents will drive hydrocarbon bioavailability
- Identified need to have science to inform response “ahead of time”

Application

- New toxicity thresholds and bioeffects data add to databases (e.g., CAFE- Chemical Aquatic Fate and Effects) used to select chemical mitigation agents for spill response
- Many mitigation agents to pick from; varying degrees of toxicity and fate data available. Some bioeffects of dispersants and dispersed oil included: altered microbial and protozoan communities, decreased dissolved oxygen, impaired marsh grass growth, decreased bivalve growth, decreased pelagic and benthic survival and negative effects on physiological functions
- Promising mitigation technologies presented will need further development and Technology Readiness Level advancement for use
 - New mitigation technologies presented included: buoyant gel dispersants, use of food grade dispersants, natural clay nanotubes, mineral substrates, waste tires, peanut hulls, & pipe cutting.
 - New/novel approaches
 - o Food-grade surfactant components appear to be promising for “greener” dispersants
 - o Clay nanotubes may be a cheap and available way to augment dispersant performance
 - o Gel formulations can improve effectiveness of dispersants by improving contact to oil

- Dispersant state-of-science project will summarize knowns & uncertainties with a focus on the Arctic
 - Dispersant state-of-the-science project will provide documents with knowns and uncertainties from peer reviewed literature for 5 areas: physical transport and chemical behavior, degradation and fate, ecotoxicity and sublethal impacts, public health and food security, with an emphasis on the Arctic
- Comparative fate and exposure modeling of sub-surface dispersant injection vs. other intervention options may provide an objective way to evaluate response tradeoffs

Challenges and research/data gaps

- Physicochemical properties of mitigation products
- Studies with more oil types, abiotic co-stressors, environmental conditions
- Analytical chemistry of mitigation agents/oil interactions; field exposure concentrations
- Seasonal and temporal variations in bioeffects, particularly microbial communities
- Access to mitigation products and oils for testing
- Transitioning new technologies from Research & Development stage to options for use in spill response
- Synthesis of large volume of data collected in way that will aid future spill response
- Laboratory to real world scaling: conditions/concentrations

Deepwater Horizon Natural Resource Damage Assessment: What Have We Learned?

Lisa DiPinto, NOAA
Tom Brosnan, NOAA

Session Overview

DWH comprehensive Natural Resource Damage Assessment (NRDA) studied impacts to a broad range of separate but interconnected ecosystem resources.

Results of our findings from six years of assessment studies were discussed by a panel of NRDA and non-NRDA experts.

Assessment concluded the entire northern Gulf of Mexico ecosystem was affected by DWH.

Session Highlights

- Broad range of impacts observed, across broad range of resource categories covering hundreds of miles with recovery times ranging from one year to 'in perpetuity'
- Everywhere oil went, we saw harm
- Conservation of injury metrics (e.g., cardiotoxic effects, reproductive failure, others observed cross-species)
- Ephemeral Data Considerations
- Work to get out ahead of the spill to collect pre-spill baseline data in real time
- Oceanic research equipment staging would help responders and assessors get critical data earlier in event
- Early coordination with response efforts to inform injury assessment
- Time taken to reach consensus on ephemeral data collection can result in loss of data

Challenges and research/data gaps

- Baseline data needed in general (especially for offshore and deepwater resources and habitats such as around platforms)
- Better methods for integrating more chronic and sublethal effects into the injury determination needed
- Significant advances made in survey designs for communicating injuries in valuation surveys
- Longer term studies useful to both capture long term injuries and inform recovery rates
- Importance of oil on water measurements (distribution, patchiness, relative or quantitative thickness) for response and assessment highlighted
- Need for development of non-lethal methods for documenting exposure and injury (e.g., biomarkers, genomics)

Deepwater Horizon Oil Spill Natural Resource Damage Assessment: Comprehensive Integrated Ecosystem Restoration

Melissa Carle, Earth Resources Technology, Inc.
Mike Peccini, NOAA

Session Overview

Part 1: Injury Assessment and Restoration Planning

- The session's introductory talks provided an overview of the DWH Programmatic Damage Assessment and Restoration Plan, which included information about the magnitude of the injury, the restoration planning process, and a detailed look at the adaptive management framework included in the plan.
- The next several presentations focused on state and regional restoration planning frameworks, with the State of Mississippi and the Ocean Conservancy providing detailed examples of each.
- The first half of the session concluded with a detailed look at the data system being used to manage DWH assessment, restoration, and monitoring data.

