Abstracts of Oral Presentations (by day and session)

Tuesday, February 2, 2016
1:30 PM - 5:00 PM

Incorporating an Ecosystem Services Approach into Restoration and Coastal Management

1:30 PM - 1:45 PM
A Place for People at the Restoration Table
D. Boesch
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Ecosystem services are anthropocentric. They are the benefits that humans receive from the natural environment. Yet, do we really consider the potential impact on human well-being as we plan, execute, and monitor restoration and conservation projects? And if we are, is there a real connection between the biophysical structure, function, and processes to ecosystem services and then human well-being? There currently exists a significant opportunity in the Gulf of Mexico to change the way we conduct our "restoration" business. Ecosystem services can play a role in selection among project alternatives but more importantly it can help elucidate the benefits of restoration and be a measure of the "impact of investment" that is being made.

1:45 PM - 2:00 PM
The Gulf of Mexico as a Hub for Ecosystem Service Science-Driven Policy
C. Shepard;
The Nature Conservancy, Punta Gorda, FL

The Gulf of Mexico's coastal and marine ecosystems provide a wide range of services that benefit people and nature. Reestablishing these ecosystem services and protecting the habitats that provide them is key to rebuilding the region's economic, ecological and social vitality. The Deepwater Horizon disaster has brought much needed scientific and political attention to the state of the Gulf of Mexico's ecosystems and the services they provide. The RESTORE act served as an initial impetus for bringing stakeholders together throughout the region, but the conversation has broadened to include multiple funding sources that can collectively improve the environmental, economic, and social resilience of the Gulf Coast. State, county and local government agencies, non-governmental organizations and industry representatives are making decisions now about where to invest in economic development, conservation and restoration projects. An ecosystem services approach can help inform on baseline

conditions, assess damages from disasters and increase the effectiveness of restoration activities. Right now, the Gulf of Mexico is a hub for both the advancement of ecosystem services science and the use of that science to inform more strategic planning and management of the region's natural resources. As we implement planning processes that work across sectors and jurisdictions to fund projects that will balance potential trade-offs and provide the greatest returns for people and nature, we need to identify what actions need to be taken to strengthen the use of an ecosystem services framework in the Gulf.

2:00 PM - 2:15 PM

U.S. Federal Policies, Gulf Restoration Initiatives, and Opportunities for Ecosystem Services Assessment

S. J. Ryker[1], A. Segal[2];
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In reports dated 1998 and 2011, the President's Council of Advisors on Science and Technology (PCAST) directed agencies' attention to the value of natural capital and recommended improving the capabilities of Federal agencies to consider ecosystem services in decision-making. Since then the Federal government has made progress in adopting ecosystem services approaches within individual agencies (for example in the 2012 Forest Planning Rule) and in setting policy across agencies (for example in the 2014 Principles, Requirements and Guidelines for Federal Investment in Water Resources). Most recently, a 2015 White House policy directed Federal agencies to promote consideration of ecosystem services within existing agency planning and decision frameworks. Long-standing research and restoration initiatives in the Gulf of Mexico have already advanced the region's understanding of a rich variety of ecosystem services, including cultural and economic resources provided by the Gulf as well as natural and restored ecosystem functions. The increased Federal focus on ecosystem services creates an opportunity to discuss potential frameworks integrating across a number of these Gulf efforts. Existing collaborations through, for example, the RESTORE Council and Natural Resources Damages Act Trustee Council, other regional restoration and recovery initiatives, and with state, local and Tribal partners already provide foundational investments in the region. Ecosystem services provide a way to articulate the values of these investments at a landscape scale, and to identify mutually supporting goals and outcomes for future investments in both research and restoration.

2:15 PM - 2:30 PM

Gulf of Mexico Ecosystem Restoration: Based on a Foundation of Ecological, Economic and Social Components

B. Sutter[1], J. R. Ehrenwerth[2], A. Dausman[3], J. Ettinger[2];
[1]Gulf Coast Ecosystem Restoration Council, Leesburg, VA, [2]Gulf Coast Ecosystem Restoration Council, New Orleans, LA, [3]Gulf Coast Ecosystem Restoration Council, Stennis, MS

The Gulf of Mexico (Gulf) is vital to our Nation and our economy, providing valuable energy resources, abundant seafood, extraordinary beaches and recreational activities, and a rich cultural heritage. Even before the Deepwater Horizon (DWH) oil spill of 2010, the health and function of the Gulf ecosystems and economies have suffered from decades of significant human and natural stressors. The Gulf has experienced chronic loss of critical wetland habitats, erosion of barrier islands, imperiled fisheries, water quality degradation, impacts from invasive species, and substantial coastal land loss due to natural forces, the alteration of hydrology, and impacts from other human activities. In addition, the Gulf Coast region has endured repeated natural catastrophes, including major hurricanes such as Katrina, Rita, Gustav, and Ike. The Gulf Coast Ecosystem Restoration Council (Council) has the responsibility to help ensure the Gulf has a strong foundation of resilient ecosystems that sustain thriving marine and coastal resources, communities, and economies. Building resilient watersheds and estuaries resulting from

restoration efforts, including such services as habitat revitalization, storm protection, pollution removal, nutrient cycling, and many aesthetic, cultural, and recreational values, as well as tourism and jobs is an economic imperative for the Gulf region. These service benefits would impact individuals, businesses, communities, and cumulatively, the Gulf ecosystem.

2:30 PM - 2:45 PM
Incorporating an Ecosystem Service Approach in NRDA
L. DiPinto;
NOAA, Silver Spring, MD

Under current NRDA practice, injuries to natural resources and losses are commonly measured in ecological terms (e.g., number of acres injured or number or biomass of fish and invertebrates killed), and restoration often follows relatively straightforward habitat and/or resource equivalency approaches (e.g., acres of habitat restored or biomass of fish/invertebrates replaced). However, these habitat- or resource-to-resource compensatory calculations and associated restoration plans can miss important ecosystem connections and linkages that are important for comprehensive injury restoration, particularly when injuries occur to multiple habitats and services. Considering these ecosystem services in damage assessment will require overcoming challenges, specifically: (1) shifting or dynamic baselines in the GoM, (2) the lack of complete or validated ecosystem models that capture the full complexity of ecosystem interactions in the GoM, (3) quantifying these ecological services in a manner that can be used to scale restoration, and (4) understanding the tradeoffs between restoration options to make the public whole.

2:45 PM - 3:00 PM
Implementing Restoration on the Gulf Coast: the State-level Perspective on an Ecosystem Services Approach
J. Lanclos;
Louisiana Coastal Restoration and Protection Authority, Baton Rouge, LA

The restoration efforts from the Deepwater Horizon Oil Spill are taking place within five Gulf States; Alabama, Florida, Louisiana, Mississippi and Texas. In addition to being members of the Restoration Council, the five Gulf States receive individual portions of the RESTORE Act Trust Funds. Each state is approaching comprehensive restoration and recovery efforts in a different manner, with different decision-making processes and criteria for project selection, including consideration of ecosystem services approaches.

3:30 PM - 3:45 PM
Breaking-Even on Ecosystem Services: The Effects of Scale on Restoration Efficiency
R. Caffey[1], H. Wang[1], D. Petrolia[2], M. Savolainen[1];
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Monetized ecosystem service values (ESV) are increasingly utilized as the justification for a wide range of environmental restoration initiatives. The use of ESV in project performance assessment; however, has been limited. Incorporated into traditional economic models, these values can be used to examine programmatic efficiency and to inform project tradeoffs - both within and between competing methods. This presentation outlines a trajectory-dependent method for examining the ESV-based return on coastal restoration project spending. Generic models are developed within a benefit-cost framework for

two major types of coastal reclamation. These models are utilized to determine the minimum ESV required to offset project costs under a wide range of comparative simulations. The resulting break-even estimates offer insight on the effects of scale-specific efficiency, and how this efficiency might change under climatological and socioeconomic risks. The approach constitutes an alternative method for evaluating the success of coastal restoration projects, and one that more fully captures the influence of scale, time and risk in the assessment of competing alternatives.

3:45 PM - 4:00 PM

Measuring Ecosystem Services and Determining Their Benefits to Communities

J. T. DeQuattro;
Gulf of Mexico Program, The Nature Conservancy, Mobile, AL

One of The Nature Conservancy's strategies is working with governmental agencies to demonstrate the value and effectiveness of restoring coastlines to re-establish ecosystem services such as shoreline stabilization and recreational opportunities while improving fish and wildlife habitat. Oyster reef restoration is an integral component of this strategy. Here we highlight two oyster restoration projects designed to deliver multiple ecosystem. The Half Moon Reef project is an underwater oyster colony in the heart of Texas' Matagorda Bay. The 54-acre project is a sub-tidal reef designed to maximize structural complexity and long-term reef stability. Early results have shown enhanced marine species diversity and colonization by oysters. Additional monitoring efforts are tracking its contribution to recreational angler opportunities both locally and regionally. The Pensacola East Bay Oyster Habitat Project in Florida will result in eight miles of oyster reef habitat. Phase I of the project is underway, which includes the design, permitting and baseline monitoring. The primary goals, which will drive its design and monitoring, are to restore oyster habitat and help prevent further shoreline erosion along natural shorelines. Analysis of monitoring data from these projects and others will ensure that lessons learned in the design and construction of these reefs will inform future restoration investments. As the scale of restoration projects increases across the Gulf, monitoring will be essential to ensuring that projects are providing benefits to coastal communities.

4:00 PM - 4:15 PM

Pay For Performance: Public Purchase of Scientifically Verifiable Restoration Results

D. Ross;
Earth Balance, North Port, FL

The concept of ecosystem services does not often factor into standards for compliance with environmental laws, or for procurement criteria for restoration contracts. This presentation discusses the notion of 'pay for performance' contracting, wherein specific ecosystem services and other attributes become the basis for contracts with private sector restoration companies.

4:15 PM - 4:30 PM

Households' Willingness-to-Pay for Coastal Habitat: An Application of a Discrete Choice Experiment to the Sarasota Bay Estuary

P. R. Hindsley[1], O. Morgan[2], C. Landry[3], J. Whitehead[2];
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In the face of difficult land use trade-offs, decision makers rely on a variety to tools to assess the benefits of coastal habitats to society. Economic valuation provides one such tool for eliciting

individuals' preferences for coastal ecosystem services. Due to its non-market characteristics, economists often rely on stated preference methods to estimate individuals' willingness-to-pay for coastal habitat. The main purpose of this study is to evaluate household preferences for the key environmental resources within the Sarasota Bay Estuary. Our objective was to design a study that quantifies resource users' and non-users' preferences for bundles of local, coastal public goods under the purview of the Sarasota Bay Estuary Program. Using multiple modes of data collection, specifically onsite and offsite interviews and an internet panel survey, we estimate individuals' willingness-to-pay for wetlands, oyster beds, sea grass beds, artificial reefs, and ecological parks with estuarine access. Because these resources are not traded in explicit markets, we employ a discrete choice experiment (DCE) to assess households' preferences for these resources.

4:30 PM - 4:45 PM

Storm Protection Benefits: A Missing Piece of the NRDA Process?

M. Imholt[1], A. Sutton-Grier[2], A. Domanski[1], E. Wellman[3]

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Storm protection is an ecosystem service provided by coastal ecosystems including wetlands, oyster & coral reefs, and dunes & beaches. The term "storm protection benefits" (SPB) describes the ability of these ecosystems to attenuate waves and storm surge through a variety of mechanisms, including friction and obstruction. Federal, State, and Tribal Natural Resource Trustees are responsible for the assessment of natural resource damages and restoration of impacted marine resources resulting from releases of oil, chemicals, and hazardous waste. Through the natural resource damage assessment (NRDA) process, Trustees assess injuries to natural resources and services and implement restoration accordingly to "make the public whole." The injury assessment process is reasonably well established and often utilizes ecological metrics to estimate the damage to the entire ecosystem. Post Hurricane Sandy there has been unprecedented attention to increasing the resilience of coastal communities to extreme events. As a result of this increased attention to coastal resilience, SPB provided by natural ecosystems are a topic of growing interest in both the scientific and policy spheres. However, SPB are not regularly incorporated into the NRDA process. This analysis adapts a Habitat Equivalency Analysis (HEA) model to examine the potential impacts of an oil spill on the storm protection benefits provided by a salt marsh to the tidal forested ecosystem behind the marsh. The model assumes some marsh loss due to oiling which leads to a loss of SPB and to further impacts on the tidal forest behind the marsh. Though HEA is traditionally used in the NRDA process, it historically has not incorporated impacts to ecosystem services that flow from the injured habitat to a secondary one. We determine that there are additional impacts of the marsh loss on the forest due to wave and salt water penetration that would not be captured by assessing injury only to habitats that are directly exposed to oiling. In our model, these impacts are fairly small, however, we assumed only average storm intensities and did not investigate the impacts on the forest of a large storm, such as a large hurricane. We also performed a sensitivity analysis to determine which factors in our model are most important for determining the degree of SPB lost.

4:45 PM - 5:00 PM

Looking beyond Ecological Functions to the Value of Ecosystem Services

D. January-Bevers, L. Harper, C. Hale, L. Roche, T. Britt
Houston Wilderness, Houston, TX

Natural landscapes and organisms serve our wellbeing in a variety of ways: water purification, flood protection, recreation, recharging of aquifers, protection from damage by hurricanes, pollution reduction, carbon sequestration and more. Identifying and understanding the services provided by local ecosystems can lead to impressive, cost-effective success in using ecosystem services to solve infrastructural and environmental issues. The Greater Houston-Galveston Bay region, which encompasses 10 distinct ecoregions, is a huge and diverse assemblage of forests, prairies, bottomlands, wetlands and bays, and receives a tremendous amount of benefits (economic and social value) from the natural world in the form of ecosystem services. Without the ecosystem services provided by these ecoregions, the Greater Houston Region would economically and environmentally suffer in trying to provide equivalent services to its residents and industries. Incorporating the value and benefits of ecosystem services into infrastructure and policy decisions in the Greater Houston Region is still evolving but a few best management practices now exist. This paper discusses ways for determining ecosystem service values using 6 different study methods depending on the goal(s) of the targeted ecosystem service study. Key case studies are provided to illustrate results from these various study methods. Local and regional Gulf area examples are discussed, including corporate use of tertiary treatment wetlands to replace gray infrastructure, increased juvenile production of fish species in wetland areas, and the role of wetlands for hurricane protection. In an expanding urban core such as the Houston-Galveston Region, there is a critical need to: (1) Provide more opportunities for regional recognition and support of the ecological functions in the ecoregions of the Greater Houston Region; (2) Engage in more region-based studies on ecosystem services to better understand the value of natural benefits and the cost-effective infrastructure policies that this understanding will enable; (3) Compare the economic value of ecosystem services to other alternative approaches when making public policy decisions regarding land-use and infrastructure; and (4) More fully incorporate ecosystem services into infrastructure decisions.

Physical and Biological Processes of Oil Droplet Dispersion, Transport, Sedimentation and Bio-degradation

1:30 PM - 2:00 PM

The Droplet Size Distribution from Blowouts: Bracketing the Possible Ranges

M. Boufadel, L. Zhao
The New Jersey Institute of Technology, Newark, NJ

The droplet size distribution (DSD) has emerged as one of the key parameters in determining the fate and transport of oil emanating from the Mississippi Canyon 252 well during the Deepwater Horizon (DWH) blowout. The decrease in the size of the droplet increases its residence in the water column and both its dissolution and biodegradation rates. One of the main challenges in predicting the DSD is the extreme conditions that could not be all replicated in the laboratory and/or numerically. These conditions include a large flow of oil and gas from a large diameter riser under high temperature and pressure. In addition, there is an ongoing debate on the effectiveness of the dispersant in reducing the DSD from the DWH. For this reason, various efforts have been pursued where some of the conditions are replicated, such as high pressure, high flow, or various oil/gas ratios.We present herein a review of the latest developments in the field that provided insights into the DSD from the DWH. These include experiments conducted from jets and reactors, and mathematical/numerical formulations calibrated to experimental data. We also dedicate time to report our latest findings of oil released from a 3-inch underwater pipe, and our latest modeling on the impact of gas and dispersant on oil droplets using laboratory data and the model VDROP-J. Special effort will be placed on addressing the effectiveness of dispersant in reducing the droplet size. We view the latest findings as providing bounds for the possible sizes of the droplets, and therefore, we aim in this talk to seek communalities between various research groups, and to make recommendations on future research needs.

2:00 PM - 2:15 PM

Particle Size Distribution in Oil and Gas Jets under Deep-sea Conditions

K. Laqua, M. Hoffmann, K. Malone, D. Krause, **M. Schlüter**
Hamburg University of Technology, Hamburg, Germany

The prediction of gas and oil distribution in deep oceans plays a major role in all regions of oil/gas exploitation. In particular the information about the fate of oil and gas after oil spills as in the Gulf of Mexico in 2010 is important for cleaning measures, in the deep, at the surface and also at the coast. To predict the distribution of hydrocarbons near- and far-field models require several input parameters. One of the most important one is the particle size distribution (PSD) of oil and gas in the rising jet/plume. In this presentation, PSD in Louisiana Sweet Crude Oil and pure methane jets in artificial seawater will be discussed with focus on pressure and temperature influence. The difficulties and differences of existing models to scale up PSD from laboratory experiments to field scale are shown and discussed on a physical basis. A comparison with a new model approach will be given. The presented laboratory experiments are done in a high pressure vessel (pmax=15 MPa) with a specific inner jet module. To measure the PSD, a specific endoscopic measuring system has been used, combined with a camera system. Further a high speed camera was placed next to the cylinder to record the expansion and formation of the jet. The pressure is varied from 0.1 to 15 MPa at temperatures from 4°C to 20°C. The results indicate that the PSD of dead oil is mainly influenced by the turbulence of the jet and less by material properties, such as density, viscosity and interfacial surface tension.

2:15 PM - 2:30 PM

Laboratory Studies and Model Results on Influence of Dispersed Oil Droplet Size on Biodegradation of Crude Oils

C. Beegle-Krause, O. Brakstad, M. Thone-Holst, R. Netzer, T. Nordtug, D. Ribicic
SINTEF MK Environmental Technology, Trondheim, Norway

Biodegradation of the surface and subsurface oil was an important topic during the Macondo oil spill. Concern lead to the formation of a Federal expert team, the "Joint Analysis Group", and an increase in experimental research regarding biodegradation of suspended oil droplets. SINTEF has developed an oil dispersion and maintenance system for conducting biodegradation studies of small droplet oil dispersions relevant for the DWH deepwater plume. This system consists of an oil dispersion generator and a slowly rotating carousel system. Several biodegradation studies have been performed in this system with oils of different properties and with cold seawater from a Norwegian fjord to simulate subsea conditions. Crude oils were premixed with dispersants and laboratory studies performed with dispersions of 10 to 30 micron droplets sizes, and with 2-3 mg/L oil concentrations. The results showed that smaller droplet degraded more quickly than the larger ones. Biotransformation rates were calculated for oil compound groups, and the rate coefficients were determined for 25 oil compound groups to be used in the oil spill model OSCAR. Analyses of microbial communities showed successions comparable to field data from DWH spill with distinctions between bacteria involved in degradation of alkanes and aromatic hydrocarbons. Next steps are to develop techniques to study biodegradation of whole oil (crude oil plus gas phases) under the GoMRI DROPPS II funding.

2:30 PM - 2:45 PM

Initial Oil Droplet Formation and Possible Subsequent Droplet Coalescence as a Function of Oil Properties and Subsea Dispersant Injection

P. J. Brandvik, E. Davis, Ø. Johansen, D. Krause, F. Leirvik
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The research described in this paper was performed in a specialised facility for studying subsurface releases of oil and gas. This facility consists of a six meter high tower basin containing 42 000 Litres of natural sea water and is located at SINTEF in Trondheim, Norway. Oil and gas were released from the base of the basin and the oil droplets are monitored by both laser scattering techniques and in-situ cameras. Shifts in oil droplet sizes towards smaller diameters were used to assess the effect of subsea dispersant injection (SSDI). To study possible coalescence after initial droplet formation a twin LISST configuration was used, with one instrument positioned 3m above the other. These experiments consisted of dispersant testing (Corexit 9500 & Finasol 52) with four different oil types (Grane, Norne, Oseberg blend and Kobbe condensate) and two different dispersant dosages (1 and 2%). Possible droplet coalescence in this comprehensive data material spanning a wide range of oil properties and droplet sizes will be presented and discussed. Both dispersant products, the four oil types and the two dispersant dosages gave no significant differences in droplet size distributions between the upper and lower LISST instruments. If coalescence was a dominant process in this early phase of the plume, a systematic shift towards larger droplets should have been observed. This study was funded by the American Petroleum Institute.

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Turbulent Crude Oil Plumes in Crossflow: Effect of Vortex Structures on Oil Residence in Plume

X. Xue, D. Murphy, K. Sampath, J. Katz
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Buoyant immiscible jets and plumes in crossflow are created by subsurface oil well blowouts in ambient currents. In this experimental study, vertical crude oil turbulent jets (2.5 m/s, Re=1100) premixed with various dispersant (Corexit 9500A) concentrations are towed in a towing tank at 0.15 m/s to simulate a crossflow. High speed visualizations examine the temporal and spatial evolution of the oil plume, and turbulent flow structures are measured using Particle Image Velocimetry. A submerged digital holographic microscopy system measures time variations in droplet size distribution (DSD). The plume shape and DSD vary substantially with dispersant concentration. Without dispersant, mm size droplets rise rapidly, widening the plume, while smaller droplets remain trapped within a counter-rotating vortex pair (CVP) that develops in the turbulent part of the flow field, similar to non-buoyant jets in cross flow. The time evolution of DSD and droplet residence within the CVP are linked to the vortex strength via a 'trapping function', which is derived from a dynamic force balance on buoyant droplets subjected to a vortex-induced pressure field. Dispersants cause a drastic reduction in droplet size and rise rate and thus increase trapping by the CVP. Hence, the oil plume width decreases, and microdroplets are also entrained into secondary vortices under the plume. Clearly, both DSD and vortex structures dominating the plume must be accounted for when modeling oil plume dynamics.

3:30 PM - 3:45 PM

Importance of Physical, Chemical, and Hydrodynamic Processes in the Near Field Plume of Oil and Gas Blowout Models

A. L. Dissanayake[1], I. Jun[1], J. Gros[2], S. A. Socolofsky[1]
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Both Integral and CFD models are available for simulating and predicting the behavior of accidental oil and gas blowout plumes. Many of the integral models in the literature do consider the physical, chemical, and hydrodynamic processes of the oil and gas (dispersed phase) such as heat and mass transfer, gas hydrate formation, and their real compressible behavior. But in some cases, such as high-resolution CFD models, these processes must be simplified or ignored in order to preserve the calculation efficiency. Here, we present integral model simulations conducted to analyze the behavior of the near-field plume in the presence and the absence of these processes. For this purpose, we simulate the behavior of the Deepwater Horizon blowout plume on 30th of May 2010 using the Texas A&M oilspill calculator (TAMOC). TAMOC is a modeling suite consisting of integral plume models to simulate oil and gas blowout plumes and their associated physical, chemical and thermodynamic processes of oil and gas. These simulations are based on a 14 pseudo-component chemistry model representative of the Macondo oil. The base case is considered to be the case where all the dispersed phase processes are considered in the simulation, and the percentage variation of performance metrics in the simplified simulations with this case is examined. Simulations predict differences in both dynamic and chemical output parameters of the model to varying degrees. Several combinations of choices of chemical processes that should be considered to gain acceptable results are presented. They are important for numerical modelers and provide them with a convenient set of options for choosing the essential chemical processes to be included in near field plume models of oil and gas blowouts.

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Large-eddy Simulation and Parameterization of Buoyant Plume Dynamics in Stratified Flow

D. Yang[1], B. Chen[2], S. A. Socolofsky[3], M. Chamecki[2], C. Meneveau[4]

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Characteristics of laboratory-scale bubble-driven buoyant plumes in a stably stratified quiescent fluid are studied using large-eddy simulation (LES). As a bubble plume entrains stratified ambient water, its net buoyancy decreases due to the increasing density difference between the entrained and ambient fluids. A large fraction of the entrained fluid eventually detrains and falls along an annular outer plume from a height of maximum rise (peel height) to a neutral buoyancy level (trap height), during which less buoyant scalars (e.g. small droplets) are trapped and dispersed horizontally forming quasi-horizontal intrusion layers. The inner/outer double plume structure and the peel/intrusion process are found to be more distinct for cases with small bubble rise velocity, while weak and unstable when the rise velocity is large. LES results are averaged to generate distributions of mean velocity and turbulent fluxes. These distributions provide data for assessing the performance of previously developed closures used in one-dimensional integral plume models. In particular, the various LES cases considered in this study yield consistent behaviour for the entrainment coefficients for various plume cases. Furthermore, a new continuous peeling model is derived based on the insights obtained from LES results. DY, BC, MC, and CM thank the support from GoMRI via a RFP-II research grant. SAS thanks the support by GoMRI via C-IMAGE and GISR.

4:00 PM - 4:15 PM

Deep Sea in a Can: Analyzing and Understanding Microbial Degradation under High Pressure

A. Liese, N. Noirungsee, S. Hackbusch, J. V. Dominguez, M. Schedler, P. Bubenheim, A. Valladares Juárez, G. Gust, R. Müller

Hamburg University of Technology, Hamburg, Germany

From the hydrocarbons released into the deep sea during the DWH accident at a depth of 1,500 m and at low temperatures, a significant part was most probably degraded by microorganisms. These reaction conditions translate to a hydrostatic pressure of 150 bar and 4°C. Additionally, amphiphiles like COREXIT were added in large amounts. Already proving that pressure is an important factor in the bacterial degradation of hydrocarbons [1,2,3], the challenges of the future lie in understanding oil biodegradation by microbial communities at high pressures as well as in establishing online analytical methods under high pressure conditions. Both topics require the development of new high pressure reactor systems and online analytics, overcoming the limitations of traditional off-line analysis [4]. Present challenges are volatile components losses during depressurization and changes in the action of microorganisms as a result of compression and decompression cycles in standard high pressure reactors. To understand oil biodegradation one key research question is whether the observed successional changes in the bacterial hydrocarbon degrading community can be reconstructed by simulating deep sea conditions in a laboratory environment. Denaturing gradient gel electrophoresis (DGGE) profiles and stable isotope probing (SIP) will give insight into crude oil degrading bacterial community structure under varying environmental conditions. At the same time aerobic methane oxidation under pressure and temperature will be investigated in order to obtain better understanding on the fate of methane discharged during the blowout.

References:

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Dispersant-Accelerated PAH Dissolution in the Deepwater Horizon Plume

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During the Deepwater Horizon blowout, unprecedented volumes of dispersant were applied both on the surface and at depth. Application at depth was intended to disperse the oil into smaller microdroplets that would increase dissolution and biodegradation and reduce the volumes buoyantly rising to the surface, thereby reducing surface exposures, recovery efforts and potential stranding. In forensically examining 5,300 offshore water samples from the Natural Resource Damage Assessment (NRDA) data set, profiles of filtered, particulate oil from the deep plume were compared with those also containing dispersant indicators to reveal a heretofore expected-but-undocumented, accelerated dissolution of PAH in the plume samples. Methods for identifying dispersant-mediated profiles are presented. We interpret these data in a fate-and-transport context and conclude that dispersant applications were functionally effective at depth.

4:30 PM - 4:45 PM

Comparison of Numerical Model Simulations to Submarine Hydrocarbon Seeps Measured at MC118 and GC600 by GISR in Northern Gulf of Mexico

I. Jun, B. Wang, K. Hutschenreuter, S. A. Socolofsky
Texas A&M University, College Station, TX

Natural gas seepage is the flow of gaseous hydrocarbons from subsurface sources to the Earth's surface. The seepage gas is composed mainly of methane and subordinately ethane, propane, and butane. Due to the rapid vertical transportation of methane in the ocean, there is a growing concern regarding the contribution of the natural gas seepage to global atmospheric greenhouse gas budget. Hence, it is important to understand the vertical oceanic transport of hydrocarbon gases escaping from the natural seepage. In this study, we compare the numerical simulation results with the field observation data for two natural gas seep sites (MC118 and GC600) in the northern Gulf of Mexico. Emissions from these two natural gas seep sites were from below the hydrate stability zone (HSZ), and both were observed by the Gulf Integrated Spill Research (GISR) consortium on the G07 cruise during July 2014. That cruise measured the ambient conditions (CTD and currents), bubble size distribution, gas composition, gas flux, the maximum rise height (flare height), and the pathways of gas seepage (flare trajectory) for each natural seep site. Using the measured boundary conditions, we simulate bubbles rising through the water column for these sites. The numerical model is developed to estimate the fate and behavior of gas bubbles released from subsea, similar to McGinnis et al. (2006). Especially, this model can handle the hydrate effects on rising bubbles within HSZ. The physical and chemical parameters of bubbles are potentially affected by the formation of clathrate hydrates on their surface, which immobilize the bubble interface. On the G07 cruise, the clathrate hydrate formation on gas bubbles below the HSZ was confirmed by the high-speed images at both sites. Based on the measurement of the height and trajectory of flares, we verify the developed numerical bubble model, and the simulation results explain the bubble behavior through the water column.

4:45 PM - 5:00 PM

Turbulence Measurements in the Northern Gulf of Mexico: Application to the Deepwater Horizon Oil Spill on Droplet Dynamics

Z. Wang, S. F. DiMarco, S. A. Socolofsky
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Several integrated observational field efforts that make simultaneous and collocated measurements of turbulence and fine-scale parameters have been conducted near the Deepwater Horizon oil spill site in the northern Gulf of Mexico (GOM) between 2013 and 2015. Full water column profiles are collected across the continental slope. The observational results suggest that strong turbulence is patchy and mostly measured in the thermocline and deepwater when using the buoyancy Reynolds number, Reb =200 criterion, the boundary between weak and strong turbulence. Bottom enhanced turbulence is often seen on the continental slope. Using the ratio of the turbulent velocity scale and the oil droplets rising velocity, we develop criteria for when turbulence will dominate the movement of oil droplets and when turbulence can be ignored. Based on the data collected, for oil droplets with rising velocity greater than 6×10^(-3) m s^(-1), the turbulence effect can be ignored on the continental slope of the northern GOM. For oil droplets with rising speed less than 10^(-4) m s^(-1), their motions will be affected by the turbulent flow at all depths. For oil droplets with rising speed between 10^(-4) and 6×10^(-3) m s^(-1), the role of turbulence will depend on the strength of the local turbulence and water stratification. We also relate turbulent velocity to the size and density of oil droplets by estimating the rising velocity of different size oil droplets due to balance between buoyancy and drag force. Droplet size and density difference are the two critical parameters in determining the role of turbulence. The results of the present study imply that the microstructure measurements combined with fine scale measurements throughout the water column can be used to study the role of turbulence in the movement and diffusion of contaminant constituents, such as oil/gas droplets during an oil spill event. The study presented here provides a first look at the turbulence field in the northern Gulf of Mexico.

A Tale of Two (Mega) Spills: Comparison of DWH and IXTOC-1 Scenarios, Fates and Effects I

1:30 PM - 2:00 PM

Ixtoc 1 vs Deepwater Horizon: A Different Day, a Different Time, but with Similarities

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As a young professor just starting my career at Texas A&M University-Corpus Christi I was horrified by the images of the Ixtoc 1 blowout, burning platform, and growing oil spill. It threatened my beloved Veracruz coral reefs where I had done my PhD dissertation research, and it also threatened to reach Padre Island where I regularly took my marine science classes. Oil did reach both places, and although some research was done in both places, little is available to inform us about the Deepwater Horizon (DWH) spill, since funding dried up and no long-term studies were done. Even though there are many similarities between these two spills, as well as some significant differences, the difference in the number of publications resulting from these two spills is astounding (less than 50 for Ixtoc and about 100 per year for DWH, which will probably continue at that rate for another five years, thanks to GoMRI). Resilience of some species and habitats has been noted in both spills, but visits to 30-35 year old Ixtoc shoreline sites reveals residual tar mats in some places, particularly low energy environments like mangroves. Original photographs from 1979 and 1980 of the Ixtoc spill in Texas and Mexico will be shown, primarily focusing on Texas barrier island beaches and a Veracruz coral reef island and lagoon.

2:00 PM - 2:15 PM

An Overview of Aspects of U.S. Funded Research Conducted During and After the Ixtoc -1 Blowout

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With the GOMRI-funded "return to Ixtoc" research now underway it is useful to understand and build on the published and unpublished work conducted on that spill between 1979 and 1981. Three specific activities that resulted in highly relevant information were: the NOAA-funded "Researcher/Pierce" offshore Surveys in 1979; NOAA/HAZMAT's science work related to the response along the Texas Coast; and the Bureau of Land Management's Natural Resource Damage Assessment Study (1980-1982) along the Texas Outer Continental Shelf. In this presentation we will present some of the chemical fate, weathering, water column exposure, and transport related research findings stemming from the offshore surveys as well as results from the first NRDA study conducted on an oil spill, and discuss the applicability and parallels with findings from the Deepwater Horizon incident.

2:15 PM - 2:30 PM

Near-wellhead Observations and Water-column Measurements of Dissolved and Particulate Hydrocarbons during the IXTOC I and Deepwater Horizon Blowouts

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Significant dissolution of lower-molecular-weight aromatics (benzenes and naphthalenes) occurred with both the 1979 IXTOC I and 2010 Deepwater Horizon (DWH) blowouts. During IXTOC, there was nearly complete partitioning of benzene into the water-column despite the shallow (60 m) release depth, and only limited evaporative loss was measured in air samples taken 1 m above the water surface. Other less

soluble hydrocarbons (C3-C10 aliphatics, toluene, xylenes, and C3-benzenes) were less effectively stripped from the rising oil droplets, and surface evaporative losses were quantified. During the DWH event, only limited air sampling immediately above the oil or water surface was completed, and again, benzene was only detected at low concentrations versus the other volatiles in one of two samples while the dissolved-phase BTEX profiles in near-surface waters were generally less than those measured during IXTOC. With both spills, two- and three-ring polycyclic aromatic hydrocarbons (PAH) in both dissolved and particulate-oil phases showed classic water-leaching with parent and lower-alkylated homologues being preferentially removed from the rising droplets. The deeper release of DWH oil at 1,500 m (plus the use of dispersants injected at the wellhead) created a deepwater plume (900-1,400 m) where dissolved and particulate oil were tracked for several hundred km to the southwest. During the IXTOC investigations, which were completed just days after the passage of Hurricane Henri to the north of the wellhead, subsurface distributions were generally found at depths between 10-20 m and only 20-45 km to the northeast. In addition to high concentrations of hurricane-induced resuspended sediments scavenging the oil, there was evidence that oceanic frontal systems also acted as barriers to subsurface transport of IXTOC oil. Both oils formed stable water-in-oil emulsions after evaporative and photo-oxidation weathering. Stranded oil residues contaminated over 1,300 miles of coastline from DWH while best estimates from 1980 surveys following IXTOC suggest impacts along 700-900 miles of shoreline in Mexico and approximately 160 miles of south-Texas beaches. Between 1979 and 2010, improvements in analytical methods and detection limits reduced required water-sample volumes from 90 L during IXTOC to 1-3 L during DWH.

2:30 PM - 2:45 PM

Surface Oil Footprint and Trajectory of the Ixtoc-I Oil Spill Determined from Landsat/MSS and CZCS Observations

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The Ixtoc-I oil spill occurred in 1979 in the Bay of Campeche, Mexico, and it is the second largest accidental marine oil spill in history, following the Deepwater Horizon (DWH) oil spill in 2010. In contrast to the DWH spill, where the wellhead was located on the ocean floor about 1500 m deep, the Ixtoc wellhead was in shallow water (50 m deep), where the released oil reached the surface rapidly. However, to date there has been no attempt to document the surface footprint of this large spill, not to mention tracing its surface transport trajectory. Our study attempts to fill this knowledge gap in order to determine where to conduct field measurements to sample the sediments for residues. Specifically, remote sensing data collected by Landsat/MSS and the Coastal Zone Color Scanner (CZCS) were used to derive the surface oil footprint and trajectory during and after the Ixtoc spill. Spatial and spectral contrasts were examined to delineate oil slicks, with oil look-alikes, such as floating algae and internal waves, ruled out. A total of 197 Landsat images and 267 CZCS images from June 1979 to March 1980 were examined, and both showed oil trajectory nearly parallel to the coastline of the western Gulf of Mexico (GoM) with possible oil landing on Mexican and Texas beaches. Field observations at selected beaches and islands along the coast of the western and southern GoM during and after the spill confirmed these satellite-based findings, which were also used to help planning a recent field campaign to collect sediment samples in the southern GoM.

2:45 PM - 3:00 PM

Characterization and Partitioning of Organic Compounds in the Water Phase of Two Submarine Oil Spill Scenarios: DWH vs. IXTOC-1

A. Jaggi, R. W. Snowdon, J. R. Radović, M. Brown, S. R. Larter, T. B. P. Oldenburg
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Oil compounds, such as hydrocarbons and other heteroatom species, partition into the water phase following petroleum spillage, depending on the pressure, temperature and composition of the oil and water. This is particularly important for submarine blowouts, e.g. Ixtoc-1 and Deepwater Horizon, where the partitioning of large quantities of released oil was influenced by a wide range of pressure and temperature gradients, due to the fact the first one was a shallow spill at 56m whilst the other a deep-water blowout at 1500m. In an attempt to compare the partitioning behavior of the crude oil compounds during such sub-marine spill events, a unique, customized oil-water partitioning device was developed to allow us to experimentally determine the partitioning behavior of water soluble oil components from live oils (methane-charged) with saline waters over a range of pressure (2 - 15 MPa) and temperature (4 - 30°C). GC-MS was used to elucidate the partitioning of the organic species, including BTEX and C0-C3 alkylated phenols, from petroleum into the water phase. In addition, we characterized the molecular structure of dissolved organic matter in the northern and southern Gulf of Mexico waters using FTICR-MS, and discuss its composition in the context of surface-to-sediment fate of oil during submarine spills.

3:30 PM - 3:45 PM

Recent Sedimentation in the Southern Gulf of Mexico

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Sedimentary records are useful tools to reconstruct environmental changes in the Oceans. In order to study the recent sedimentation processes in a large region of the Southern Gulf of Mexico, we collected 23 box-cores from depths ranging from 249 to 1785 m. Cores were analyzed for 210Pb, through 210Po in secular equilibrium, by using high-resolution alpha spectrometry and recent mean sediment (SAR) and mass (MAR) accumulation rates were determined by using the Constant Flux Constant Sedimentation (CFCS) 210Pb dating model. Accumulation rates showed a 5-6 fold variation range: SARs ranged from 0.48 to 2.61 (mean 1.0 ± 0.5) mm yr-1, and MARs ranged from 0.026 to 0.164 (mean 0.07 ± 0.03) g cm-2 yr-1. Based on geographical, geochemical and sedimentological parameters, the study region was sub-divided into 8 zones. The highest SARs were observed in a submarine delta (zone IA: 1.49 ± 0.01 mm yr-1), the closest area to the Coatzacoalcos river (zone VI: 1.45±0.08 mm yr-1), and the lowest in a plateau in the salt domes province (zone VII: 0.54 ± 0.09 mm yr-1). The geomorphological complexity of the region prevents a statistically significant correlation of SARs with depth. However, high SARs and 210Pb fluxes could be observed in deep stations, located in the distal part of the western slope.

3:45 PM - 4:00 PM

Spatial and Temporal Variability of 234Th Inventories and Mass Accumulation Rates over the 5 Years following the DwH Event

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Following the 2010 DWH event, a depositional pulse was recorded in the Desoto Canyon region of the NE Gulf of Mexico (GoM). Excess 234Th age dating (~4-5 month time period) was utilized on time-series cores collected between 2010 and 2014 to investigate the sedimentation pulse, and compare to subsequent years on a monthly time-scale. Time-series data show: 1) a well-defined, short-lived, depositional pulse recorded as elevated excess 234Th inventories and mass accumulation rates (MAR) in cores collected between Nov. 2010 and Feb. 2011, 2) a rapid decrease in excess 234Th inventories in 2011, followed by general stability over the following 3 years, which is likely indicative of "natural" sedimentation patterns and variability on this time-scale, 3) increases in MAR, with little to no change in inventory, at some sites during 2013/2014 likely due to the reestablishment of bioturbation that mixed excess 234Th downcore. Consequently, excess 234Th inventories and MAR can be useful, but must be used in conjunction to determine if data represent deposition, and/or bioturbation/mixing. Continuation of the time series will further establish the natural system variability, as well as recovery of the benthic system. Pulse and post pulse excess 234Th data will be compared to cores collected in 2015 near the 1978/1979 IXTOC spill site in the southern GoM, to determine GoM spatial variability, as well as similarities/differences in sedimentation processes.