Part 2: Restoration Planning for the DWH Open Ocean Injury

- The second half of the session provided a targeted focus on open ocean restoration. The subject was introduced with an overview of the resource types being addressed and an update on the activities and progress of the Open Ocean Trustee Implementation Group.
- The remainder of the session's presentations provided details of open ocean fish restoration efforts either being currently implemented or considered for implementation. Restoration through bycatch reduction was highlighted with initiatives that included a voluntary alternative long-line gear program, crab trap removal, and mortality reduction through the use of alternative hooks.

Session Highlights

- DWH Trustees have developed a comprehensive integrated ecosystem restoration plan based on the injury assessment that incorporates monitoring and adaptive management and a commitment to long term data management.
- The DWH restoration plan is being integrated with existing state and regional frameworks and is informing on-the-ground restoration and restoration planning in all the DWH implementation areas including the five Gulf States and for open ocean resources in the gulf region.
- In addition to habitat restoration, Trustees are considering a range of innovative approaches to directly address injuries to open ocean resources including the use of bycatch reduction as a method of restoring open ocean fish stocks.

Challenges

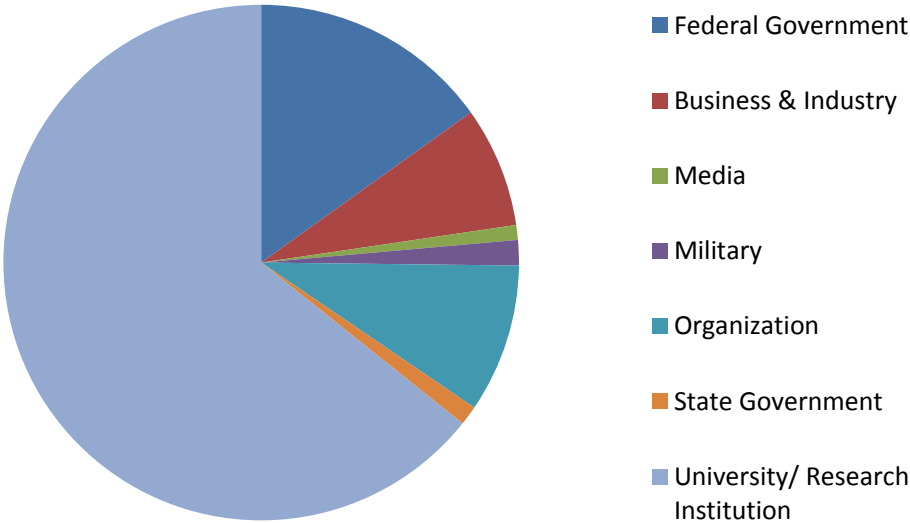
- Planning large-scale restoration from an integrated, ecosystem perspective.
- Maintaining the ability to adapt to new information and unknown conditions during the restoration process.
- Integrating the DWH restoration plan with the many other state and regional funding streams and restoration planning frameworks.
- Managing large amount of diverse data in a way that can effectively inform restoration planning and adaptive management.
- Understanding stressors on open ocean resources targeted for restoration.
- Identifying and filling data gaps for restoration planning, implementation, and evaluation for each restoration type.
- Developing effective, non-regulatory approaches to bycatch reduction.

ATTENDANCE AND DEMOGRAPHICS

12 countries (Australia, Canada, China, Denmark, France, Germany, Italy, Mexico, Netherlands, Norway, South Korea, United Kingdom)

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

Figure 7: Attendees by Sector



MEDIA

The conference submitted two national press releases through PR NewsWire ([December 20, 2016](#) and [January 25, 2017](#)) to generate interest in coverage from national and local media. Ten members of news media registered, representing the Times Picayune, WWNO (local NPR affiliate), The New Orleans Advocate, and Motherboard. Searches through PR NewsWire, Meltwater, and Google News returned 455 examples of coverage before, during, and after the meeting. The coverage includes stories in newspapers and magazines; on radio and television; and on various Internet sites, including blogs and press-release aggregators.