4:00 PM - 4:15 PM

Source and Distribution of Polycyclic Aromatic Hydrocarbons in the IXTOC I Spill Area

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Recent systematic studies have been conducted in the IXTOC I area to register Polycyclic Aromatic Hydrocarbons concentration in river discharge, surface and bottom coastal-offshore water column, and in three sediment layers (0-5, 5-10 and 10-20 cm depth) from coastal to oceanic area (0-3900m). PAH discharged by river runoff was estimated between 2.1535x10-08-0.1014-2. tons / day. Highest PAH discharge was in Boca del Carmen inlet, Laguna de Términos with 0.1014 Tons/day. Surface (0.0001-0.3027µg/L) and bottom water (0.0002-.0286µg/L) concentration showed a general decreasing pattern from coast to offshore. However, some stations located around natural seeps registered high values both in surface and bottom water (0.0060 and 0.0286 µg/L, respectively). Sediment PAH higher levels were found in the IXTOC oil blowout zone with a maximum (943.63 µg/kg). PAH values in the three different layers show a decreasing general pattern from deeper (10-20 cm) layer corresponding to IXTOC I blowout, to recent upper sediment layer 0-5 cm, although in some locations are the contrary. The sediment PAH values also show a spatial decreasing pattern from IXTOC area to the north-west matching with the prevalent current pattern. Some recent high spots were found in certain areas affected by river discharge and recent oil activities. PAH contents in the water column and sediment show that they have multiple sources: river runoff, natural seeps, IXTOC I blowout and recent oil activities.

4:15 PM - 4:30 PM

Evidence for Sea Floor Oil Sedimentation Associated with the Ixtoc Oil Spill

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We have examined a series of cores collected in the vicinity of the Ixtoc Oil Spill which occurred in 1979 in the Southern Gulf of Mexico. Our objective is to test the hypothesis that a Marine Oil Snow Sedimentation and Flocculent Accumulation (MOSSFA) event, similar to that recorded after the Deepwater Horizon (DWH, 2010) event, occurred in association with the second largest oil spill (140 million gallons) and longest duration spill--10 months-- for an uncontrolled petroleum discharge in the Gulf. MOSSFA events transfer petrocarbon from the water column to the seafloor. In contrast to the DWH (1500 m), the Ixtoc spill was in shallow water (50 m). To test our hypothesis we used natural abundance radiocarbon and stable carbon isotopes as a marker for petrocarbon residue. The surface sediments in the vicinity of the Ixtoc spill varied from Δ14C values of -94 to -258 ‰ while surface sediment δ13C varied from -20.7 to -21.3 ‰. We observed a layer at 9-10 cm from a site sampled approximately 150 nm to the west of the Ixtoc wellhead at a depth of 1263 m with a Δ14C value of -789.5 and a δ13C value of -26.6‰. The DWH oil had a δ13C value of -27‰ whereas its Δ14C value was -1000 ‰. Our observations are consistent with the hypothesis that oil-sedimentation occurred in conjunction with the Ixtoc spill. The most depleted sediment layer Δ14C value observed in association with the DWH oil spill was -500 ‰ with a δ13C value of -23‰. As in the case for the DWH spill, the apparent layer of petrocarbon-containing sediment found in the Ixtoc spill was no more than 1 cm thick. These analyses will be complimented with additional sediment data collected from the Southern Gulf of Mexico, and with ramped pyrolysis Δ14C measurements and solvent extraction of the organic material.

4:30 PM - 4:45 PM

Geochemical Characterization and Accumulation Rates in Sediment Cores Influenced by the IXTOC Oil Spill in the Southern Gulf of Mexico

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On early June 1979, the blow out of the PEMEX exploratory well Ixtoc-1 in the Bay of Campeche (Mexico) produced a major oil spill, which caused 10 months of surface oil dispersion that resulted in serious fires and water pollution along extensive coastal zones of the Gulf of Mexico. In this work, we present preliminary results of ongoing research to evaluate potential geochemical traces of this major environmental event. Thirty six years after the Ixtoc-1 oil spill, three sediment cores were recently collected in the Southern Gulf of Mexico during the C-IMAGE 2015 oceanographic expedition. Short-lived radionuclides (210Pb and 137Cs) were used to determine sediment accumulation rates and the chronology of the sediment cores (up to 100 years). The magnetic susceptibility signal was useful to identify the sediment layers affected by the event; whereas the textural composition and the concentration of indicator elements commonly used to assess terrigenous inputs (Ti/Al, Si/Al, Zr/Al, K/(Fe + Mg) and redox conditions (Fe, Mn, Mo, Re) were also studied to understand the influence of such factors on the distribution and concentration levels of metal pollutants associated to the oil spill, such as Cd, Cu, Ni, V and Pb.

4:45 PM - 5:00 PM

Comparison of Sedimentary Redox Conditions following Two Major Marine Blowouts: Deepwater Horizon and Ixtoc-1

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Following the Deepwater Horizon blowout event, sediment cores reveal a region wide organic rich sedimentation pulse, which resulted in changes to sedimentary redox conditions. Microbial respiration of carbon rich marine snow deposited to sediments resulted in decreased pore-water oxygen concentrations and a shoaled redoxcline, which produced two distinct solid Mn oxide peaks and an enrichment of solid Re consistent with reducing sediments. The Re enrichment increased 3-4 times for the first two years, then decreased, suggesting a return to pre-impact conditions. The other major sub-marine blowout in the southern Gulf of Mexico (IXTOC-1 event; 1979-80) also released a large volume of crude oil below the water surface. Visual descriptions of sediment cores revealed multiple redox boundaries similar to those observed after the DWH event. They are typically 3-8 cm deep, and best preserved in deeper sediments beyond the continental shelf break. Down core profiles of redox sensitive metals, including Mn, Re, and Cd will be presented at four priority sites to more fully constrain the record of changing redox conditions after this event. Preliminary trace metal results from the SGoM indicate that redox changes are preserved in the sedimentary record, decades after the event. In situ oxygen profiles of dissolved oxygen are used to characterize the present day redoxcline. The temporal evolution of reducing conditions in both regions will be compared to assess similarities and differences as the two systems return to pre-event conditions.

Sustainable Coasts and Human Impacts on Marsh Food Webs in the Gulf of Mexico I

1:30 PM - 2:00 PM

The 'Dead Zone' is a Lesson in Complexities and What Should Be Done

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The Deepwater Horizon oil spill drew the world's attention, not only to the immense nature of the discharge of Macondo oil and added dispersants, but also to continuing problems including petroleum contaminants and activities, coastal erosion and landscape change, and the low oxygen zones in broad areas of the Gulf. Each of these challenges presents its own complexities with regard to restoration when viewed from an ecosystem perspective. Combined, the complexity increases by more than three orders of magnitude. The upstream activities of humans in the Mississippi River watershed and others are key factors to address in any restoration attempts. What happens in the watershed does not stay in the watershed. There was worry that the oil spill would worsen the perennial, annual area of hypoxia on the northern Gulf continental shelf. There were oxygen anomalies (negative) at approximately 1200 m, and the oxygen minimum layer was always present at 400-800 m; but, the oxygen levels in neither of these areas declined to the 2 milligrams/liter concentration that defines continental shelf hypoxia. A multivariate analyses of the 2010 dissolved oxygen concentration and ancillary data indicates that 2010 was well within the boundaries of what influences hypoxia physics and an overload of primarily nitrate-N. Restoration must address the multiple physical, biological, landscape and social processes at play, in the context of other long-term restoration needs.

2:00 PM - 2:30 PM

Diversified Cropping Practices in the U.S. Corn Belt for Water Quality Protection in the Gulf of Mexico

M. Liebman

Iowa State University, Ames, IA

The development of modern, industrial agriculture has been characterized by large reductions in biological diversity, both across landscapes and within farming systems. Loss of biodiversity is particularly evident in the U.S. Corn Belt. Simplification of crop and non-crop vegetation in the Corn Belt has resulted in huge amounts of crop and livestock products, but has also led to wide-scale degradation of water quality through nutrient, pesticide, and sediment emissions. Two of the most striking examples of these water quality impacts are the legal suit filed in 2015 by the Des Moines Water Works against upstream agricultural drainage districts and the hypoxic zone in the Gulf of Mexico. We review data from two field experiments in Iowa addressing the impacts of cropping system diversification on agroecosystem performance, including water quality. Results indicate that (1) conversion of small amounts of cropland to strips of reconstructed prairie can provide disproportionately large improvements in soil conservation and nutrient retention; and (2) diversification of the dominant corn-soybean rotation with small grain and forage crops can lead to substantial reductions in agrichemical use and lower nitrogen and phosphorus concentrations in soil drainage water, without compromising yields or profitability. These patterns suggest that increasing biodiversity can be a viable strategy for improving agroecosystem health in the U.S. Corn Belt and water quality in the Gulf of Mexico.

2:30 PM - 3:00 PM

Developing High-efficiency Agricultural Systems: A Forever Green Agricultural Initiative

D. Wyse

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Throughout the Midwest, large portions of the agricultural landscape do not have a living cover from the time of soybean and corn harvest in late summer and fall until these crops establish a canopy cover in late June the following year. This lack of plant cover leaves the soil vulnerable to soil erosion and to the loss of nutrients. Soil erosion results in sediment loading of rivers, lakes and wetlands, and the loss of nitrate-N through surface flow and leaching into surface waters, which reduces fresh water quality and contributes to the development of the "Dead Zone." By selectively adding winter-annual and perennial crops to the Midwestern agricultural landscape it may be possible to enhance yields of existing summer-annual cropping systems, enable production of new commodities, enhance soils and wildlife, and improve water resources. All of these benefits are possible because perennial and winter-annual crops are active during a large portion of each year, including many periods in fall, winter and spring when summer crops are absent. To realize the great potential of these systems, two kinds of research and development are critically needed: 1) genetic improvement of plant materials, and 2) the development of new enterprises based on these systems. To accomplish these goals the University of Minnesota has initiated the Forever Green Initiative to rapidly domesticate both new winter annual and perennial crops that will enable the development of high-efficiency cropping systems. These plant materials include winter-annual crops, and perennial woody and herbaceous species. To enhance the program breeding programs and associated agronomic research and extension programs have been expanded and intensified. To make use of these new plant materials, it will be necessary to develop markets for the oils, bioactive compounds, and food products developed from these new crops. These opportunities can produce new prosperity for farmers, landowners, and rural communities, but many barriers stand in the way. To overcome these, new 'incubators' are needed that focus on commercializing high-efficiency production systems based on these new materials, by linking effort and investments from private enterprise, government, NGOs and research institutions.

3:30 PM - 4:00 PM

Climate and Sea Level Rise (SLR) - the Nuts and Bolts of an Inescapable Coastal Driver

J. Chanton[1], G. Mitchum[2], S. Locker[3], H. Parker[4], R. Turner[5]

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Coastlines are dynamic features that may build out, recede, or remain stable depending on the balance between sea level, sediment supply, isostacy and processes that effect peat stability in marsh coastlines. Drivers of global sea level are the changes in the quantity of terrestrial ice and the thermal expansion of seawater. On a local scale sea level is also affected by isostacy associated with ice volume and reduction in sediment supply. The rate of global SLR in the 20th century was on the order of 2 mm/year, or 8 inches per century. In Florida, the rates are similar to the global rate because Florida is a stable platform. The 20th century rates are 3 to 5 times greater, 6.7 to 9.5 mm/year in Galveston, Tx, and Grand Isle, La, due to subsidence. Global rates in the early 21st century have increased by 50%, to 3 mm/year or 12 inches per century. In Florida, 50% of the beaches are classified as critical erosion areas and an additional 11% as erosion areas. These beaches are maintained by "re-nourishment", pumping offshore sand upon them, and armoring. These efforts yield but a few years for soft beaches or a decade or more for hardened shores. So far, the economics of cost versus revenue return (tourism or real estate) have been acceptable. However, in the face of increasing rates of SLR, the economics of restoration begs

serious reconsideration with an eye toward future sustainability of coastal systems. In addition, locating offshore sand for re-nourishment projects is increasingly difficult, especially on the Atlantic Coast. St. Vincent Island, a case study in the panhandle of Florida, was until recently building up and prograding into the Gulf, but is now experiencing severe erosion, likely due to the impoundment of sediment behind multiple dams upstream of the Apalachicola River, combined with rising sea level. On marsh coasts, recent work indicates that the decomposition of wetlands soils is enhanced by nutrient additions which will increase marsh fragmentation. These drivers are important to consider in planning coastal restoration, and the community needs to distinguish between short- and long-term solutions, and to clearly define the time scales of these solutions.

4:00 PM - 4:30 PM

Goodbye Miami: Sea Level Rise, Drowning Habitats, and the Inevitably Soggy Future of the Coastal Gulf of Mexico

J. B. C. Jackson
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Sea level will rise by 1 m by 2100 while much of the Gulf Coast is subsiding at comparable to faster rates; a combination that increases almost exponentially the potential damage to life, property, and coastal ecosystems from storm surge. Miami and New Orleans are the 1st and 12th most exposed cities worldwide to just 0.5 m of sealevel rise. Miami's vulnerability is staggering, with an average elevation <1 m, $3.5 trillion in exposed assets, and >5 million exposed population. The numbers soar to >$10 trillion and 10 million exposed population including the Florida Gulf Coast. Miami will be destroyed by the next direct hit of a sustained category 5 hurricane and there isn't enough insurance money in the world to rebuild. What does this mean for the environment and environmental restoration? The southern third of Florida will be at or below sea level by 2100. Florida Bay will extend north into the Everglades, which will in turn migrate northward into Lake Okeechobee. So what are the goals of "restoring" the Everglades without preparing for the migration of all ecosystems north? The same logic extends to the coast of Louisiana, which will move north to Baton Rouge by the end of the century. Restoration might slow this advance by filling in gas and oil channels in the marshes and protecting natural barriers, but the shoreline will inexorably retreat. Restoration efforts need to incorporate these stark realities for any meaningful effect.

4:30 PM - 5:00 PM

#OceanOptimism: Why Even Small-Scale Examples of Success in Ocean Conservation and Restoration Matter

N. Knowlton
Smithsonian, Washington, DC

Every day brings news of another ocean disaster - collapsing fisheries, plastic pollution and eroding coasts are just a few recent examples in the tide of bad news. Yet if you look beyond the doom and gloom, there are genuine examples of success in saving species, protecting spaces, harvesting wisely, reducing pollution and restoring habitats. The brown pelican is with us today in part because we banned DDT, oysters are beginning to return to the Chesapeake, shark numbers are up where they have been protected, and local management strategies have brought sustainable incomes to artisanal fishers around the world. The news about climate can seem overwhelming, but it is important to remember that most of the damage to the ocean we have caused to date is from overfishing, pollution and habitat destruction, all things we know how to address. Thus local successes buy valuable time while we tackle the harder problem of weaning ourselves off a carbon-based economy, and even here successes are

starting to emerge. Yes, there is still much, much work to do, but to paraphrase Bill Gates, we often overestimate the amount of change that will take place in two years, but underestimate how much will occur in ten.

One Health: Unraveling the Interconnectedness between Human and Ecosystem Health through the Lens of Oil Spills I

1:30 PM - 2:00 PM

Genotoxic Effects Related to Participation in *Prestige* Oil Clean-up: Immediate and Follow-up

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In November 2002 the oil tanker *Prestige* broke into two and sank in the Atlantic Ocean 130 miles off the north-western coast of Spain (Galicia), releasing about 63,000 tonnes of heavy oil No. 6. More than 1,000 km of coastline were affected, from the northern coast of Portugal and Spain to Brittany and the southern coast of the United Kingdom, including protected areas of great ecological and economic value. A general concern led to a huge mobilization of human resources, and more than 300,000 people participated in clean-up activities, which lasted up to ten months. Until *Prestige* accident, few studies were published on the human health effects related to exposure to oil spills, most of them focused on acute health and psychological effects. However, no data were available on genotoxicity, which is a relevant outcome since several chemicals contained in the oil have mutagenic and carcinogenic properties. An initial study was carried out in early 2003 in volunteers and workers to evaluate possible genotoxic effects associated with the exposure to *Prestige* oil. Results obtained showed significant increases in genotoxicity biomarkers with regard to a control population, especially in individuals exposed for several months, and no protection offered by the use of protective mask or clothes. On this basis, a follow-up study was performed in order to determine if the genotoxic risk in *Prestige* oil exposed individuals was still significantly increased seven years after the exposure. Data obtained in this new evaluation showed no significant increase in any of the parameters evaluated in the exposed population with regard to the controls. Moreover, using protective devices during the clean-up labours or the time of exposure to the oil did not influence the genotoxicity results. In conclusion, although exposure to *Prestige* oil induced rise in the genotoxicity parameters, suggesting an increased risk of DNA damage related diseases, e.g. cancer, seven years later the risk seemed to return to basal levels. Research funded by *Xunta de Galicia* (GPC2013/058).

2:00 PM - 2:15 PM

Oil Spill Clean-up Exposures and Incident Hypertension in the GuLF STUDY

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Background: Workers who cleaned up after the Deepwater Horizon oil spill were potentially exposed to volatile organic compounds and other toxicants in crude and weathered oil. These chemicals can have negative effects on human health, but little is known about their association with hypertension.
Methods: We explored the association between oil spill exposures and hypertension using data from the GuLF STUDY, a longitudinal study of oil spill clean-up workers and non-workers. We included 8,541 participants ≥ age 21 who completed a study home visit and had not been previously diagnosed with hypertension. Demographic factors, job exposures, lifestyle, education and health information were collected via telephone interviews. We developed a semi-quantitative estimate of total hydrocarbon exposure (THC) as a marker of oil exposures. Based on the maximum exposure across all jobs, participants were classified as having exposure at levels 1 (<0.3 ppm), 2 (0.3-0.99 ppm), 3 (1.0 - 2.99 ppm), or 4 (≥ 3.0 ppm). Systolic (SBP) and diastolic blood pressure (DBP) were measured at the home visit, 1-3 years after the oil spill. Hypertension was defined as having one or more of: physician diagnosis

of hypertension; antihypertensive medication use; or measured SBP ≥140 mmHg and/or DBP ≥90 mmHg. Associations between THC levels and blood pressure were analyzed using multiple linear regression adjusting for age, gender, body mass index, race, education, and smoking after excluding participants taking antihypertensive medications. Logistic regression was used to estimate adjusted odds ratios (OR) for incident hypertension. **Results**: Both systolic and diastolic blood pressure were non-significantly higher for THC exposure levels 2-4 compared with level 1, but there was not a monotonic trend with increasing exposure levels. The odds of developing hypertension increased with increasing level of exposure with significant increases in hypertension for the two highest exposure categories (OR1.17, 95% CI 1.00-1.36 at level 3 and OR 1.26, 95% CI 1.03-1.53 at level 4). **Conclusions**: Our results suggest that elevated blood pressure and incident hypertension 1-3 years after the oil spill may be related to oil spill exposures.

2:15 PM - 2:30 PM

The Effect of Mobile Health Technology-enabled Community Health Workers on Disaster Readiness and Resilience in Low-income, First-time Pregnant Women

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Tulane University School of Public Health and Tropical Medicine, New Orleans, LA

The Transdisciplinary Research Consortium for Gulf Resilience on Women's Health conducted a community-based participatory research project to assess pregnancy experience and resilience in low-income, first-time pregnant women living in disaster prone parishes of Southeastern Louisiana (SE LA). Mobile health technology-enabled Community Health Workers recruited women in their first trimester and followed them through six months postpartum. Community Health Workers provided social support and facilitated psychosocial survey data collection, including Connor Davidson Resilience Scale (CD-RISC). All participants received disaster preparedness messages through the mobile health technology portal and a subset were given a binder with similar information. Participants (N=141) were predominately African American (69%), less than 25 years of age (65%), never married (53%) and enrolled in Medicaid (60%). Resiliency (CD-RISC) increased significantly from first trimester to six weeks postpartum (p=0.015). Women who received messages and a binder had significantly increased CD-RISC score when compared to women who did not receive a binder (p=0.006). Moreover, about 63% of participants reported creating or modifying a preparedness plan as a result of participation. Findings suggest that disseminating disaster preparedness information may have a positive effect on the resilience, self-efficacy and disaster readiness of young, low-income mothers living in disaster prone parishes of SE LA.

2:30 PM - 2:45 PM

Method Development to Assess Cardiovascular and Blood Hemostasis Effects of Oral and Dermal Oil Toxicity Testing in Double-Crested Cormorant (*Phalacrocorax auritus*)

K. Harr[1], T. Rupp[1], J. Link[2], F. Cunningham[3], K. Dean[4], D. Cacela[4], A. McFadden[4], B. Dorr[3], K. Hanson-Dorr[3], K. Horak[5], K. Healy[6], P. Tuttle[6], S. Bursian[2]
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At necropsy, double-crested cormorants (DCCO) orally dosed with artificially weathered Deepwater Horizon oil showed signs of cardiopathy and extended clotting time. Methods for assessment of pathophysiologic endpoints and functional imaging of DCCO hearts were developed. Techniques modified for avian species included echocardiography, activated clotting time, and troponin I analyses,

in addition to previously developed light and electron microscopic evaluation of anemia. Activated clotting time of externally oiled cormorants was significantly increased over control cormorants, indicating coagulopathy and possible external hemorrhage due to lack of clotting hemostasis. Further, opportunistic fecal cytology comparing treated versus control birds documented hematochezia in treated birds only. Echocardiography revealed a significantly increased left ventricular chamber size and therefore decreased myocardial contractility both between treated and control birds and treated birds before and after oil exposure. Echocardiography also revealed significant cardiac arrhythmia, including probable ventricular tachycardia, in treated birds only, which could ultimately result in mortality. Troponin analyses revealed a significantly increased plasma concentration in treated birds compared to their pretreatment values. Evidence of damage to the cardiovascular system by exposure to MC252 oil was supported by techniques developed during this scoping study. In this scoping study we developed valuable tools that can be used in birds to assess cardiovascular and clotting pathology resulting from oil exposure and intoxication.

2:45 PM - 3:00 PM

Obesogenic Activity of Oil Dispersant Corexit 9500 in the American Alligator

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An estimated 2.1 million gallons of oil dispersant was released into the Gulf of Mexico in response to the 2010 Deepwater Horizon oil spill. A major dispersant used, Corexit 9500, has dioctyl sodium sulfosuccinate (DOSS) as a main component, which has been shown to have obesogenic activities in mammals. However, the obesogenic effect of Corexit 9500 components on non-mammalian species has not been clarified. In this study, obesogenic activity was defined as activation of peroxisome proliferator-activated receptor-γ (PPARγ) and/or retinoid X receptor-α (RXRα). This study examined *Alligator mississippiensis* to better understand the obesogenic activities of Corexit 9500 and the mechanism by which non-mammalian obesity occurs. Using nuclear hormone receptor Luciferase reporter assays with alligator PPARγ-RXRα and their response element (PPRE or RXRE), activities of Corexit, DOSS, and Corexit water accommodated fractions of oil (CWAF) were compared to the known obesogen, rosiglitazone (ROSI). Exposure to CWAF at 1:200 dilution significantly induced higher transactivation on PPRE (equivalent to 1.7 × 10-7 M ROSI) than the control ($P<.05$). However, transactivation on RXRE by CWAF was not significant ($P>.05$). No significant transactivation was observed in the assay with DOSS or Corexit on either RXRE or PPRE ($P>.05$). These findings suggest that a previously unidentified component(s) of crude oil in CWAF (not Corexit or DOSS) has the potential to be an obesogen in the American alligator and reveal both similarities and distinct differences compared to mammals worthy of further investigation. Using the alligator sentinel, we have shown that we can further leverage obesogen detection capacity through comparative biological approaches.

3:30 PM - 3:45 PM

Improving Disaster Research to Better Understand Oil Spills and Human Health

A. K. Miller[1], A. L. Bennett[2], S. Garatziotis[3], **J. Hughes**[3], S. Arnesen[4], K. Yeskey[5], B. Galluzzo[5], R. Kwok[3], L. O'Fallon[3], C. Thompson[3], S. Masten[3], J. Remington[3], L. Reinlib[3], C. Love[4]

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Oil Spills, hazardous waste releases and other environmental disasters routinely impact public health, yet researchers and studies often arrive too late to collect valuable data that will help us to better understand the environment health impacts and the efficacy of our responses to such events. To address this important research gap, the National Institutes of Health (NIH) has developed a new Disaster Research Response Program (DR2). The DR2 Program aims to develop a system of needed products, processes, and relationships to encourage rapid 'bench to trench' transdisciplinary research to better understand the human health effects of oil spills and other environmental disasters. In the 18 months since DR2 began NIH has launched a new website providing over 165 tools to support data collection, developed a new Institutional Review Board pre-approved protocol, created a new national environmental health network, and held national workshops, conferences, and training exercises bringing together federal researchers, academia, public health, and communities. Additionally, new NIH efforts spawned as part of this program have been used to support the WV Elk River Spill and the recent Ebola Response. This presentation will discuss this rapidly evolving Program designed to facilitate our collective research capacity, as well as the ongoing integration and promotion of community participation as a cornerstone of improved resilience.

3:45 PM - 4:00 PM

The Gulf Oil Spill and Multiple Disaster Exposures: Cumulative Risk, Sensitization, or Habituation?

E. Harville[1], A. Shankar[1], **L. Zilversmit**[1], C. Dunkel Schetter[2]

[1]Tulane University, New Orleans, LA, [2]University of California-Los Angeles, Los Angeles, CA

Background: The Gulf coast has been exposed to multiple disasters over the last ten years, including hurricanes, flooding, and the 2010 oil spill. Exposure to multiple traumas could produce cumulative effects on mental health, could sensitize people to greater effects, or could habituate people to experiencing such effects. **Methods**: 1169 women were interviewed about their experience of the Gulf oil spill; Hurricanes Katrina, Rita, Gustav, Ike, and Isaac; and Mississippi flooding. Experiences of the oil spill were divided into direct contact, traumatic experiences, economic losses, and overall, and experience of natural disaster into experiencing danger, damage, illness/injury, and evacuation. Depressive symptoms were measured using the Edinburgh Depression Scale and PTSD using the Post-traumatic checklist. Mental health was modeled using log-Poisson regression with individual, cumulative, and interactive effects of the oil spill and natural disasters as predictors and adjustment for confounders, to determine which model was most consistent with the effects seen. **Results**: Both oil spill experiences and disaster exposure were associated with depression and PTSD, consistent with a cumulative model [e.g., both high contact with oil and overall disaster exposure were independently associated with depression (adjusted relative risk (aRR) for oil 2.10, 95% CI, 1.49-2.96, aRR 1.03, 1.02-1.04 per indicator for disaster) and PTSD (aRRs 2.03, 1.19-3.45; 1.03, 1.02-1.50, respectively.] No evidence for sensitization was found. **Conclusions**: The cumulative burden of oil spill and natural disasters contributed to experiencing worse mental health, but previous disaster does not appear to have sensitized women in the area to the effects of the oil spill.

4:00 PM - 4:15 PM

Self-reported Perceptions Regarding Seafood Safety and Consumption in Southeast Louisiana Following the Deepwater Horizon Accident

B. R. Simon-Friedt[1], J. Howard[1], E. Frahm[1], D. Gauthe[2], D. Bogen, Jr.[2], D. Nguyen[3], M. Wilson[1], **J. Wickliffe**[1]
[1]Tulane University, New Orleans, LA, [2]Bayou Interfaith Shared Community Organizing, Thibodaux, LA, [3]Mary Queen of Vietnam Community Development Corporation, New Orleans, LA

The Deepwater Horizon (DWH) accident distinctly and disproportionately impacted communities along the Gulf of Mexico. The direct effects of this event on Gulf waters, marshes, aquatic life, and fisheries were evident during and after the event. Misinformation and lack of trust in government agencies and officials in some communities exacerbated negative perceptions of oil spill related dangers. Perceptions of possible health risks lead to behavioral modifications that, in some cases, became long-term. We surveyed residents from 7 parishes in southeast Louisiana to examine their perceptions before, during, and after the DWH event. We found that some behaviors such as self-reported consumption of local seafood decreased dramatically, by approximately 50%, during the DWH oil spill, but consumption appears to have returned to pre-event levels. Other perceptions such as seafood quality remain altered after the DWH event and have not returned to what were generally positive pre-event levels. Participants tend to trust relatives, friends, and neighbors more than government officials or scientific experts regarding information about locally harvested seafood. Nearly 50% of participants report they lack the information needed to make informed decisions regarding the safety of consuming local seafood. We will report on a number of responses regarding seafood and seafood safety among low-SES participants in southeast Louisiana including several that have been influenced by the DWH. Such information can be used to understand how people respond to events like the DWH and perhaps foster improvements to risk communication strategies used by health agencies.

4:15 PM - 4:30 PM

One Health Case Study: Community-based Science to Bridge Environmental & Public Health Concerns Post-DWH in Gulf Coast Communities

A. S. Kane[1,2], R. M. Brooks[1], M. K. S. Charles[1], S. M. Roberts[1], M. O. James[1], L. Stuchal[1], J. Blackburn[1], B. Brumback[1], A. Mathews[1], A. Lindsey[1], T. Irani[1], S. R. Mathews[3], W. F. Patterson[4], J. J. Connors[5], R. Cantwell[6], S. Colson[7], T. McKinney[8], J. Taylor[9], S. Hartsfield[10], C. Philips[11], M. Cabassa[12], G. Nelson[13], G. Morris[1]
[1]University of Florida, Gainesville, FL, [2]UF Environmental and Global Health; & Emerging Pathogens Institute, Gainesville, FL, [3]University of West Florida, Pensacola, FL, [4]University of South Alabama, Dauphin Island, AL, [5]University of South Alabama, Mobile, AL, [6]Cedar Key Aquaculture Association, Cedar Key, FL, [7]Cedar Key City Commission, Cedar Key, FL, [8]McKinney Seafood, Steinhatchee, FL, [9]Franklin's Promise Coalition, Apalachicola, FL, [10]Franklin County Seafood Workers Association, Eastpoint, FL, [11]Hot Spot Bait & Tackle, Pensacola Beach, FL, [12]Pensacola Bud Light Fishing Tournaments, Pensacola, FL, [13]Nelson Charters and Boat Yard, Mobile, AL

Communities along the northern Gulf of Mexico have long been dependent on the well-being of coastal ecosystem resources for their economy, commercial and subsistence seafood harvests, and the remarkable environment they call home. The 2010 DWH oil spill was a devastating environmental event that directly and/or indirectly harmed Gulf coastal communities regardless of the presence of physical oiling of their shorelines. In response to community concerns, we developed a transdisciplinary team to address the analytical toxicology, risk assessment and communication issues that could both protect public health and support needed individual- and community-based resiliency after the disaster. Our research team included expertise in environmental toxicology, aquatic pathobiology, risk assessment, food science and human nutrition, GIS, biostatistics, community outreach, and our community partners, was supported by the NIEHS to fill critical gaps left by NOAA and US FDA by measuring locally-caught

and consumed seafood types, and from locations not surveyed by state or Federal agencies. Results from over 1,000 finfish, shrimp, blue crab, oyster were sampled from Gulf coastal waters between November 2010 and February 2013, and were analyzed using GC/MS-SIM. The sum of parent PAHs and associated C1-3 alkyl homologs, revealed that 74% of samples were below detection limits; 23% were between 0.1-0.9 ng/g; and 3% were between 1.0 and 48.0 ng/g wet weight. Analytical toxicology data, combined with consumption patterns of coastal high-end consumers of inshore Gulf seafood, are being used to refine outreach and resiliency programs, and develop probabilistic, community-specific risk assessments. Community-based science was a critical component in our research design that facilitated sample collections, engaged fishers, seafood workers and residents throughout the study, and built trust and resource linkages that fostered meaningful outreach and partnerships.

4:30 PM - 4:45 PM

Environmental Exposure Assessment in the Women and Their Children's Health (WaTCH) Study

D. Harrington, A. Rung, E. Trapido, E. Peters
LSUHSC School of Public Health, New Orleans, LA

The Women and Their Children's Health (WaTCH) study is an ongoing, prospective cohort study to examine the physical, mental, and community health effects resulting from the Deepwater Horizon oil spill among approximately 2800 women and 625 children residing in the most heavily affected seven coastal parishes in southeast Louisiana. None of the participants were involved in cleanup activities. Subjects were enrolled between July 2012 and August 2014, and they completed an extensive survey including a series of questions related to environmental oil exposure. The objective of this presentation is to describe our approach for assessing environmental exposure. A key advantage of prospective cohort studies is that current exposure can be measured, but we did not begin enrolling participants in this study until after the active phase of the oil spill, therefore we were not able collect traditional individual-level exposure data and were thus required to assess exposure indirectly through our questionnaire. We developed questions to assess environmental exposure including questions about coming into physical contact with the oil and questions on the strength and frequency of smelling perceived oil contamination. We are also developing an exposure metric incorporating distance to shore and level of shoreline oiling. This presentation will describe our approach to quantifying exposure using this data with recommendations for improving exposure assessment in future studies.

4:45 PM - 5:00 PM

Post Oil Spill Indoor Air Threats and the Role of Culture in Air Management Strategies among Low-income Mothers

C. Mundorf[1], J. Howard[1], B. Simon-Friedt[1], D. Bogen, Jr.[2], D. Gauthe[2], E. Frahm[1], J. Wickliffe[1], M. Wilson[1], M. Lichtveld[1]
[1]Tulane University School of Public Health and Tropical Medicine, New Orleans, LA, [2]Bayou Interfaith Shared Community Organizing (BISCO), Thibodaux, LA

Following the Deepwater Horizon oil spill, pregnant women and new mothers were highly concerned about exposure to contaminated air. While this concern was primarily focused on outdoor air, exposures to contaminants in indoor air are also known to adversely affect health. In phase 1 of a mixed-methods research strategy, indoor air risk analyses were conducted of Gulf Coast low-income mothers' homes. Results indicate that select volatile organic compounds are at higher concentrations indoor than outdoors. Mothers make many household decisions that modify the family's indoor air quality; however, research examining the role of culture in these decisions is limited. In study phase 2, cultural consensus analysis identified a highly shared model of indoor air management strategies in Gulf Coast mothers

(n=112). An examination of the shared model showed a number of perceived protective actions (e.g. painting over mold spots, using air fresheners) that increase contaminant air exposure. Additionally, women most engaged with culturally related social networks were more likely to implement such perceived protective actions: painting over mold spots (OR: 9.78); and air fresheners to ameliorate chemical smells (OR: 11.93). Comparing culturally related indoor air management strategies with sampling data is an effective approach to uncover upstream determinants of environmental health risks and tailor environmental health interventions in at-risk populations.

Wednesday, February 3, 2016,
8:30 AM - 12:00 PM

A Tale of Two (Mega) Spills: Comparison of DWH and IXTOC-1 Scenarios, Fates and Effects II

8:30 AM - 9:00 AM
Connecting People and Places: A Tale of Two Gulf Spills
D. Yoskowitz
Harte Research Institute, Corpus Christi, TX

Both IXTOC and Deepwater Horizon created significant environmental disturbance which led to human impact on both health and economic well-being. While there is a perceived difference between the countries in economic and social conditions, the lasting effects of the two events may not be that dissimilar. Separated in space and time, the tale of the two spills is revealing interesting things about the resilience of the communities dependent upon the natural resources of the two regions.

9:00 AM - 9:15 AM
A Large Scale Comparison of Seafloor Microbial Communities in Regions Impacted by Two Gulf of Mexico Mega Spills
W. A. Overholt[1], K. Carlson[1], P. Schwing[2], D. J. Hollander[3], J. E. Kostka[1]
[1]Georgia Institute of Technology, Atlanta, GA, [2]University of South Florida, St. Petersburg, FL, [3]University of South Florida, St. Petersburg, GA

The Ixtoc-1 and Deepwater Horizon discharges both resulted in the transport of a large and poorly constrained amount of released oil to the seafloor where it was subject to degradation and transformation by sedimentary microbial metabolism. Deep sea sedimentary microbial communities are poorly studied relative to their planktonic counterparts. The objectives of this research are to (1) characterize un-impacted sedimentary microbial communities to establish baseline conditions over large spatial scales, and (2) effectively model the microbial community response to sedimentary oil deposition to guide future response efforts. Microbial communities were elucidated through next generation sequencing of SSU rRNA gene sequences for 23 and 10 sites in the northern and southern Gulf of Mexico, respectively. The results have been incorporated into a generalized, depth stratified model delineating microbial community structures across the Gulf. Preliminary results reveal surficial microbial communities are dominated by Gamma- and Alpha-proteobacteria that decrease with increasing sediment depth concomitant with increases in Deltaproteobacteria, Chloroflexi, and Planctomycetes. Microbial community structure is linked to oxygen penetration depth and sedimentological regime, which are controlled by the composition of carbon inputs (relative lability), sediment grain size distribution (clays vs silt vs sand), texture (carbonate vs terrigenous) and sedimentation rates. The distributions of key microbial populations can be calculated and deviations from these predictions may be used to indicate impacted sites.

9:15 AM - 9:30 AM

Benthic Foraminiferal Response to the IXTOC Oil Spill, Southern Gulf of Mexico

M. L. Machain-Castillo[1], A. Gracia[1], A. C. Ruiz-Fernández[2], J. A. Sánchez-Cabeza[1], A. Rodríguez-Ramírez[1], H. M. Alexander-Valdés[1], X. A. Nava-Fernández[1], L. E. Gómez-Lizárraga[1], P. T. Schwing[3], I. C. Romero[3], D. J. Hollander[3]
[1]UNAM, Ciudad de México, D. F., Mexico, [2]UNAM, Mazatlán, México, Mexico, [3]UNAM, St. Petersburg, FL

A C_IMAGE II 2015 oceanographic cruise was conducted to assess the IXTOC sedimentary record in the Southern Gulf of Mexico. The abundance and characteristics of benthic foraminifera in three cores to the West of the IXTOC I were analyzed as indicators of the environmental health pre and post-Oil Spill. Preliminary results indicate pre-IXTOC sand fraction is of biogenic origin, composed of well preserved, abundant and diverse foraminifera, without oil stains or morphological deformities. At the layer of the postulated IXTOC Oil Spill event, foraminiferal abundance and diversity decrease, and the shells show oil stains. Isotopic composition (δ13C) of foraminiferal shells is under study to determine their carbon provenance and the incorporation of petrocarbon, as well as 210Pb dating to assess the age. Core top samples are mostly biogenic. A few foraminiferal tests exhibit carbon staining and infillings. Isotopic and organic geochemical studies are under way to determine whether PAHs and other biomarkers and the foraminiferal shells are associated with the IXTOC I oil spill. Previous studies of total PAHs in the area exhibit elevated PAHs concentrations in the upper 5cms (impacted layer by the IXTOC Oil Spill) relative to the deeper layers. Downcore foraminiferal and geochemical analyses indicate that the IXTOC-I oil spill has left a sedimentary record in the study area. Dispersion of the surface oil followed a western path, according to the main oceanographic currents in the area. Further analysis of the cores collected during the C-IMAGE II expedition will provide a clearer image of transport pathways and the distribution of sedimentary oil in the southern gulf.

9:30 AM - 9:45 AM

Using Foraminifera to Assess Benthic Distribution, Impacts and Recovery following Sedimentary Oil Deposition Associated with the DWH and Ixtoc Events

P. Schwing[1], M. Martínez-Colón[1], M. Machain-Castillo[2], I. Romero[1], J. Chanton[3], B. O'Malley[1], E. Fridrik[1], G. Brooks[4], D. Hastings[4], R. Larson[4], D. Hollander[1]
[1]University of South Florida, Saint Petersburg, FL, [2]Universidad Nacional Autónoma de México, Mexico City, Mexico, [3]Florida State University, Tallahassee, FL, [4]Eckerd College, Saint Petersburg, FL.

This study assesses the distribution, impacts and recovery rates of benthic ecosystems following sedimentary oil deposition associated with the DWH and Ixtoc events by utilizing benthic (BF) and planktic (PF) foraminifera isolated from sediment cores collected from the NE and SW Gulf of Mexico (GoM). We used the isotopic composition (δ13C, Δ14C) of foraminiferal shells (tests) to determine incorporation of petroleum carbon, BF as a community structure bioindicator of petroleum contamination and PF were implemented as a proxy for depositional flux of water-column-derived material. In the NE GoM following DWH, we have documented a 2-4 fold increase in the accumulation rate of PF, an 80-93% decline in BF density, a benthic recovery rate of at least 2 years and the incorporation of petroleum carbon (~2%) into BF carbonate. These findings were all associated with increased sedimentary oil accumulation, petroleum toxicity and intensification of reducing conditions. Preliminary results from the SW GoM suggest that a decline in BF density and incorporation of petroleum carbon into BF tests occurred following the Ixtoc event. Further results of PF accumulation rates and petroleum carbon incorporation will be discussed. Foraminiferal indicators of petroleum incorporation into biomass, impacts/recovery of the benthos, and surface fluxes have implications for long-term ecosystem function impacts and mineral sequestration of petroleum carbon.