The conference also maintained a strong social media presence, with 294 Twitter followers and 253 Facebook page “likes.” To date, at least 222 tweets have included at least one of the conference hashtags (#gulfscienceconference; #OneGulf).

The full media report is available in Appendix III (page 55).

APPENDIX I: CONFERENCE AGENDA

MONDAY, FEBRUARY 6

Time	Event	Location
12:00p-6:00p	Registration & Check-in Open	Elite Foyer
12:00p-6:00p	Exhibit Set Up	Elite Hall
12:00p-6:00p	Speaker Ready Room Open	Bolden 2
1:00p-6:00p	Poster Hang-Up	Elite Hall

Associated Meetings and Events

9:00a-12:00p	Assessing the State of Gulf of Mexico Benthic Habitat Maps	Strand 13
9:00a-12:00p	Gulf of Mexico Oil Spill Research: International Collaborations Involving Science, Policy and Response	Strand 12
9:00a-1:00p (Open)	Hypoxia Effects on Fish and Fisheries: Kick-Off Meeting of Decision Support Tool Development	Bolden 1
1:00p-5:00p (By invitation)	Hypoxia Effects on Fish and Fisheries: Kick-Off Meeting of Decision Support Tool Development	Bolden 1
9:00a-5:00p	MOSSFA Workshop	Empire B
1:00p-4:00p	Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) - Informational Meeting, Year 2	Strand 13
1:00p-4:00p	Physical Methods of Oil Spill Remediation: Research Needs and Lessons Learned in Remediating Oil Spills in the Gulf of Mexico and Michigan	Bolden 5
1:00p-5:00p	Exploring the Intersection between Oil Spill Science and Response	Bolden 6

TUESDAY, FEBRUARY 7

Time	Event	Location
7:30a-5:30p	Registration & Check-in Open	Elite Foyer
7:30a-6:00p	Speaker Ready Room Open	Bolden 2
7:30a-8:00p	Exhibits Open	Elite Hall
	Poster Hall Open	Elite Hall

Opening Plenary Program Schedule

Starting at 7:30a	BREAKFAST	Strand & Elite Foyers
9:00a-10:00a	Welcome and Introduction Dr. Rita Colwell, Gulf of Mexico Research Initiative Research Board Keynote Address Dave Westerholm, NOAA	Empire A/B
10:00a-10:15a	BREAK	Strand & Elite Foyers
10:15a-12:30p	Panel and Discussion	Empire A/B
12:30p - 2:00p	LUNCH	Strand & Elite Foyers

Scientific Program Schedule

2:00p-3:30p	Session 001	Strand 11
	Session 002	Empire A
	Session 003	Bolden 1
	Session 004	Bolden 5
	Session 005	Strand 12
	Session 006	Bolden 6
	Session 007	Strand 13
	Session 008	Empire B
3:30p-4:00p	BREAK	Strand & Elite Foyers
4:00p - 5:30p	Session 001	Strand 11
	Session 002	Empire A
	Session 003	Bolden 1
	Session 004	Bolden 5
	Session 005	Strand 12
	Session 006	Bolden 6
	Session 008	Empire B
6:00p-8:00p	Poster Session & Reception (featuring Sessions 001 - 008)	Elite Hall

Associated Meetings and Events

3:30p-4:00p	Dataset Management Planning via the GRIIDC Dataset Information Form (DIF)	Bolden 4
6:00p-8:00p	Gulf of Mexico Data Tools Café	Elite Hall

WEDNESDAY, FEBRUARY 8

Time	Event	Location
7:30a-5:30p	Registration & Check-in Open	Elite Foyer
7:30a-6:00p	Speaker Ready Room Open	Bolden 2
7:30a-8:00p	Exhibits Open	Elite Hall
	Poster Hall Open	Elite Hall