9:45 AM - 10:00 AM

Tails of Two Spills: Comparison of Marine Fish Communities in the Aftermath of Deepwater Horizon and IXTOC-I

S. A. Murawski[1], A. Gracia[2], E. Peebles[1], E. Pulster[1], S. Snyder[1]
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The Deepwater Horizon (700 kt, 2010) and IXTOC-I (500 kt, 1979-1980) incidents represent the two largest marine oil blowouts in global history. That they occurred along the north-south axis of the Gulf of Mexico provides a rich opportunity to characterize and contrast the species composition, population demographics, species associations, contaminant burdens and fish health metrics of marine species that occur in common and that are unique to the two spill areas. To augment ongoing marine fish monitoring of continental shelf species in the northern Gulf of Mexico, we initiated a parallel comprehensive survey of southern Gulf of Mexico waters using identical longline survey methods. Sampling in the Yucatan and Campeche regions in the southern Gulf provided collections for (1) describing fish community structure, (2) comparing size/age compositions of similar species between the northern and southern Gulf, (3) characterizing fish health (e.g., extent of external diseases and other conditions), and (4) comparing contaminant levels in tissues. In this study, we report on the first results of this comparative survey effort. Multivariate methods (e.g., SIMPROF implemented in PRIMER-7) are used to identify location groupings of similar species composition and the species associations that drive the location groupings. These communities are compared with similar data from the northern Gulf. Fish health indicators and demographic characteristics are also compared. Taken together, the analyses of fish data from the northern and southern Gulf provide a comprehensive Gulf-wide baseline for understanding the impacts of a variety of perturbations from natural and human-caused factors.

10:30 AM - 10:45 AM

Comparing PAH Profiles across the Gulf of Mexico: Red Snapper Liver Analysis

S. M. Snyder, E. L. Pulster, I. C. Romero, D. J. Hollander, S. A. Murawski
University of South Florida, St Petersburg, FL

The Gulf of Mexico has experienced two large submarine blowouts in the past forty years, the 2010 Deepwater Horizon blowout in the northern Gulf and the 1979 Ixtoc-I blowout in the southern Gulf. Polycyclic aromatic hydrocarbon (PAH) analysis of the two light crude oils shows similar profiles, dominated by low molecular weight PAHs, with some differences in the relative abundance of certain PAHs and their alkylated homologs. The profile of PAHs from the Deepwater Horizon wellhead strongly correlated with average PAHs and alkylated homologs in red snapper (*Lutjanus campechanus*) livers ($r^2 = 0.82$; $p < 0.001$) sampled in the northern Gulf in 2011, suggesting local red snapper were exposed to Deepwater Horizon oil and were accumulating the associated PAHs in their livers. With continued longline sampling in the northern Gulf of Mexico (2011 - 2015), and a 2015 longline cruise in the southern Gulf of Mexico (Yucatan and Campeche regions), red snapper livers from across the Gulf of Mexico are analyzed and compared for PAHs and alkylated homologs and referenced against the regional crude oil to infer any exposure to fresh or weathered oil in the environment, and metabolism.

10:45 AM - 11:00 AM

An Assessment of Fish Health in the Northern and Southern Gulf of Mexico in 2015 Using Traditional Immune System Markers

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In August and September, 2015, extensive field sampling of red snapper (*Lutjanus campechanus*) and golden tilefish (*Lopholatilus chamaeleonticeps*) occurred in both the northern and southern Gulf of Mexico. Fish were sampled from areas impacted by the 2010 Deepwater Horizon oil spill, from the vicinity of the 1979 IXTOC I disaster, and from areas with no history of drilling or oil production. In this study, traditional markers of immune status were examined in each fish to establish a basic assessment of fish health. Hematological targets included erythrocyte and leukocyte counts and analysis of differential white blood counts. In addition, micronuclei formation in whole blood and immune-relevant organs (spleen and liver) was quantified as an indicator of genotoxicity, which can be observed in fishes after oil or contaminant exposure. Markers were compared between sexes, species, oiled and non-oiled sites, and between samples from the northern and southern Gulf of Mexico. These data form the basis of a multi-year evaluation of fish health and immune status in the Gulf of Mexico.

11:00 AM - 11:15 AM

Two White Shrimp Fisheries in Two Mega Oil Blowouts

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Deepwater Horizon (2010) and IXTOC I (1979) mega blowouts ocurred north and south of the Gulf of Mexico where shrimp fisheries represent a valuable activity. Oil spill potential impact on shrimp fisheries was of great concern due to its economic and social importance. White shrimp *Litopenaeus setiferus* is a common and important species in the two spill areas. White shrimp stock did not exhibit an apparent impact after IXTOC-I blowout. Recruitment and spawning stock variations following 1979 oil spill were not large (20%) and fell within the seasonal variation ranges. White shrimp stocks in the Northern Gulf of Mexico neither registered an apparent impact related to Deepwater Horizon blowout, even though, studies showed an increasing trend in spawning biomass and recruitment. White shrimp stocks have a high resiliency and may recover quickly after oil spills due to its high reproductive potential and life cycle with two generation per year. Fishing effort had different effect on White shrimp stocks of the two areas. In the NGoM the reduced fishing effort both inshore and offshore allowed the shrimp population rebuilding. In the SWGoM the combined increase of artisanal and industrial fishing effort caused a recruitment overfishing that collapsed white shrimp fishery (to 10 % of maximum yield) in the long term. Fishing effort seems to be the main factor driving White shrimp biomass variations rather than effect related to mega oil spills.

11:15 AM - 11:30 AM

Development of an Atlantis Ecosystem Model to Study the Impact of Ixtoc Oil Spill

J. G. Ortega-Ortiz, C. Ainsworth
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We describe the development of a biogeochemical marine ecosystem model for the southern Gulf of Mexico. The spatially explicit Atlantis model represents bioregional features through an irregular polygon geometry with bathymetric, biogenic substrate and hydrodynamic characterization. We will

build upon a previous model developed to study the effects of the Deepwater Horizon oil spill (DWHOS) with a more detailed focus on the area potentially affected by the 1979 Ixtoc oil spill. We used results from previous C-IMAGE research projects, including use of generalized additive models (GAMs) to allocate biomass spatially, and fish gut content analysis to parameterize the diet matrix. The model will also include fisheries statistics and bycatch estimations. Model simulations will be used to analyze changes in ecosystem structure and function following the Ixtoc-I oil spill in a comparison against DWHOS. We will consider whether reduced shrimp landings in the Southern Gulf may have been influenced by Ixtoc.

11:30 AM - 11:45 AM

Can Lessons Learned from the 1979 IXTOC-1 Oil Spill (SGoM) Foretell the Recovery Time and Long Term Ecologic Consequences of the 2010 DWH Oil Spill (NGoM)?

D. J. Hollander[1], A. Gracia[2], S. A. Murawski[1], M. L. Machain-Castillo[2], P. Schwing[1], E. Ecobar-Briones[2], I. R. Romero[1], H. `. Alexander-Valdés[2], G. Brooks[3], E. Chancellor[1], J. Chanton[4], K. Freeman[5], D. Hastings[3], J. Kostka[6], C. Hiu[1], A. Jaggi[7], S. Lincoln[5], P. Montanga[8], T. Oldenburg[7], W. Overholt[6], E. Peebles[1], D. Portnoy[8], E. Pulster[1], J. Radovic[7], A. C. Ruiz-Fernandez[9], J. A. Sanchez-Cabeza[2], S. Synder[1], A. Wallace[1], W. Tunnell[8], D. Yoskowitz[8]

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In summer of 2015, C-IMAGE II undertook two ocean-going cruises to the Southern Gulf of Mexico (SGoM) to collect sediment cores, waters and demersal fishes in the region around the IXTOC-1 blowout site. The goal of these interdisciplinary cruises is to determine whether the IXTOC-I event provides an important historical analog that has direct bearing on the interpretation of data from the Deepwater Horizon (DWH) incident. In other words, can we use what has occurred in the past in the SGoM to foretell future recovery times and long-term consequences to ecosystems in the Northern Gulf (NGoM). Are the processes that gave rise to sedimentary oil deposition (MOSSFA) and impacts to benthic ecosystems the same? How will oiled sediments of DWH origin degrade and be buried by subsequent sedimentation in the next few decades? How are fish populations responding to petroleum exposure in areas where industry activity is high but have been closed to fishing and other marine activities for many years? How does fish life history combine with their proximity to hydrocarbon sources control PAH body burdens and other indicators of physiological, toxicological and population-level effects? What have been the impacts to human communities and ecosystem services as a consequence of the spills? These and other questions can be addressed by understanding what has become of the residual IXTOC-I oil and how has the benthic and fish communities evolved over time and across impacted and unimpacted areas. This talk will summarize and integrate the initial findings from the IXTOC-1 cruises with data from previous research to provide a provisional comparison between the IXTOC-1 and DWH oil spills. These comparative geologic, chemical and biological (microbial, meiofauna, macrofauna and fisheries) studies are expected to result in new insights about both the IXTOC-I and the DWH blowout events. Discussions with the GoMRI research community about future directions will be strongly encouraged.

Sustainable Coasts and Human Impacts on Marsh Food Webs in the Gulf of Mexico II

8:30 AM - 8:45 AM

Assessing the Effects of River Diversions on Oil Transport in Deltaic Louisiana Estuaries

D. Justic, L. Wang, H. Huang, L. Cui
Louisiana State University, Baton Rouge, LA

Freshwater diversions on the lower Mississippi River are considered an important component of wetland restoration efforts in coastal Louisiana. Diversions are used primarily for salinity control but increasingly proposed also as a major way to reduce the coastal wetland loss. Several large-scale sediment diversions projects are currently being considered for Barataria and Breton Sound estuaries that would convey an order of magnitude more water than existing Davis Pond and Caernarvon diversions. The impacts of current and proposed diversions on surface oil transport in these estuaries were investigated using a prognostic, three-dimensional, Finite-Volume Coastal Ocean Model (FVCOM). The numerical model domain covers most of the Alabama-Mississippi-Louisiana-Texas continental shelf with very high horizontal resolution (on the order of 20 meters) in Barataria Bay and Breton Sound. The model was driven by tidal and subtidal forcing at the open Gulf of Mexico boundary, freshwater discharge from the diversions, and surface wind stress. A number of different diversion scenarios were assessed, including concurrent operation of six diversions (Davis Pond, mid-Barataria, lower-Barataria, Caernarvon, mid-Breton Sound and lower-Breton Sound) with a combined flow of 6,500 cubic meters per second. Numerical modeling results indicate that river diversions have the potential to strongly influence estuarine residence times and alter oil transport pathways, albeit with significant tradeoffs associated with estuarine freshening.

8:45 AM - 9:00 AM

Nitrification, Denitrification, and Greenhouse Gas Production during Peak Growing Season in Oiled and Unoiled Louisiana Salt Marshes

A. Chelsky[1], J. M. Marton[1,2], A. E. Bernhard[3], A. E. Giblin[4], S. P. Setta[1], T. D. Hill[1], B. J. Roberts[1]
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Louisiana salt marshes are important sites for carbon and nitrogen cycling because they can mitigate fluxes of nutrients and carbon to the Gulf of Mexico where a large hypoxic zone develops annually. The aim of this study was to investigate spatial and temporal patterns of biogeochemical processes in Louisiana coastal wetlands during peak growing season, and to investigate whether the 2010 Deepwater Horizon oil spill resulted in persistent changes to these rates. We measured nitrification potential and sediment characteristics at two pairs of oiled/unoiled marshes in three regions across the Louisiana coast (Terrebonne and east and west Barataria Bay) in July from 2012 to 2015, with plots along a gradient from the salt marsh edge to the interior. Nitrification potentials across the coast (overall mean of 901 ± 115 nmol gdw-1 d-1 from 2012-2014) were high compared to other published rates for salt marshes. Within each region interannual means varied by factors of ~2-5, and rates were highly variable at the plot level (4 orders of magnitude). Nitrification potential did not differ with oiling history, but did display consistent spatial patterns within each region that corresponded to changes in relative elevation and inundation, which influence patterns of soil properties and microbial communities. In 2015, we also measured greenhouse gas (CO2, N2O and CH4) production and denitrification enzyme activity rates in addition to nitrification potential across the region to investigate spatial relationships between these processes.

9:00 AM - 9:15 AM

Tracking Organic Carbon Changes in Louisiana Marshes following the Deepwater Horizon Oil Spill

A. S. Engel[1], A. Paterson[1], R. E. Turner[2], E. B. Overton[2]

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Coastal Louisiana marshes received varying amounts of fresh and weathered oil and oil emulsions during the 2010 Deepwater Horizon spill. As part of the Coastal Waters Consortium I & II sampling efforts, marsh inland soils and subtidal sediments were sampled from 18 *Spartina*-dominated sites across three regions (Terrebonne Bay, Grand Isle, northern Barataria Bay) from 2011 through 2015. Marsh physicochemistry, hydrocarbon organic geochemistry, and bacterial diversity were evaluated to assess biotic responses to changes in natural and contaminated organic C over time. Diagnostic n-alkane indices were calculated to identify spilled oil, vegetation, or other organic C types. In May 2010 prior to the spill, n-alkanes were predominately sourced from plant leaf waxes and marine phytoplankton. By fall 2010, shorter-chain n-alkanes indicative of petrogenic oil persisted in the marshes. Re-oiling persisted for two years because biodegradation would be expected to decrease shorter-chain n-alkanes preferentially, and therefore diminish an oil signature, which was not observed. By spring 2013, n-alkane indices showed that marsh n-alkanes in sediments and soils had >80% plant wax contributions, which was exchanged within five months by petrogenic oil in the fall of 2013. Spring 2014 through spring 2015 saw a return to n-alkane indices for plant and phytoplankton n-alkane contributions. Differences in persistence and relative changes of n-alkane concentrations and profiles may be due to changes in microbial communities and their associated degradation rates, which could affect ecosystem level processes and food web dynamics within the marshes over time.

9:15 AM - 9:30 AM

A Three Year Record of *Spartina alterniflora* Biomass, Primary Production, and Allometry in Coastal Louisiana

T. D. Hill[1,2], B. J. Roberts[1], H. Sullivan[1,3], S. P. Setta[1], A. Chelsky[1], M. W. Rich[1,4], A. Hopple[1,5]

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Salt marsh primary production underpins many ecosystem-level processes, yet few long term datasets exist. We present three years of high-resolution above- and belowground biomass data from seven *Spartina alterniflora* marshes across three regions in coastal Louisiana, including areas affected by the BP oil spill. In one region (three marshes), above- and belowground biomass were measured at monthly intervals by destructive harvests; seasonal harvests occurred in two additional regions (four marshes). We calculated production using five methods and examined the effect of environmental conditions on the timing and magnitude of production peaks. Peak aboveground biomass ranged from 1,100-3,000 g·m-2, among the highest values reported on the Gulf Coast. Belowground production was comparable to peak aboveground biomass. In addition to reporting patterns of primary production, we use heights and masses of harvested stems to parameterize allometric equations useful for non-destructively estimating aboveground biomass. Although oil spill impacts on allometry were not detected, allometry varied seasonally, suggesting that long-term data be used to establish *S. alterniflora* allometry. Seasonal changes in allometry were similar between regions, suggesting that our equations could be applicable throughout the coast. This research directly aids sampling efforts that are sensitive to repeated destructive harvests, such as post-disaster assessments or large-scale efforts to estimate marsh productivity.

9:30 AM - 9:45 AM

Effects of Oil on Submerged Vegetation: an Experimental Assessment of *Ruppia maritima*

C. W. Martin, L. O. Hollis, E. M. Swenson, R. E. Turner
Louisiana State University, Baton Rouge, LA

Oil spills threaten the productivity of ecosystems through the degradation of coastal flora and the ecosystem services these plants provide. While lab and field investigations have quantified the response of numerous species of emergent vegetation to oil, the effects on submerged vegetation remain uncertain. Here, we discuss the results of several manipulative experiments to determine the impacts of oil exposure on *Ruppia maritima*, one of the most common species of submerged vegetation found in the region affected by the Deepwater Horizon oil spill. We grew *R. maritima* in a range of manipulated sediment oil concentrations and tracked changes in growth, reproductive activity, root characteristics, and uprooting force of plants. While no statistical differences were detected in growth, we found that plants in high oil concentrations had significantly reduced reproduction, altered root morphology, and required less force to uproot. Building on these results, we also discuss several additional experiments to determine how oil affects plant persistence in coastal areas and the food web supported by these foundation species. Specifically, we will discuss how seed oiling and oiled sediments impact seed germination rates and whether plant oil exposure affects herbivory of *R. maritima* in both field and laboratory settings. The results provide vital information to assess the large-scale impact of oil on submerged macrophytes.

9:45 AM - 10:00 AM

Macondo Oil Effects on Terrestrial Arthropods in Louisiana Marshes

L. Hooper-Bui, R. Strecker, X. Chen, B. Hesson, S. Peterson
Louisiana State University, Baton Rouge, LA

Previously, we've shown that the ants in the marsh are intimately connected to the terrestrial food web and that they are good indicators of the presence of stressors that affect food availability for vertebrates such as fish and birds. Initially populations of ants survived the oiling of the marshes but the population crashed in the summer of 2011 in response to the decreased food availability in the marsh. We started to see recovery of ants in the oiled areas in August 2012, but the populations were annihilated by hurricane Isaac. Similarly, beetles, flies, true bugs, and other terrestrial arthropods were suppressed by Isaac. The ants largely recovered in the unoiled plots, but not in oiled plots in 2013, which matches the uptick in the aromatic compounds measured at the same sites. In 2015, we started to measure recovery of the ant population in the oiled areas but lack hydrocarbon data at this time to associate with the recovery. We saw an increase in abundance on some species (abundance) but species richness is still suppressed across the northern Gulf of Mexico in 2015.

10:30 AM - 10:45 AM

Phytoplankton-Zooplankton Interactions in Gulf of Mexico Upper Waters as Inferred from Stable Isotopes

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Stable carbon and nitrogen isotopes (13C/12C and 15N/14N) were measured in copepods, euphausiids and hyperiids, and particulate organic matter (POM, a proxy of phytoplankton) collected in shelf and

deep-waters of the southern Gulf of Mexico. Zooplankton (333 um mesh size) were trawled from the surface to 250 m depth, and POM were sampled at chlorophyll maximum (chlmax) depths along three zonal transects (23oN, 24.5oN and 25.5oN) spanning from 86oW to the western shelf (97oW). Shelf POM and zooplankton were 15N-enriched suggesting either the incorporation of terrestrially-derived N or of in-situ recycled N to the shelf's trophic web. In contrast, deep-water POM from the chlmax were 15N-depleted reflecting the fractionation during assimilation of subsurface nitrate entering the photic zone from below. The d15N values of POM and zooplankton decreased linearly with the depth of the chlmax in accordance with isotopic discrimination at high N concentrations. At the two northernmost transects, where chlorophyll concentrations of the chlmax were high, zooplankton groups had similar d15N values. This contrasts with the low-chlorophyll southernmost transect, where zooplankton trophic levels were clearly separated. Shelf POM and zooplankton d13C values were 2 permille heavier than corresponding deep-ocean samples, but the difference in d13C of POM and zooplankton of each región was very small, in accordance with the low fractionation during carbon transfer in the trophic web. Results suggest that at higher food source concentrations, such as the chlmax layer, these zooplankton groups tend to occupy the same trophic level, while resource partitioning (due to lower chl concentrations) leads to differences in zooplankton trophic levels in regions of resource limitation. Finally, the d13C values of all measured groups suggest that no oil-derived products were incorporated into the trophic web during the study.

10:45 AM - 11:00 AM

Estimating Predator-Prey Relationships in Louisiana Salt Marshes: a Combination of Stomach Content, Stable Isotope, and Fatty Acid Analysis

P. Lopez-Duarte[1], K. Able[1], J. Fodrie[2], M. McCann[3], S. Melara[3], C. Noji[3], J. Olin[4], J. Pincin[3], K. Plank[5], M. Polito[6], O. Jensen[3]

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Multiple studies conducted over five years since the 2010 Macondo oil spill in the Gulf of Mexico indicate that oil impacts vary widely among taxonomic groups. For instance, fishes inhabiting marshes show no clear differences in community composition or population characteristics between oiled and unoiled sites, despite clear evidence of physiological impacts on individual fish. In contrast, marsh insects and spiders are sensitive to the effects of hydrocarbons. Both insects and spiders are components of the marsh food web and represent an important trophic link between marsh plants and higher trophic levels. Because differences in oil impacts throughout the marsh food web have the potential to significantly alter food webs and energy flow pathways and reduce food web resilience, our goal is to quantify differences in marsh food webs between oiled and unoiled sites to test the hypothesis that oiling has resulted in simpler and less resilient food webs. Diets and food web connections were quantified through a combination of stomach content, stable isotope, and fatty acid analysis. The combination of these three techniques provides a more robust approach to quantifying trophic relationships than any of these methods alone. Stomach content analysis provides a detailed snapshot of diets, while fatty acid and stable isotopes reflect diets averaged over weeks to months. Initial results include samples collected in May 2015 from a range of terrestrial and aquatic consumer species.