Scientific Program Schedule

Starting at 7:30a	BREAKFAST	Strand & Elite Foyers
9:00a-10:30a	Session 003	Bolden 1
	Session 004	Bolden 5
	Session 005	Strand 12
	Session 008	Empire B
	Session 009	Empire A
	Session 010	Strand 11
	Session 011	Bolden 6
	Session 012	Strand 13
10:30a-11:00a	BREAK	Strand & Elite Foyers
11:00a-12:30p	Session 003	Bolden 1
	Session 009	Empire A
	Session 010	Strand 11
	Session 011	Bolden 6
	Session 012	Strand 13
	Session 013	Bolden 5
12:30p - 2:00p	LUNCH	Strand & Elite Foyers
2:00p-3:30p	Session 009	Empire A
	Session 010	Strand 11
	Session 011	Bolden 6
	Session 013	Bolden 5
	Session 014	Strand 13
	Session 015	Bolden 1
	Session 016	Empire B
	Session 017	Strand 12
3:30p-4:00p	BREAK	Strand & Elite Foyers
4:00p - 5:30p	Session 009	Empire A
	Session 010	Strand 11
	Session 011	Bolden 6
	Session 013	Bolden 5
	Session 014	Strand 13
	Session 015	Bolden 1
	Session 016	Empire B
	Session 017	Strand 12
6:00p-8:00p	Poster Session & Reception (featuring Sessions 010 - 023)	Elite Hall

Associated Meetings and Events

10:30a-11:00a	Organizing Your Data - Best Practices and GRIIDC Submissions	Bolden 4
3:30p-4:00p	Submitting Your Data to GRIIDC	Bolden 4
5:45p - 7:15p	Town Hall: Ocean Research in the Coming Decade	Empire A

THURSDAY, FEBRUARY 9

Time	Event	Location
7:30a - 12:00p	Registration & Check-in Open	Elite Foyer
7:30a - 8:30a	Speaker Ready Room Open	Bolden 2
7:30a - 12:00p	Exhibits Open	Elite Hall
	Poster Hall Open	Elite Hall

Scientific Program Schedule

Starting at 7:30a	BREAKFAST	Strand & Elite Foyers
9:00a - 10:30a	Session 014	Strand 13
	Session 017	Strand 12
	Session 018	Bolden 6
	Session 019	Bolden 5
	Session 020	Empire A
	Session 021	Bolden 1
	Session 022	Strand 11
10:30a - 11:00a	BREAK	Strand & Elite Foyers
11:00a - 12:30p	Session 014	Strand 13
	Session 017	Strand 12
	Session 018	Bolden 6
	Session 020	Empire A
	Session 021	Bolden 1
	Session 022	Strand 11
	Session 023	Empire B
12:30p - 2:00p	LUNCH	Strand & Elite Foyers

Plenary Program Schedule

2:00p - 4:00p	Linking Science & Restoration: Now and in the Future Moderated by Dr. Monty Graham Session Summaries and Discussion Moderated by Michael A. Celata Conference Wrap-Up	Empire A/B
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Associated Meetings and Events

8:15a - 8:45a	Organizing Your Data – Best Practices and GRIIDC Submissions	Bolden 4
10:30a - 11:00a	Submitting Your Data to GRIIDC	Bolden 4

APPENDIX II: ASSOCIATED WORKSHOPS & MEETINGS

MOSSFA Workshop

The 2017 International MOSSFA workshop was held Monday February 6, 2017 at the Hyatt Regency Hotel in New Orleans prior to the annual GOMRI meeting. Sixty-three participants registered for the meeting and nearly 100 people attended overall. The attendees represented multiple GOMRI consortia, individual investigators, international collaborators, agency personnel and industry representatives. The workshop organizing committee consisted of David Hollander (Chair), Adrian Burd, Jeff Chanton, Kendra Daly, Claire Paris, Antonietta Quigg, Kai Ziervogel. The workshop focused on new and still pressing issues surrounding the MOSSFA phenomena.