11:00 AM - 11:15 AM

Tracking Carbon Flow through Marsh Food Webs Using Compound Specific-Stable Isotope Analysis

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Stable isotope analyses are based on the principle of "you are what they eat" with bulk isotopic ratios of animal tissues generally reflecting the isotopic ratios found in their diet. However, bulk isotopic approaches are often confounded in estuarine habitats where a mixture of primary production sources and trophic fractionation processes complicates interpretations of isotopic data. Compound-specific stable isotopic analysis of amino acids (AA) has become a popular alternative to bulk isotopic methods as essential AAs transfer from food source to consumer without alteration to their carbon skeletons or isotopic values (δ13C). In addition, diversity in AA synthesis pathways among primary producers leads to unique δ13C values that can be used to identify the relative importance of basal carbon sources to higher level consumers. Here we present the results of two studies using compound-specific stable isotope analysis of essential AAs to track carbon flow from primary producers to consumers in coastal Louisiana marsh food webs. First, we test for differences in the importance of specific basal carbon sources to marsh fishes at unoiled and oiled marsh sites affected by the 2010 Macondo spill. Second, we examine how climate driven expansion of black mangroves (*Avicennia germinans*) in salt marshes may lead to shifts in the basal carbon sources supporting important marsh consumers. These examples highlight the utility of compound-specific approaches to marsh food web studies.

11:15 AM - 11:30 AM

Louisiana Commercial Fishing Industry Response to the Deepwater Horizon Oil Spill

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The Deepwater Horizon oil spill (20 April - 15 July 2010) and resulting mitigation efforts (dispersants and freshwater diversions) have been predicted to significantly lower landings and revenue in the Gulf of Mexico. In 2009, the commercial fishing industry in Louisiana harvested over 1 billion pounds of fish, second in the United States only to Alaska, and generated nearly $250 million in revenue. Yet, there has been minimal research on how the decreased catches of certain important commercial species (shrimp, oyster, and blue crab, which constitute over 70% of the total revenue) may change the commercial fishing industry of Louisiana as a whole and whether the change will be permanent or temporary. We used data collected on landings, value, trips, vessel size, and gear type from commercial fishery trip tickets provided by the Louisiana Department of Wildlife and Fisheries (LDWF), as well as independent fisheries data from LDWF. These data were used to determine the trajectory of recovery of the industry temporally and spatially from the oil spill. The data were separated by basin and aggregated monthly from 2000-2012. Results suggest that as areas affected by the oil spill were closed to fishing, fishing pressure of oysters increased in areas that were unaffected. Fishing did not cease with the oil spill, but rather shifted to different basins. Analysis of the independent fisheries data shows a spike in brown shrimp numbers and average size in the year following the spill. This suggests that periodic fishing closures may benefit certain species in the long term and that the commercial fishing industry has the potential to be resilient to disturbances with smart management practices.

11:30 AM - 11:45 AM

Coastal Ecosystem Supply Chain Vulnerability: A Framework for Propagation of Impacts and Recovery

B. Tansel, D. Boglaienko
Florida International University, Miami, FL

A framework was developed to evaluate vulnerability of coastal ecosystems, propagation of impacts within the ecosystem network, and correlate the economic impacts in relation to ecosystem vitality (service quantity and quality) in view of the interconnected dynamics of marine environment. A case study was developed for evaluating the propagation of impacts of oil spills near coastal areas by analyzing the interconnected functioning of mangroves, sea grass communities and coral reefs. In terms of number of organisms impacted, area impacted, number of species impacted and the appropriate recovery times, the propagation of the impacts can be classified as:

1. Primary effects (i.e., immediate damaged/affected ecosystems at spill location)
2. Secondary effects (i.e., subsequent damages in neighboring ecosystems)
3. Tertiary effects (i.e., economic losses, reduced property values in neighboring areas)

Specific metrics were developed for measuring and quantifying vulnerability and risks for marine ecosystems and their vitality. Patterns of spill occurrence, resulting impacts, and recovery profiles were analyzed in terms of the magnitudes of the spill and impact area. Spill occurrence characteristics (continuous, intermittent, cyclic, random, and one time), and the impact types (rapid, slow, delayed) and magnitude were analyzed to develop possible recovery profiles within the supply chain of the coastal ecosystems based on spill characteristics.

11:45 AM - 12:00 PM

Using a Food Web Network Model to Understand Vulnerability of Gulf of Mexico Salt Marsh Food Webs to Oiling

M. J. McCann[1], O. Jensen[1], K. Able[2], R. Christian[3], J. Fodrie[4], J. Johnson[5], P. Lopez-Duarte[2], C. Martin[5], J. Olin[6], M. Polito[5], B. Roberts[7], S. Ziegler[4]
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Single-species studies of the impacts of oil suggest that salt marsh taxa vary widely in their sensitivity. These differences in oil impacts throughout the marsh food web have the potential to significantly alter food web structure and energy flow pathways and reduce food web resilience. Therefore, developing a holistic understanding of the impacts of oiling on the entire marsh food web is essential. Here, we present a network model of a Louisiana salt marsh. The model depicts binary (i.e., present or absent) feeding links between taxa, which are represented as nodes. To infer the feeding relationships between taxa, we used a combination of published literature values, expert opinion, and gut content data of consumers. Then, measures of both network-wide (e.g., connectance, link density) and node-specific (e.g., connectivity, trophic level, omnivory index) food web properties were calculated. This model represents a composite view of salt marsh food web structure and aggregates over space and time. In addition to assembling the network model, we also compiled measures of oil vulnerability from published studies for a variety of marsh taxa in the network. The relationships between oil vulnerability and node-specific properties were used to identify key taxa that are expected to be both important to network stability and highly sensitive to oil. This model and the associated oil-sensitivity analysis provide initial expectations for comparing future marsh food web studies.

One Health: Unraveling the Interconnectedness between Human and Ecosystem Health through the Lens of Oil Spills II

8:30 AM - 9:00 AM

The Health Effect Research on Hebei Sprit Oil Spill (HEROS) study in Taean, Korea

M. Park[1], S. Lee[1], Y. Chu[1], J. Kim[1], Y. Choi[1], M. Ha[2], H. Cheong[3]

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Background: The oil spill from the Hebei Spirit 12,547kl in December 2007 contaminated Taean country in Korea. The oil was contained volatile organic compounds (VOCs), heavy metals and polycystic aromatic hydrocarbons (PAHs). **Methods**: This study is prospective cohort study to assess the exposure of the oil pollutants discharged after the Hebei Spirit oil spill region and to analyze the correlation between the degree of exposure and the health state. We performed health survey every 2 years for adults, children and adolescents from 2009 to 2015. We collect information regarding all subjects demographic and socioeconomic, complications related to health behaviors and environmental exposure (oil spill clean-up duration, nutritional, physical, and psychosocial). We also collect samples of blood, urine and hair. A health examination, including a skin prick test, pulmonary function test, and methacholine bronchial provocation test (MBPT), was performed. The participants are follow-up every 2 years. **Conclusion**: The HEROS study recruited 9,246 adults and 1,172 children and adolescents in 2009. Every 2 years, about over 1,000 adults and 800 children and adolescents participated our cohort study. We expect this study to provide evidence to support the hypothesis that the oil spill exposure has an effect on the human health.

9:00 AM - 9:15 AM

A Review of Exposure Pathways for Oil Spill Dispersants, the Effects of Constituents, and Analysis of Human Health Studies

W. J. Konkel, M. A. Popovech, J. M. Frasca

ExxonMobil, Annandale, NJ

The response to the Macondo oil spill utilized significant quantities of dispersants. Oil spill dispersants were not well understood outside of the oil industry and as a result, a great deal of new effort has gone into the study of these materials. Many of these studies were performed without consideration of environmentally realistic exposure concentrations or routes of exposure. This paper attempts to correct that oversight by addressing the following:

• Placing environmental exposure of the public and oil spill responders to chemical dispersants into perspective

• Describing the constituents of dispersants with regard to what is known about their human health effects

• Reviewing published studies of dispersant health effects in order to put those findings into perspective and offer study design considerations to maximize result applicability to human health risk assessment

The volume of chemical dispersant utilized in the Macondo response is often presented as an indicator for human exposure. However the application rate, dilution in the water column, and environmental persistence are far better measures of the potential for human exposure. Furthermore, the controls that were required by the Federal-On-Scene-Coordinator to ensure responder and public safety are critical

considerations. These controls were designed and implemented by Regulators and supported by health professionals to avoid the possibility of human exposure.

The constituents of Corexit dispersants were well known to the oil industry prior to their utilization in the Gulf of Mexico. These materials were known to be utilized in a variety of household consumer products as well as the food service industry. The constituents will be identified and discussed with regard to their human health effects.

Numerous studies have been published on the human health effects of dispersants since 2010. This review examines these studies with regard to the techniques utilized relative to standard test protocols, the exposures concentrations that were considered, and the exposure pathways examined. This summary should provide guidance for future scientific investigators and improve the quality and utilization of the science.

9:15 AM - 9:30 AM

Respiratory Symptoms and Eye Irritation Related to Corexit 9500A and 9527A Exposure in the GuLF STUDY

C. J. McGowan[1], R. K. Kwok[2], L. S. Engel[1], P. A. Stewart[3], M. R. Stenzel[4], **D. P. Sandler**[2]

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Background: Over 1.8m gallons of dispersants were used following the 2010 *Deepwater Horizon* disaster. Little is known about health effects, but toxicological profiles for components of Corexit 9500A and 9527A suggest potential for acute respiratory and irritant effects. We used data from the GuLF STUDY, a cohort of 32,608 clean-up workers, to evaluate associations between dispersants and respiratory or eye symptoms at the time of the spill. **Methods**: Data were obtained through a telephone interview administered 1-3 years after the spill. We included participants with complete data on exposures, outcomes, and covariates (28,402 for respiratory and 29,224 for eye symptoms). We calculated adjusted prevalence ratios (PR) for associations between having symptoms most or all of the time and performing clean-up activities involving dispersants. Covariates included demographic and socioeconomic factors, exposures to oil and cleaning chemicals, and smoking. **Results**: Activity-related dispersant exposure was significantly associated with respiratory symptoms with prevalence ratios between 1.27 and 1.44 for cough, wheeze, tightness in the chest, shortness of breath, and burning in the nose, throat, or lungs. Dispersant exposure was also associated with burning or itching eyes (PR: 1.34; 95% CI: 1.21, 1.48 and 1.23; 95% CI: 1.13, 1.33). Associations with respiratory symptoms at time of study enrollment were somewhat attenuated. **Conclusions**: Dispersant exposure was significantly associated with respiratory and eye symptoms during clean-up. Ongoing analyses are focusing on improving exposure metrics and isolating effects of exposure to specific dispersants.

9:30 AM - 9:45 AM

Bayou to Bench and Back: How Dissemination of Personal Air and Seafood Sample Results are Improving Health Literacy in Southeast LA

J. L. Howard[1], E. Frahm[1], T. Stock[2], E. Overton[3], D. Gauthe[4], D. Bogen[4], D. Nguyen[5], M. Wilson[1], J. Wickliffe[1]

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During and following the Deepwater Horizon accident in 2010, concerns regarding negative impacts on air and seafood quality were paramount. Though individual perceptions varied, many people in coastal communities in southeast Louisiana felt that they experienced increased exposure to oil- and dispersant-related compounds. We hypothesized that involving the community directly in the research process might promote a more transparent and mutually beneficial relationship between the researchers and the community. We conducted both in-home and community-based assessments (n=200) over the last three years, looking at VOCs in paired indoor/outdoor air samplers, PAHs in seafood samples, and collecting data from multiple self-administered surveys regarding perceptions and behaviors. Results indicate that levels of the selected volatile organic compounds are generally higher in indoor air samples when compared to paired-outdoor air samples. Seafood analyses do not support the presence of PAHs at any levels that would represent a consumption health risk. In an effort to enhance public understanding of the interconnectedness of their health with the Gulf ecosystem, we have been disseminating the information back out directly to the participants as well as the larger communities at stake. Through post-dissemination follow up surveys, we examined the effectiveness of our CBPR research strategy in improving risk communication to better address health risk perceptions in these vulnerable populations. Our primary goals are to promote informed decision making and improve environmental health literacy among our coastal populations.

9:45 AM - 10:00 AM

Process and Impact Evaluation Findings from an Applied Community-Based Participatory Research Curriculum for Gulf Cost Communities in Louisiana

L. Brown[1], C. Canfield[1], J. Boselovic[1], R. Angove[1], M. Y. Lichtveld[2], S. Denham[2], P. Davis[2], T. Bui[3], S. Gauthe[4], D. Gauthe[5]

[1]Louisiana Public Health Institute, New Orleans, LA, [2]Tulane School of Public Health and Tropical Medicine, New Orleans, LA, [3]Mary Queen of Vietnam CDC, New Orleans, LA, [4]BISCO, Houma, LA, [5]BISCO, New Orleans, LA

The Gulf Resilience on Women's Health (GROWH) addresses health disparities in the Gulf Coast by linking communities and scientists through community-engaged research. Funded by NIEHS, GROWH's Community Outreach and Dissemination Core (CODC) seeks to utilize Community Based Participatory Research (CBPR) strategies to strengthen community resilience in vulnerable Gulf Coast populations. The CODC is an academic-community partnership with Tulane University, Mary Queen of Vietnam CDC, Bayou Interfaith Shared Community Organizing, and the Louisiana Public Health Institute (LPHI). The GROWH CODC collaboratively developed and implemented a 7 module CBPR curriculum covering types of research (traditional and CBPR), research ethics, forming and sustaining CBPR partnerships, and dissemination and translation techniques. Seven day-long sessions were held monthly. The curriculum was evaluated through module specific surveys and post implementation in-depth interviews to assess overall scope and efficacy. Results revealed improved relationships (more effective and honest communication, an increase in trust, and better understanding of one another's limitations & strengths) between community and academic partners. To measure learner performance, a set of competencies is linked to each module. Following pilot testing, the validated curriculum will be translated into a "shovel

ready" pedagogical portfolio targeting community partners as adult learners. Plans are underway to develop a "flipped" classroom curriculum developed by community partners for research partners. Ultimately this reciprocal learning framework will strengthen community-academic research partnerships and promote trust in research findings.

10:30 AM - 11:00 AM

Examination of One Health Concepts for Determining and Predicting Oil Spill Impacts

E. M. Faustman

Institute for Risk Analysis and Risk Communication, Seattle, WA

One of the challenges in determining both the potential as well as actual impacts for oil spills is the multidisciplinary nature of the science experts needed to answer these questions. In addition, we need to integrate local knowledge with broad based biomonitoring, informatics and conceptual frameworks for our evaluations of potential and actual risks. This presentation will discuss three facets of such evaluations with the first detailing development of conceptual models that frame this research and allow for incorporation of new findings into risk estimates and policy decisions. The second focus will discuss the adequacy and characteristics of available databases for making such scientific assessments. Gulf oil spill cases and others will illustrate what was possible and what was desirable for making science based risk evaluations. The third focus will propose essential factors required in our research framing in order to better protect public health and impact policy decisions.

Oceanographic Controls of Oil Transport and Microbial Hydrocarbon Biodegradation in the Water Column: from the Surface to the Deepsea

8:30 AM - 8:45 AM

Planetary and High-pressure Effects on Deep Blowout

C. B. Paris[1], Z. Aman[2], M. Schlueter[3], N. Perlin[4]

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Accurately generating quantitative data is the final objective of oil model output and analysis. However, it is often difficult to compare the modeling output with punctuate observations and to identify the processes controlling deep blowout. Here we present a realistic visualization rendering technique to trace the evolution of blowouts and optimize evaluation with observations. The proposed method uses the droplet size distribution and biodegradation from high-pressure experiments as input to the oil application of a Lagrangian stochastic model, which output is then tested against the comprehensive dataset collected during and post the DWH event. The model tuning is achieved by varying the boundary conditions and parameterization of oil droplets and their chemical attributes, as well as the fate processes (i.e., dissolution and biodegradation). Four-dimensional (4D) visualization of oil isosurfaces at various thresholds of oil concentration reveals that planetary anticyclonic rotation contributed to create a coherent oil helix with higher oil concentrate made of atomized droplets in its center. Capped cyclonic eddies might have interacted with the rising oil but were not the driving process of the corkscrew feature that is detected with the 4D rendering. We show how these methods are essential to partition the dynamic processes involved in the rising of oil from deep blowout to the surface and in the lateral mixing, and facilitate the estimation of water column exposure through time.

8:45 AM - 9:00 AM

Oceanographic Controls of Microbial Hydrocarbon Degradation

X. Sun, J. Kostka

Georgia Institute of Technology, Atlanta, GA

After a catastrophe like the Deepwater Horizon oil spill, the ultimate fate for the majority of released oil is biodegradation by indigenous microbial communities. Oceanographic parameters, such as temperature, pressure and nutrient availability, determine biodegradation rates and pathways. Knowledge of these controls will benefit model predictions of the transport and degradation of discharged oil as well as formulation of appropriate response strategies for future oil spills. Nutrient availability is an important factor that controls microbial community composition and oil degradation. From incubations of deepsea sediments collected in the northern Gulf of Mexico, we have characterized microbial community shifts following exposure to Macondo oil in the presence and absence of macronutrients. To simulate the in situ condition, the enrichments are maintained under cold conditions. Shifts in microbial community composition can be explained by oil and nutrient addition. The group of Colwelliaceae dominates all of our oil-amended samples. The relative abundance of this group is positively related to the nutrient level. The group Oceanospirillaceae is also enriched in oil-amended samples, which indicates it may also play an important role in responding to the oil-contamination. Although the degradation rates differ between our sediment and water column enrichments, the shifts in the sediment microbial community agree with previous findings in the water column during the spill, indicating oil degraders in both water column and sediment are closely related.

9:00 AM - 9:15 AM

Boundary Mixing along the Northern Deep Water Gulf of Mexico

K. Polzin[1], A. Angulo[2], A. Costa[3], S. DiMarco[4], J. Ledwell[1], Z. Wang[4]

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A tracer released near the site of the Deepwater Horizon well and at the depth of the deep plume from the 2010 rupture shows that there is very strong vertical mixing along the northern continental slope of the Gulf. This mixing would be effective at dispersing contaminants released from wells up and down the slope, potentially affecting the ecosystem of the slope and fisheries and cetacean communities that depend on that ecosystem. Data collected during the year long field program might explain the observed diapycnal dispersion. We find only background diffusivities in the interior Gulf of Mexico, diagnosed from finescale parameterizations applied to LADCP/CTD data. However, LADCP/CTD shear and strain levels from profiles in the boundary region, but above the bottom boundary layer, are also not sufficient to explain the tracer dispersion. The possibility that non-propagating form drag is responsible for the enhanced mixing is therefore explored with a 2-D advection diffusion model. The model is used with current meter data to show that flow over complex topography on the continental slope could provide a turbulent energy source sufficient to explain the tracer dispersion. Implied is an O(1) effective drag coefficient. The model indicates a strong response of diapycnal mixing to Hurricane Isaac, implying that enhanced mixing along the slope may be correlated with extreme weather events of the kind that damage drilling infrastructure.

9:15 AM - 9:30 AM

Vertical-Velocity Observations in the Northeastern Gulf of Mexico

A. M. Thurnherr[1], Y. M. Cardona Orozco[2], J. Montoya[3]

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In 2010, a set of hydrographic profiles including all three velocity components (u, v and w) was collected in the northeastern Gulf of Mexico during the Deepwater Horizon oil spill. Here, we report primarily on the vertical velocity observations. Many of the profiles show layers spanning 100s of meters with w of either sign exceeding 1cm/s. In addition to high-frequency internal waves, which typically dominate oceanic vertical kinetic energy (VKE) on those scales, and which are closely related to turbulence and mixing (Thurnherr et al., GRL 2015), the Gulf data set shows persistent layers of vertical convergences and divergences in all profiles collected near the oil-well blow-out site but not elsewhere, suggesting a connection to the rising plume. Additional notable vertical velocity signals include a 400-m-thick layer of 4cm/s upwelling associated with a bubble plume rising from a seep at the GC600 site, as well as a 100-m-thick upwelling bottom boundary layer associated with the generation of internal waves. On the other hand, layers of apparent downward motion in the top 200m of the water column that were observed exclusively at night are most likely caused by vertically moving organisms.