Three sessions were developed, each consisted of 2-4 keynote lectures, extended breakout group discussions and associated posters. The sessions were:

1. chemical and biological factors that control Marine Oil Snow formation, and its vertical transport from its location of origin at the surface and in the deep sea,
2. diagnostic parameters/observations that best and broadly characterize MOSSFA events in sediments in order to determine its spatial distribution, its benthic ecosystem impacts and its temporal evolution recovery rate / preservation; including the nature and characterization of past MOSSFA events,
3. the current state of numerical modeling of MOSSFA events, what set of observations are needed to produce accurate simulations of MOSSFA spatial distributions, and the definition of specific advances to models that are needed, such as oil droplet aggregation, vertical transport rates, and microbial, biogeochemical, and sedimentary cycling modules.

Beyond advances in each of these specific focus areas, workshop participants concurred that MOSSFA observation, experimentation and modeling could be coupled with near- and far-field transport models to aid first responders in predicting the occurrence and spatial distribution MOSSFA events in waters and sediments, integrated into regional-scale ecosystem modeling of biological impact and consequences and used in refining a terminal oil budget.

Assessing the State of Gulf of Mexico Benthic Habitat Maps

This workshop will bring together agency, industry, academic and other partners to discuss and examine the inventory and quality of existing benthic habitat data, and opportunities to share, reprocess, digitize and modernize this information in support of a single baseline map to serve as source information for activities to come (including a collaborative partnership or community of practice for data sharing and habitat mapping). We invite you to bring your maps and/or your understanding of the benthic environment and join us for an interactive discussion of existing resources, gaps in our understanding of bottom habitats and potential collaborations and partnerships to advance the state of Gulf of Mexico habitat maps. [Download the full report.](#)

Gulf of Mexico Oil Spill Research: International Collaborations Involving Science, Policy and Response

It has been over half a decade since the DWH oil spill occurred. This disastrous large scale spill acted as a major shift for the industry and the scientific community and magnified the need of the former to understand ocean processes on smaller scales. Many research endeavors have been funded as a direct result and largely through the Gulf of Mexico Research Initiative (GoMRI) in the US, and through the former Instituto Nacional de Ecología and presently by the Hydrocarbon Fund of SENER-CONACyT in México. Although divided by three international borderlines the Gulf of Mexico is a semi-enclosed sea, also referred to as the Mediterranean of the Americas, where ocean processes and the large ecosystem are all interconnected. The continuity of all these processes justifies the need for Cuban, Mexican and American researchers to collaborate on resolving the critical issues that the Gulf is faced with, post-DWH and in the event of another catastrophe. Just as interconnected as Gulf waters are, so too are the roles of science, policy and response – one influenced by the next.

This workshop was an interdisciplinary event that will provide researchers with the opportunity to explore international collaborative efforts and for those already involved in such projects to share their science and experiences with others. Similarly, regulatory and response concerns were addressed at this meeting with the hopes of tackling current issues with a multi-faceted approach. This was an excellent opportunity to identify areas where collaborations would be appropriate, not only across the GoMRI consortia but with international institutions and agencies as well. With only a few years left of funding, meetings such as this one are important, not only to avoid doubling efforts but also to achieve similar objectives in the most cost-efficient way.

Hypoxia effects on fish and fisheries: kick-off meeting of decision support tool development

This was the first of three workshops organized as part of the project: “NGOMEX 2016: User-driven tools to predict and assess effects of reduced nutrients and hypoxia on living resources in the Gulf of Mexico” funded by NOAA’s Center for Sponsored Coastal Ocean Research (CSCOR) under grant no. NA16NOS4780202. The morning of the workshop was open to all interested parties, while the afternoon served as an advisory panel meeting. [All presentations given at the workshop](#) and a [complete report with presentation summaries](#) are available.

Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) – Informational Meeting, Year 2

The GoMMAPPS study is a partnership program to improve information about protected species and provide a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in Gulf offshore waters. The program will conduct repeated, broad-scale surveys over multiple years and seasons using various methods, including aerial surveys, ship-based surveys, and tag telemetry work. GoMMAPPS is moving from its first planning year in 2016 to the start of its field campaign during 2017-2019, as guided by a well-considered science framework required to collect this comprehensive dataset. Outreach and coordination are important aspects of GoMMAPPS, including annual meetings held as part of the GoMOSES Conference.

A second annual informational and public outreach meeting was held during the GOMOSEs Conference and brought together an audience of approximately 100 people. The goal of the meeting was to provide overview presentations and a forum for an interactive discussion regarding the evolving program, science considerations, coordination with other Gulf programs, and incorporation of stakeholder input. The 2-hour public meeting was composed of various presentations, including a GoMMAPPS Overview, outreach and education support, and program perspectives on each of the target resources: marine mammals, sea turtles, and seabirds. Additionally, related program presentations were provided on sea turtle ecology in the northern Gulf of Mexico (GOM), the GOM Avian Monitoring Network (GOMAMN), and development of a GOM Marine Mammal Action Plan. The GoMMAPPS project team will continue to actively engage various Gulf stakeholders and the community to ensure that GoMMAPPS best meets our common goals for a healthy and productive Gulf ecosystem. Following the public meeting, a 2-hour closed meeting brought together program Principal Investigators to discuss logistics for the upcoming field season.

Physical methods of oil spill remediation: Research needs and lessons learned in remediating oil spills in the Gulf of Mexico and Michigan

The focus of the workshop was on physical separation methods (e.g., booms, skimmers, hydrocyclone, voraxial separators) for oil spill remediation and on contrasting Gulf of Mexico and Kalamazoo River oil spill events.

The meeting consisted of three consecutive sessions:

(~ 45 min) The workshop started with a brief synopsis of each spill.

(~ 1 hour) Workshop participants discussed cleanup technologies employed in each of the two remediation efforts with an emphasis on what worked and what did not work and why. The discussion provided an analysis of the role of physical separation methods (booms, skimmers, hydrocyclones, voraxial separators) and their relative value and importance with respect to other remediation methods (e.g., dispersant, sorbents, bioremediation, other).

(~ 1 hour) The participants compared Michigan and Gulf of Mexico practices to identify important lessons that can be learned by comparing and contrasting the two cases. The oil spills occurred within two months one from another yet the contexts varied significantly: the type of oil spilled, land vs open sea environment, freshwater vs seawater. The discussion concluded by formulating research needs to enable more effective remediation of oil spills by physical methods of separation.

This was the final event in a series of workshops focused on this topic. A white paper on a comparative analysis of 2010 DWH and 2010 Kalamazoo River oil spills will be developed and released.

Exploring the intersection between oil spill science and response

The Sea Grant Oil Spill Science Outreach Team hosted this workshop in conjunction with the 2017 Gulf of Mexico Oil Spill & Ecosystem Science Conference in New Orleans, LA. The workshop focused on bringing local oil spill scientist and emergency responders together to communicate their needs and explore potential partnerships.

The workshop consisted of two panels of speakers. Speakers represented various government agencies, the oil industry, and academia. After each panel spoke, they answered audience questions, with lively discussion ensuing. Participants broke out into smaller groups during the last hour of the workshop to discuss challenges associated with oil spill response in a smaller setting.

Groups talked about ways to improve communication between academic, government, and industry scientists as potential solutions to these challenges. The discussions with attendees in the breakout sessions will help the oil spill specialists decide the agenda for future workshops. Part of a regional series, the team built this workshop upon the success of another that took place in Texas and plan to host more around the Gulf states.

The [*full report including key discussions*](#) is available online.

Gulf of Mexico Tools Café

A large number of tools and platforms have been developed to support scientific efforts in the Gulf of Mexico. This workshop allowed tool developers time to give hands on demonstration of tools and allow for collaborative discussions among developers. This workshop provided a highly interactive environment where participants learned how to use and apply available tools. These tools included web and paper based applications that focused on conference themes and objectives. This workshop was offered in conjunction with the moderated session, “Decision Support and Integration Tools for Response and Restoration.”