9:30 AM - 9:45 AM

Time-Series Measurements of Methane Transport and Sediment Total Oxygen Utilization in the Northern Gulf of Mexico Using Novel Sensor Technologies

C. S. Martens[1], H. Mendlovitz[1], H. Seim[1], L. Lapham[2], M. Joye[3], V. Asper[4], A. Diercks[5], I. MacDonald[6]
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Time-series measurements of light hydrocarbon concentrations and currents in the benthic boundary layer (BBL) of the northern Gulf of Mexico reveal spatial and temporal variability controlled by horizontal advection of methane-rich plumes originating from dissolution of rising bubbles from natural hydrocarbon seeps. Methane concentrations at 882-1622m depth range from near atmospheric saturation (<3 nM) to over 4000 nM depending on seep proximity, current speed and direction. Continuous methane measurements in September 2015 from newly designed mini-landers at Horn Dome revealed methane concentrations ranging from <3 to >250 nM over a two-week period. Net current speeds in the BBL at six lander sites in blocks GC600, OC26 and MC118 ranged from near zero to 5 cm/s; instantaneous speeds ranged from near zero to over 30 cm/s with directions often topographically steered. Sediment Total Oxygen Utilization (TOU) rates were estimated from continuous, in situ current speed and optode oxygen sensor measurements over periods up to several months utilizing a multi-sensor open “chimney” system. TOU values estimated as the product of calculated eddy diffusivities K and measured gradients of dissolved oxygen (DO) within the chimney or between ambient and chimney water: $J = K (\Delta DO/\Delta z)$ were within the observed range of TOU for upper slope environments. Near real-time acquisition of chemical and physical data including continuous hydrocarbon concentration, currents and TOU within the BBL and friction layer from untethered platforms provides important new opportunities for monitoring the impacts of natural seeps and potentially accidental hydrocarbon releases.

9:45 AM - 10:00 AM

Lateral and Vertical Dispersion Induced by Submesoscale Dynamics in the Gulf of Mexico

J. Choi[1], R. Barkan[2], A. Bracco[1], J. C. McWilliams[2]
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The study of lagrangian transport in the ocean provides a crucial guidance for the decision makers who deal with spill disasters, and for the ecologists who are interested in nutrient movement across the water column. Here we focus on submesoscale processes and their impacts, and we investigate the representation of transport within and across the euphotic layer of the Gulf of Mexico in ocean models with increasing horizontal resolution. The Regional Ocean Modeling System (ROMS), at 0.5, 1 and 3 km horizontal resolution, is used to simulate the GOM hydrodynamics, and the Lagrangian TRANSport model (LTRANS) is used to track the spreading of passive tracers over 2D isobaric surfaces and through the 3D water column. The submesoscale-driven lateral dispersion is characterized by comparing lagrangian dispersion statistics in the outputs at different resolutions and across seasons. Comparing statistics from 2D vs. 3D tracers emphasizes the effects of submesoscale-driven vertical transport on the lateral dispersion, and in turn of submesoscale convergence on vertical transport. Comparing summer vs. winter statistics allows for investigating the submesoscale-driven dispersions in presence of a shallow (deep) mixed-layer but large(low) fresh water inflow from the Mississippi River System.

10:30 AM - 10:45 AM

Sedimentation of Oil-derived Material to the Seabed is an Unrecognized Fate for Oil Derived from Natural Seepage

S. Joye[1], S. Harrison[1], R. Sibert[1], J. Montoya[2]

[1]University of Georgia, Athens, GA, [2]Georgia Institute of Technology, Atlanta, GA

The fate of oil derived from natural seepage in the marine environment is poorly constrained. In the aftermath of the 2010 BP/Macondo oil well blowout, sedimentation of oil-containing material to the seafloor was an important fate for discharged oil. During the Macondo blowout, the amount of oil accounted for by sedimentation processes remains poorly constrained. Despite that, sedimentation is now considered an important fate of oil during large open water spills with extensive surface slicks. In the northern Gulf, vigorous natural oil seeps generate extensive surface oil slicks. In the case of highly active seeps, these surface oil slicks persist at the sea surface over the seep site a majority of the time. We investigated the fate of oil released through natural seepage and the potential for the sedimentation of surface-slick derived oil at two vigorous hydrocarbon seeps in the Gulf of Mexico, Green Canyon block 600 and block 767. Hydrocarbon analyses were performed on samples collected from oil vents at the seafloor, in surface slicks, and in sediments cores apparently containing sedimented oil. Sediment cores collected from both of these active seep sites away from known oil vents contained distinct (1-3 cm thick) layers that were brown in coloration and which displayed distinct sedimentology compared to deeper strata. The oil fingerprint was also different, suggesting this material was not the result of weathering during transit through the sediment column. Available data suggest that sedimentation of weathered oil also occurs at vigorous natural seeps. Detailed studies of the weathered oil sedimentation process at natural seeps will help reveal the mechanisms driving this phenomena and are important for understanding the fate of oil released during accidental discharges and spills.

10:45 AM - 11:00 AM

Bacterial Production of Ancient Dissolved Organic Matter from Deepwater Horizon Oil: Insights from Carbon Isotopes, 4 Years after the Spill

B. D. Walker[1], E. R. M. Druffel[1], J. Kolasinski[2], B. J. Roberts[3], X. Xu[1], B. E. Rosenheim[4]

[1]UC Irvine, Irvine, CA, [2]Université de La Réunion, La Réunion, France, [3]Louisiana Universities Marine Consortium, Chauvin, LA, [4]University of South Florida, St. Petersburg, FL

Oil spills in deep waters, such as the Deepwater Horizon (DWH) spill in 2010, significantly impact marine ecosystems and can alter the marine carbon cycle. Previous work in the Gulf of Mexico (GOM) has shown incorporation of petroleum carbon (petrocarbon) into dissolved and particulate organic carbon (DOC, POC), biota, and onto the seafloor resulting from DWH. Petrocarbon can be metabolized and chemically transformed into many distinct molecules. However, petrocarbon conserves a unique isotopic composition through such chemical changes - readily identifiable with stable (δ13C) and radiocarbon (Δ14C) isotope ratio measurements. To date, ~11-30% of the 4.1-4.6 million barrels of fossil petroleum injected into the GOM during DWH remains unaccounted for in the oil spill budget. In particular, the relative persistence (e.g. biodegradation) and contribution of DWH DOC petrocarbon remains largely unknown. Here, we present the first Δ14C and δ13C DOC depth profiles for the GOM, sampled from three stations in July 2014. Our results suggest oil and methane degrading bacteria have converted spilled crude oil and methane into more stable DOC molecular forms - resulting in a 19-24% DOC increase with substantially low Δ14C and δ13C signatures. These results close a key portion (10-16%) of the 'missing oil' DWH spill budget and provide new insight into the long-term biogeochemical impact oil spills have on the marine DOC reservoir.

11:00 AM - 11:15 AM

Hydrocarbon Biodegradation in Permanently Cold Marine Sediment

A. C. Noel, C. Hubert
University of Calgary, Calgary, AB, Canada

Some of the released hydrocarbons from the Deepwater Horizon oil spill were discovered trapped in a deep cold-water plume or deposited onto cold marine sediments. Uncertainty about the fate of hydrocarbons in these situations showed that a better understanding of hydrocarbon biodegradation at cold temperatures is needed. Permanently cold marine sediment from a hydrocarbon seep in the Canadian Arctic, Scott Inlet (N71° W70°), was incubated under aerobic and anaerobic (sulfate reducing) conditions to examine potential processes for hydrocarbon removal. Diesel was used as a simple hydrocarbon source and organic acids (OA) as a control for stimulating microbial activity. Sediment incubated at 4°C with diesel under aerobic conditions showed increased carbon dioxide production in microcosms with higher concentrations of diesel (0.1, 0.3, and 0.9% v/v) over 150 days. Under anaerobic conditions, no evidence of hydrocarbon degradation was seen at 4°C over the same 150 day period, consistent with hydrocarbon biodegradation being much slower in the absence of oxygen. Incubations amended with OA instead of diesel showed rapid activity under both oxic and anoxic conditions. This suggests that microbial communities in permanently cold marine sediment close to known hydrocarbon seeps, like those in the Gulf of Mexico, are able to degrade simple hydrocarbons aerobically, and potentially anaerobically under sulfate-reducing conditions at cold in situ temperature.

11:15 AM - 11:30 AM

Investigating the Chemical and Isotopic Kinetics of Aerobic Methane Oxidation in Two Different Novel Environments

E. W. Chan[1], J. D. Kessler[1], A. M. Shiller[2], M. C. Redmond[3], E. Arrington[4], D. L. Valentine[4]
[1]University of Rochester, Rochester, NY, [2]University of Southern Mississippi, Stennis Space Center, MS, [3]University of North Carolina - Charlotte, Charlotte, NC, [4]University of California - Santa Barbara, Santa Barbara, CA

Methane seepage in areas such as the Gulf of Mexico and along the US Atlantic margin has led to speculation on the fate of the released methane. Here we examine the kinetics of aerobic methane oxidation to gain a fundamental chemical and isotopic understanding of this methane sink. Our ultimate goal was to determine the amounts of substrates required to remove a quantity of methane from seawater as well as fundamental isotopic fractionation parameters. Thus, in order to investigate this process in its entirety, a unique mesocosm incubation system was developed with a Dissolved Gas Analyzer System (DGAS) to monitor the real time chemical and isotopic changes involved with aerobic methane oxidation. This system measures changes in methane, carbon dioxide, and oxygen concentrations as well as the stable carbon isotopes of methane and carbon dioxide with time. Since many other substrates are required for methane oxidation, additional samples are strategically collected to characterize trace metals, nutrients, cell density, and microbial community genetics. This presentation will detail the results obtained from samples collected at Sleeping Dragon seep field, Mississippi Canyon 118 (MC 118) as well as inside the Hudson Canyon at the edge of the methane clathrate stability zone and outside the Hudson Canyon, not influenced by the methane seepage. These results show that in both environments, methane was consumed aggressively but the timing of start of aggressive consumption varied based on location. These results are leading to insights into the chemical requirements needed for aerobic methane oxidation and the resulting isotopic fractionation.

11:30 AM - 11:45 AM

Effects of Surface Waves on Ocean Currents and Transport in Hurricane Isaac (2012) and Winter Storms in Gulf of Mexico

M. Curcic, S. S. Chen
University of Miami, Miami, FL

Tropical cyclones and winter storms induce large surface waves, strong currents, and vigorous upper-ocean mixing. Surface waves are known to induce a mean drift and affect surface transport of oil and other pollutants. Grand Lagrangian Deployment (GLAD) in the summer of 2012 and Surfzone Coastal Ocean Pathways Experiment (SCOPE) in the winter of 2013 were two observational field campaigns aimed at better understanding the role of oceanographic processes on surface material transport in Gulf of Mexico. Here we use the data collected during GLAD and SCOPE and the Unified Wave Interface - Coupled Model (UWIN-CM), a fully coupled atmosphere-wave-ocean model that was used in real time in support of the field campaigns, to quantify the relative role of wave-induced drift and Eulerian currents on surface transport. In addition to advection of material, waves also interact with the Eulerian circulation through the so-called Stokes-Coriolis and vortex forces, resulting in a modulated geostrophic balance in the ocean. While the advection by Stokes drift alone contributes to over 20% of surface transport, its interaction with currents enhances surface divergence on the vortex scale, promoting stronger cold water upwelling in the wake of the storm. We find that including the Stokes drift interaction with currents results in a broader and cooler cold wake. The relative importance of these wave-current interactive processes for the storm evolution and structure is investigated for the first time in the context of a regional high-resolution coupled atmosphere-wave-ocean model.

11:45 AM - 12:00 PM

Lagrangian Transport and Parameterization of Submesoscales Coupled with Mesosocale Flows

A. C. Haza[1], T. M. Ozgokmen[1], A. Griffa[2], P. J. Hogan[3]
[1]RSMAS /University of Miami, Miami, FL, [2]CNR, La Spezia, Italy, [3]NRL, Stennis Space Center, MS

The interplay of mesoscales and submesoscales (SMS) in terms of surface Lagrangian transport is investigated by focusing solely on the type of SMS coupled with mesoscales emerging from mixed-layer frontal instabilities. While the mesoscales remain the main steering mechanism, their transport barriers are disrupted by the SMS, resulting in a significant fraction of tracer crossing them, thereby enhancing the dispersion and mixing. Lagrangian parameterizations are reassessed based on these results and implemented to enhance tracer dispersion in the Gulf of Mexico, while preserving the mesoscale transport pathways of an ocean model.

The Physiological Resiliency of Marine Fish and Invertebrates following Oil Exposure

8:30 AM - 9:00 AM

Sublethal and often Subtle Impacts of Oil Exposure on Aquatic Animals Can Inform Us of Modes of Action and Long Term Effects

M. Grosell
RSMAS, University of Miami, Miami, FL

Crude oil toxicity can manifest in obvious deleterious effects in birds and aquatic fauna even following short term exposures. However, sublethal and often seemingly subtle effects may arise from exposure to low levels of crude oil derived water soluble compounds and such effects may have delayed and/or long term effects on individuals, populations and thus ecosystems. For all fish examined to date, exposure of early life stages to low levels of PAHs (low µg/L range total PAHs) results in cardiac dysfunction and malformation. When severe enough, this phenotype results in mortality shortly after hatch. However, less pronounced impacts evident from altered gene expression, altered metabolic rates and alterations to cardiac performance still allows for survival and seemingly normal growth and development under laboratory conditions. However, such early sublethal impacts have been demonstrated to result in reduced swim performance in juvenile as well as young adult survivors and have been proposed to be the source of reduced juvenile to adult survival in the wild. These observations of delayed higher level effects have been ascribed to impairment of cardiac function and oxygen delivery but other factors likely contribute to reduced fitness following early life stage sublethal exposures. A detailed understanding of the physiological mechanisms underlying sublethal oil toxicity will greatly improve our ability to predict long term impacts of recent and future oil spills. Grosell is supported by funding provided by the Gulf of Mexico Research Initiative.

9:00 AM - 9:15 AM

Eco-Physiological Implication of Early Life Cardiotoxicity in a Coastal Fish Species, *Sciaenops ocellatus*

A. J. Esbaugh
University of Texas Marine Science Institute, Port Aransas, TX

Pelagic larval fish have been shown to be some of the most sensitive organisms to oil exposure via water accommodated fractions. These fast developing species also represent a large portion of the commercial fisheries found in the Gulf of Mexico and elsewhere. The available evidence suggests that toxicity is driven by the relative concentration of polycyclic aromatic hydrocarbons (PAHs), and more specifically the concentration of 3-ring PAHs, which result in a characteristic cardiotoxic phenotype. This phenotype consists of a malformed heart, and in some instances extra-cardiac abnormalities, which can lead to reduced swim performance, aerobic performance and survival. While much is known regarding the developmental impacts on pelagic species, relatively little is known of coastal species that are generally more tolerant of environmental perturbations. Red drum is a fast growing species that spawns off shore and recruit to estuaries early in development, making them an ideal coastal comparison. Here we will describe on-going research examining the sensitivity of embryonic, larval and juvenile red drum to acute oil exposure with a specific emphasis on integrating early life cardiotoxicity, eco-physiological performance and recovery. The specific eco-physiological performance indices will include measures of aerobic and swim performance, foraging activity and prey capture ability as well as conspecific competition. Funding for this work was provided by the Gulf of Mexico Research Initiative through the RECOVER consortium.

9:15 AM - 9:30 AM

Effects of the Presence of Plankton on the Acute Toxicity and Morphological Effects of Crude Oil to Larval Bay Anchovy (*Anchoa mitchilli*)

S. J. Webb[1], E. E. Saal[2], K. A. O'Shaughnessy[1], T. A. Duffy[1], R. J. Portier[2], E. J. Chesney[1]

[1]*Louisiana Universities Marine Consortium, Chauvin, LA,* [2]*Louisiana State University, Baton Rouge, LA*

Bay anchovy (*Anchoa mitchilli*) are abundant in estuaries of the eastern United States and Gulf of Mexico. Because they are spring and summer spawning fish it is likely that larvae were exposed to crude oil following the Deepwater Horizon oil spill. While most toxicity studies are undertaken in experimental systems without plankton, environmental exposure occurs in the presence of zoo- and phytoplankton. We determined the effects of the presence of plankton on the outcome of toxicity studies by exposing bay anchovy larvae both in the presence and absence of marine plankton. Bay anchovy embryos were exposed to Macondo surrogate oil as high-energy water-accommodated fraction (HEWAFs) for 24 hours. Embryos were added to static exposure systems beginning at 10-12 hours post-fertilization that hatched mid-exposure. For exposures with plankton, the zooplankton (*Brachionus plicatilis*) and phytoplankton (*Nannochloropsis oculata*) were added to beakers to determine the impacts of these organisms on crude oil toxicity. At low HEWAF concentrations (<500 ppm total aromatic hydrocarbons), mortality of larvae was significantly higher in the presence of plankton, while at higher concentrations (>500 ppm total aromatic hydrocarbons) mortality was similar in exposures with and without plankton. Additionally, frequency of morphological effects increased at the lower doses in the presence of plankton as compared to trials without plankton. Morphological effects included curved spine, yolk sac abnormalities, fin fold degradation, and craniofacial abnormalities. These results suggest that exposures that include plankton are essential to understanding the effects of crude oil on bay anchovy larvae.

9:30 AM - 9:45 AM

Exposure to Ultraviolet Radiation Increases the Toxicity of Oil to Mahi mahi (*Coryphaena hippurus*) Embryos

L. E. Sweet[1], J. Magnuson[1], T. R. Garner[1], M. Alloy[1], J. D. Stieglitz[2], E. M. Mager[2], D. Benetti[2], M. Grosell[2], A. P. Roberts[1]

[1]*University of North Texas, Denton, TX,* [2]*University of Miami, Miami, FL*

The timing of the Deepwater Horizon oil spill in 2010 overlapped with the spawning of several ecologically and economically important fish species, including the mahi mahi (*Coryphaena hippurus*). Polycyclic aromatic hydrocarbons (PAHs) released into the marine environment during this oil spill have been shown to cause photo-enhanced toxicity under ultraviolet (UV) radiation. Mahi mahi eggs are positively buoyant and transparent, making these embryos at risk for photo-enhanced toxicity. In this study, mahi mahi embryos were exposed to high-energy water accommodated fractions (HEWAF) of source oil a (SOA), source oil b (SOB), and the Massachusetts source oil (MASS) for 48 h. The timing of the co-exposure with UV radiation varied between an early UV exposure at 7 hpf for 8 h and a late UV exposure at 27 hpf for 8 h. Hatching success was documented at approximately 48 h and samples were collected for oxidative stress gene expression analysis. The early UV exposure had a photo-enhanced toxic effect on embryo mortality in all three oil types. The early UV exposure LC50 values were 5.9% HEWAF for SOA, 4.2% HEWAF for SOB, and 2.0% HEWAF for MASS, which were all five-fold lower than the non-UV controls. The late UV exposures were significantly more phototoxic than the early UV exposures, with a seven-fold decrease in the LC50 values. This study provides evidence that the developmental window when UV exposure occurs has a significant effect on the degree of photo-enhanced toxicity of oil. Funding for this research was provided by GOMRI.

9:45 AM - 10:00 AM

Effects of Deepwater Horizon Crude Oil Exposure on the Intestinal Transport Physiology of the Gulf Toadfish (*Opsanus beta*)

E. Mager, I. Ruhr, Y. Wang, B. Locher, M. Grosell
University of Miami, RSMAS, Miami, FL

Marine teleosts are faced with the continuous challenge of diffusive water loss, primarily through the gills, due to the high osmolarity of the surrounding seawater. To combat this diffusive water loss, marine teleosts must drink seawater to maintain hydration and excrete the absorbed salts through their gills. Thus, the gastrointestinal tract of marine fish represents a potentially significant route of exposure to waterborne pollutants such as those found in crude oil, most notably polycyclic aromatic hydrocarbons (PAHs). To investigate the potential osmoregulatory responses of the marine teleost intestine to crude oil exposure, short-circuit current (Isc) and conductance were measured in isolated intestinal epithelia from the Gulf toadfish exposed to various dilutions of high energy water accommodated fractions (HEWAF) of Deepwater Horizon slick oil using Ussing chambers. Results showed a dose-responsive decrease in the absorptive Isc with increasing %HEWAF dilution in the anterior intestine but no significant effects in the middle and posterior intestine. These findings suggest that crude oil exposure may impair the osmoregulatory function of the marine teleost intestine. Future efforts will focus on utilizing Ussing chamber exposures with individual PAHs or PAH classes in an attempt to identify the primary components of crude oil that account for the observed effects. This research was made possible by a grant from BP/The Gulf of Mexico Research Initiative to the RECOVER Consortium.