Environmental Disasters Data Management (EDDM)

This meeting provided an update on the EDDM working group’s activities this year. Three working groups have been developed to address the goals and outcomes on these topics: Common Data Model, Field Protocols and Training, Gold Standard (including vocabularies, interoperability, QA/QC, baseline data).

Special Town Hall: Ocean Research in the Coming Decade

The Subcommittee on Ocean Science and Technology (SOST), under the White House National Science and Technology Council, has initiated, in alignment with the National Ocean Council, development of a 10-year ocean research plan (tentatively titled “Ocean Research in the Coming Decade” and hereafter, “the Plan”). Members of the SOST provided an overview of the Plan, which will describe the most pressing research questions and most promising areas of opportunity within the ocean science and technology enterprise* for the coming decade, and set the stage for agency-specific and interagency coordinated actions across Federal agencies and with other ocean sectors to address societal needs and issues of national importance.

*For the purposes of this town hall, “ocean science and technology enterprise” encompassed basic, inquiry-driven, fundamental research; applied science and research driven by societal and management needs; the translation and application of research results; technology, tools, and infrastructure; innovation; education and workforce development; social sciences as related to ocean issues; and operational oceanography.

GRIIDC WORKSHOPS

Dataset Management Planning via the GRIIDC Dataset Information Form

The Gulf of Mexico Research Initiative Information & Data Cooperative (GRIIDC) Dataset Information Form is a dataset management planning tool required for all datasets that will be submitted to the GRIIDC system. The DIF is a tool that helps researchers plan and determine how they will organize data for submission to GRIIDC. The details provided in the DIF assist GRIIDC in designing the system, determining storage capacity, and preparing to distribute data. This workshop provided information about how to use the GRIIDC Dataset Information Form to identify a dataset in the GRIIDC system.

Organizing Your Data – Best Practices and GRIIDC Submissions

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 is not properly managed, it 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 your Data to GRIIDC

GRIIDC operates a data management system that stores datasets and related information collected and generated by Gulf of Mexico Research Initiative (GoMRI) funded researchers. Datasets are submitted to the GRIIDC data management system directly or registered with GRIIDC by providing a link to the dataset if housed at a national data archive. This workshop demonstrated how to submit and register data through the GRIIDC website to submit or register data to GRIIDC.

APPENDIX III: PRESS COVERAGE SUMMARY REPORT

MECHANISMS ACCOMPLISHED: CONFERENCE MEDIA PLAN

- Created and updated media section on the [Conference website](#)
- Created targeted media lists
- Created, distributed & pitched a media alert “Save the date”
- Distributed two press releases through email and PR Newswire
- Received media inquiries and facilitated media interviews
- Promoted Conference on social media accounts
 - Continued Conference [Facebook](#) and [Twitter](#) accounts
 - Hashtag: #OneGulf, #gulfscienceconference
- Developed key message document specific to the Conference
- Determined Conference “hot topic” science sessions and pitched to media
- Provided a Press Room (media work room and quiet interview space) for media attendees

QUANTIFYING SUCCESS:

News media attendance:

10 members of news media registered

News media outlets represented, include: The Times Picayune, The New Orleans Advocate, WWNO (local NPR affiliate), and Motherboard.

News coverage:

Searches through PR NewsWire, Meltwater, and Google News returned 455 examples of coverage before, during, and after the meeting with a total reach of 106.3M. 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.

Examples:

The Times-Picayune: “What the BP spill did, and how scientists figured it out” http://www.nola.com/environment/index.ssf/2017/02/assessing_bp_spill_damage_to_n.html

The New Orleans Advocate: “Oil spill experts convene in New Orleans to help align research with future response efforts” http://www.theadvocate.com/new_orleans/news/business/article_1839c0b8-ed82-11e6-b66b-eb60b7ffa6bb.html

Total Circulation

To date, total circulation for the event is 106,332,818.

Social Media Statistics

Twitter account: 294 Followers

Twitter hashtag (#gulfscienceconference; #OneGulf) use: 222

Facebook: 253 page “likes”

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