10:30 AM - 10:45 AM

Toxicity of Very Thin Surface Slicks of Deepwater Horizon Oil to Pelagic Gulf of Mexico Fish Embryos and Invertebrates

J. M. Morris[1], H. Forth[1], C. R. Lay[1], R. Takeshita[1], M. Krasnec[1], J. Lipton[1], M. Alloy[2], C. Overturf[3], T. Garner[2], A. Roberts[2], E. Mager[4], J. Stieglitz[4], C. Pasparakis[4], Z. Yao[4], D. Benetti[4], M. Grosell[4], E. Chesney[5], K. O'Shaughnessy[5], M. Gielazyn[6]
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In support of the Deepwater Horizon (DWH) Natural Resource Damage Assessment, we conducted several exposures of Gulf of Mexico invertebrates and early life-stage fish to very thin surface slicks generated with DWH oil. This presentation will focus on the results of tests conducted with bay anchovy, mahi-mahi, red drum, speckled sea trout, and mysid shrimp. The surface slicks were very thin (~1µm) and we generated the slicks using two types of naturally weathered DWH oil collected from the field during the spill. We conducted the exposures for various lengths of time ranging from 2 to 96 hours during different embryologic and larval developmental periods for some tests. Additionally, for some species we included UV light as an additional stressor to assess the impacts of photo-induced toxicity. Following exposure to the surface slicks, we measured survival and hatching success. Exposure to the thin surface slicks was acutely toxic and exposure timing and duration affected toxicity. Additionally, exposure to UV light following exposure to the surface slicks resulted in severe photo-induced toxicity. We will present a synthesis of the results of more than 20 bioassays and chemical characterization tests conducted in collaboration with 4 different laboratories.

10:45 AM - 11:00 AM

Oil Degradation in Deep Sea Mussels of the Genus *Bathymodiolus*: Physiological Insights from Metagenomics

M. A. Saxton[1], R. J. Sibert[1], J. M. Petersen[2,3], N. Dubilier[2], S. B. Joye[1]
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Mussels of the genus *Bathymodiolus* inhabit some of the most extreme ecosystems on the earth, including hydrothermal vent and cold seep systems. Growth of these mussels is made possible by harboring chemosynthetic symbiotic bacteria in gill tissue. Though *Bathymodiolus sp*. mussels are frequently observed in hydrocarbon seepage areas, often associated with methane hydrate, we report, for the first time, *Bathymodiolus* mussels, associated with, and living in, crude oil bearing sediments. To further investigate the ecology of these unique mussels, individuals of the species *B. brooksi* and *B. childressi* were collected from active hydrocarbon seepage site GC600 in the Gulf of Mexico and tissues were tested for their ability to degrade hydrocarbon constituents of oil via radiotracer analysis and the identity and genetic potential of their chemosynthetic symbionts using metagenomics. The hydrocarbons naphthalene and hexadecane were observed to oxidize in the presence of *B. brooksi* tissue and hexadecane was oxidized in the presence of *B. childressi* tissue. Symbiont metagenomic analysis revealed both *B. brooksi* and *B. childressi* to host the expected chemosynthetic symbiotic bacteria, methnotrophic and a thiotrophic symbiont in *B. brooksi* and a methanotrophic symbiont in *B. childressi*. The genetic potential of these symbionts appear to be similar to those observed in *B. brooksi and B. childressi* collected from other environments. Also, these symbionts do not appear to possess traditional n-alkane oxidation genes, suggesting the potential involvement of one of the multiple gene clusters currently annotated as methane monooxygenases. These results suggest that oil exposed *Bathymodiolus* sp. mussels are able to live in oily environments, likely through the oil degradative abilities of microbial symbionts, and that this ability may be widely distributed among mussels of this genus.

11:00 AM - 11:15 AM

Metabolomics as a Cutting-Edge Tool to Examine the Effect of Oil on Deep-Water Corals

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The Pennsylvania State University, University Park, PA

Untargeted metabolomics such as Liquid Chromatography-Mass Spectrometry (LC-MS) has the potential to rapidly and quantitatively fingerprint biological states and identify key metabolites in biological processes. However, experimental standards have to be established for coral-focused research. First, we quantified sources of variation to understand its reproducibility. Samples of the deep-water coral, *Leiopathes glabberima*, were grouped in order from fewest sources of variation to most: identical extracts, multiple extractions of the same tissue, extractions from across one colony, and extractions from separate colonies. Variation was calculated as spectrum wide-relative standard deviations (RSD). Mean RSD increased with additional sources of variation. Beginning with largest, the sources of variation before noise removal were machine, extraction, between colony differences, and within colony differences. A comparison of four deep-sea coral species is underway. The high reproducibility of LC-MS allows us to apply it as a fingerprinting tool to compare colonies of *Callogorgia delta* occurring near natural hydrocarbon seepage to those away from active seeps in the deep Gulf of Mexico. Previous work has shown that some colonies have δC13 and δN15 values reflecting input of seep derived organics, while others do not. LC-MS will provide a powerful tool to examine the metabolic response of *Callogorgia delta* to exposure to natural seepage in the deep Gulf of Mexico.

11:15 AM - 11:30 AM

Potential Genetic Impacts of the Deepwater Horizon Oil Spill on a Demersal, Sedentary Deepwater-burrowing Species

S. J. O'Leary[1], D. S. Portnoy[2], J. R. Gold[1]

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Golden tilefish, *Lopholatilus chamaeleonticeps*, is a commercially and recreationally exploited species that is discontinuously distributed throughout the northern Gulf of Mexico. Adults inhabit vertical burrows in the clay substrate of the shelf-slope break, exhibit sedentary behavior, and have an intimate association with local sediments. High concentrations of biomarkers, consistent with extended periods of oil exposure following the Deepwater Horizon oil spill, have been found in individuals from oil-impacted areas. Associated reductions in local reproductive output and selective mortality could result in changes in genetic diversity as a result of demographic processes and local adaptation. Population genomics is a powerful approach to simultaneously characterize aspects of both adaptive and neutral genomic variation providing insight into population structure, demographic history, and patterns of gene flow. We are in the initial stages of using restriction-site-associated DNA sequencing to identify several thousand genetic markers throughout the golden tilefish genome. Assessment of patterns of genetic diversity within and among samples taken across both temporal (before and after the spill) and spatial scales (northern Gulf, southern Gulf and Atlantic) will be used to determine potential genetic impacts of the Deepwater Horizon oil spill on golden tilefish. Preliminary results of the current study and application of the techniques to other Gulf species will be discussed.

11:30 AM - 11:45 AM

Genome-wide Transcriptional Responses to Deepwater Horizon Oil in Mahi-Mahi (*Coryhaena hippurus*) Embryos

G. Xu[1], E. Mager[2], M. Grosell[2], E. S. Hazard[3], S. Courtney[3], G. Hardiman[3], D. Schlenk[1]

[1]University of California, Riverside, Riverside, CA, [2]University of Miami, Miami, FL, [3]Medical University of South Carolina, Charleston, SC

The Deepwater Horizon (DH) oil spill contaminated the spawning habitats for pelagic fish. Exposure to water accommodated fraction (WAF) of oil from the spill is known to result in cardiotoxicity across fish species. The syndrome is consistently characterized by defects in heart formation and function. Unraveling the potentially diverse molecular mechanism of cardiotoxicity is essential for understanding the hazard posed by complex DH oil mixtures present in the environment. We analyzed the time-course (24, 48 and 96 hpf) transcriptional responses to field-collected DH oil, prepared as a WAF exposure in Mahi-Mahi (*Coryhaena hippurus*) embryos. The mRNA expression was quantified using high-throughput Illumina RNA sequencing (RNA-Seq) on a HiSeq2500. To analyze the Mahi-Mahi RNA sequencing data, a data analysis pipeline was developed. Reads were mapped to reference transcriptomes using the Diamond Basic Local Alignment Search Tool (Diamond Blast) and subsequently counted using a custom perl script, and subsequent translation of the RNA ID's to gene ID's was performed using the NCBI database. RNAseq was analyzed using DEseq2. Significantly up-/down-regulated mRNAs were identified, and the selected targets were verified by quantitative real-time PCR (qRT-PCR). Downstream gene ontology enrichment analysis was performed using the DAVID Bioinformatics Resources, and network analysis and biomarker identification performed using Ingenuity Pathway Analysis software (Ingenuity Systems, Inc.). Hypothesized transcriptomic responses include AHR-mediated response, HIF1 signaling, immune signaling, Ca2+-cycling and cardiac-associated genes. This RNA-Seq experiment was successfully

applied to a non-model wild, and ecologically significant organism affected by the DH oil spill, and may reveal the molecular mechanisms of cardiotoxicity of DH oil mixtures (Grant No: SA-1520; Name: Relationship of Effects of Cardiac Outcomes in fish for Validation of Ecological Risk (RECOVER)).

11:45 AM - 12:00 PM

Epigenetic Transgenerational Inheritance and Its Implications for Organismal Resilience to Oil Spills

W. Burggren
University of North Texas, Denton, TX

Phenotypic modification in the face of environmental stressors has long been an area of focus for biologists. Recently, epigenetic studies are becoming of increasing interest the context of the mid- to long-term effects of environmental stressors, including substances released from oil spills. Yet, "epigenetics" means different things to different life scientists. Most agree that this term generally refers to the processes whereby stressors lead to altered gene expression and modified phenotype, typically through DNA methylation, histone modification and/or the actions of small RNAs. However, many life scientists focus on the phenotypic modifications that occur during a single animal's lifetime, especially because such effects are often maladaptive (e.g. the "epigenetics of cancer"). Less emphasis has been placed on epigenetic inheritance of modified molecular, morphological or physiological phenotypes across generations. Such phenotypic modifications can be maladaptive, but can also be highly adaptive, enhancing survival in the face of dynamic environmental stressors. This presentation reviews some of the key studies examining the epigenetic inheritance of modified phenotypes in fishes as a response to polycyclic aromatic hydrocarbons (PAHs) and other pollutants released from oil spills. Some epigenetically inherited traits appear maladaptive (e.g. morphological malformations such as edema in the F1 and beyond), while positive effects on fitness (enhanced hypoxia tolerance) have yet to be assessed. Additionally, "epigenetic dynamics" (e.g. wash in and wash out of modified phenotypes over multiple generations) results in a complex suite of interactions between stressor dose and generation (e.g. F1, F2, etc.), the full implications of which have yet to be determined in the context of the lingering effects of oil spills. (Financial support to RECOVER Consortium provided by Gulf of Mexico Research Initiative)

Applications of Research in Oil Spill Transport, Fate and Effects Modeling for Decision Support and Ecosystem Services

8:30 AM - 8:45 AM

Application of Extreme Value Theory to Oil Spill Risk Analysis

Z. Ji, W. Johnson, G. Wikel
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Offshore drilling for oil and gas has been conducted since the early 1900s. Oil and gas deposits under the seabed continue to be an important part of the energy resources of the United States. After The Deepwater Horizon oil spill (DWH) in 2010, key questions were asked: What is the likelihood that a similar catastrophic spill will happen again? What are the spill sizes and frequencies of possible catastrophic spills in the future? The extreme value theory (EVT) has been widely used in studying rare events, including hurricane damage, stock market crash, insurance claim, flooding, earthquake, etc. Specific methods based on the EVT are needed for the statistical treatment of rare events such as the tail behavior, and to compensate for the insufficient data available. Two methods are often used in the statistics of extremes. The first is called the Blocks method and the second is the Peaks-Over-Thresholds (POT) method. The Blocks method relies on deriving block maxima series as a preliminary step. It is often convenient to extract the annual maxima. The POT method involves fitting two distributions: one for the number of events in a basic time period and the second for the volume of the exceedances. In this study, both methods are applied to analyze oil spills in the U.S. outer continental shelf (OCS), based on the 51 years (1964-2014) of OCS oil spill data. The EVT is capable of describing the oil spills well. The return periods of catastrophic oil spills with different spill sizes in the OCS areas are estimated. Findings in this study are very useful to oil spill risk assessment, contingency planning, and environmental impact statement on oil exploration, development, and production.

8:45 AM - 9:00 AM

Hindcast Modelling for the Persistence of Floating Oil Slicks Released from Natural Seeps

S. R. Daneshgar Asl[1], D. Dukhovskoy[1], M. Bourassa[1], R. Jenkins[2], I. R. MacDonald[1]
[1]*Florida State University, Tallahassee, FL,* [2]*SailDrone.com, Oakland, CA*

Persistence of floating oil in the ocean is an important factor for evaluating hydrocarbon fluxes from natural seeps and anthropogenic releases. The objective of this work is to estimate the surface residence-time and the importance of the wind and surface currents on the trajectory and fate of oil released from natural seeps in the Gulf of Mexico (GoM) or from persistent anthropogenic releases at fixed points. We simulated the trajectories of the oil slicks with an ocean model which derives with currents and surface wind. To verify the simulation results, oil slicks were delineated in 42 SAR images. During the simulation, the ocean surface currents were obtained from the HYCOM GoM 1/25-degree analysis and the wind history data during the days before SAR imaging were obtained from CCMP data base. Previous comparisons between the geometrical shapes of the oil slick from SAR outline to that predicted by wind indicated an average oil surface residence-time of approximately 12 hours. We find that ocean currents predict average surface residence-time of about 6.5 hours. A SailDrone study and our analysis indicated the currents tend to elongate oil slicks, while wind was the dominant factor causing disappearance of the oil slicks from sea surface. Results of the linear regression showed a good agreement between simulated trajectories and subsequent satellite observations (R2 = 0.97), suggesting that 20 degrees deflection angle is a good approximation for modeling wind effects.

9:00 AM - 9:15 AM

Next Generation Oil Spill Contingency and Response Modelling and Integrated Results for Decision Making and Common Operating Picture

U. Brönner, R. L. Daae, K. R. Sørheim
SINTEF Materials & Chemistry, Trondheim, Norway

The Deepwater Horizon accident in 2010 turned the focus in oil spill research towards the subsea aspects of an oil spill and on how to respond to it. Blowout modelling, gas-oil-ratios (GOR) and droplet size distributions where studied with respect to their importance for the fate and behavior of the spilled oil, which consequently will determine environmental impact by short- and long-term effects. Availability of different response options like in-situ burning, subsea dispersant injection, mechanical subsea dispersion vs. mechanical recovery and containment, increased the demands for NEBA analyses where different (combinations) of response strategies and their outcome are assessed with respect to environmental and economic resources and the expected impact on these. Oil Spill Transport, Fate and Effects Models will have to implement new and update existing processes in order to deliver the required information to decision makers. Next generation models will implement newest research results while at the same integrate with solutions for decision making, incident management, common operating picture, risk assessment and contingency planning. We will present this by the example of SINTEF's OSCAR model which is currently under development for next generation model requirements. Research results from API, IOGP and GOMRI funded projects for oil spill response are combined with targeted post-processing tools and facilitate informed decision making in oil spill situations.

9:15 AM - 9:30 AM

Effect of Subsea Dispersant Application on Oil Fate and Water Column Hydrocarbon Concentrations - Evaluation of the Deepwater Horizon Spill

D. P. French-McCay, Z. Li, M. Horn, D. Crowley, M. Spaulding, D. Mendelsohn, C. Turner
RPS ASA, South Kingstown, RI

The objective of dispersant application to spilled oil is to achieve a net environmental benefit by enhancing breakup and dispersion of oil in the water column, reducing exposure of natural resources to floating and stranded oil, and facilitating microbial degradation. While dispersants have been used on floating oil for many spills, the 2010 Deepwater Horizon (DWH) spill was the first incident where dispersant application was performed at a subsea blowout discharge location. Oil fate modeling of the DWH discharge was performed to estimate oil droplet and dissolved hydrocarbon concentrations in the water column for the release conditions and dispersant applications as occurred, as well as for the contrasting case of no sub-sea dispersant application. Pipe-discharge, blowout and droplet size models were used to develop mass and droplet size distributions used as input to the far-field oil fate model. The concentrations of soluble and semi-soluble hydrocarbon components predicted by the simulation of the actual event were validated by comparisons with chemistry data from the NRDA program. Due to the differences between the modeled and actual field conditions and the patchiness of observed chemistry, there is the potential for displacement between modeled and observed concentrations in both space and time. Therefore, a direct overlay of the detectable chemistry measurements on the model would be insufficient for evaluating if the concentrations predicted by the model were realistic. To account for likely displacement, results are plotted as probability distributions within a spatial and time window containing a population of chemistry samples. The chemistry samples and modeled results were ordered by concentration so that the distributions could be compared. In general, the modeled concentrations of the various components were of the same order of magnitude as the measured concentrations.

9:30 AM - 9:45 AM

A Numerical Study of Near-Inertial Resonant Response in the Northern Gulf of Mexico to Various Surface Wind Products

C. Hsu, P. Chang, J. Zhao, M. Howard
Texas A&M University, College Station, TX

Vertical mixing in the water column triggered by near-inertial surface winds has been identified as a prominent feature in the Gulf of Mexico, which can have an important impact on oil spill dispersion. In boreal summer, strong land-sea breeze circulation occurs in the Northern Gulf of Mexico, which acts to enhance the near-inertial wind work input. However, this linkage between the land-sea breeze circulation and near-inertial oscillation induced vertical mixing has not been fully understood. In addition, previous numerical studies have been focusing on the influence of temporal/spatial resolution of the surface winds, but not so much on the impact of land-sea breeze. In this study, we attempt to examine this issue through comparison of near-inertial wind work derived by forcing a simple slab ocean model using various wind products. We further conducted several numerical experiments using ROMS where different wind products were used to study vertical mixing and transport impacted by the near-inertial oscillation in the northern Gulf. The results show that the near-inertial wind work is closely linked to the structure of land-sea breeze in each of the wind products and varies significantly for different wind products. For example, NCEP2 has a strong land-sea breeze near the Texas-Louisiana Shelf, while winds from CCMP have a strong land-sea breeze over the Mississippi river basin. The modeling results also show that more near-inertial energy propagates into the ocean interior when near-inertial wind work input is enhanced. However, unlike the observations, the vertical shear variance generated by the near-initial waves is mostly confined within the top 150m in the model and unable to trigger the deep mixing in the northern Gulf.

9:45 AM - 10:00 AM

Lagrangian Simulations of Oil Droplets with Biodegradation and Chemical Dispersal: Applications for Decision Support

E. North[1], P. Kulis[2], E. Adams[3], W. Cesanek[2], P. Duzinski[4], R. He[5], S. Socolofsky[6], J. Testa[7], A. Thessen[8]
[1]University of Maryland Center for Environmental Science, Cambridge, MD, [2]CDM Smith, Edison, NJ, [3]Massachusetts Institute of Technology, Cambridge, MA, [4]Philadelphia Water, Philadelphia, PA, [5]North Carolina State University, Raleigh, NC, [6]Texas A&M University, College Station, TX, [7]University of Maryland Center for Environmental Science, Solomons, MD, [8]The Data Detektiv, The Ronin Institute for Independent Scholarship, Boston, MA

To be useful for decision support, new modeling tools for oil spills must enhance understanding of important processes, improve predictability, and be able to be rapidly implemented. The objectives of this presentation are to 1) provide 'lessons learned' from the academic modeling efforts that simulated oil droplets from the Deepwater Horizon spill with the Lagrangian TRANSport model (LTRANS) coupled with SABGOM hydrodynamics, and 2) provide an example of the use of LTRANS in response mode for chemical spills in the Delaware Valley Early Warning System (DE EWS). Academic simulations with LTRANS focused on the influence of biodegradation and chemical dispersants on oil droplet size and the resulting fate and transport of small droplets in the subsurface as well as the surface expression of oil above the well head. The influence of these processes on fate and transport and useful algorithms will be highlighted. The DE EWS was designed to make real-time predictions and forecasts of chemical spills to provide warning to industrial operators whose water intakes could be impacted. Innovations for implementing LTRANS in response mode will be shared and discussed with the aim of offering generalizable recommendations for response efforts.

10:30 AM - 10:45 AM

Defining Dynamic Bio-optical / Physical Events across the Mississippi Shelf and the Influence of River Plumes for Water Mass Transport

R. Arnone[1], R. Vandemeulen[1], I. Soto Ramos[1], M. Cambazoglu[1], S. Howden[1], G. Jacobs[2], J. Book[2], T. Miles[3], A. Weidemann[2]

[1]University of Southern Mississippi, Stennis Space Center, MS, [2]Naval Research Laboratory, Stennis Space Center, MS, [3]Rutgers University, New Brunswick, NJ

The dynamic circulation of the Mississippi Shelf is shown to have a strong influence on the surface bio-optical response as observed in satellites. Several dynamic events occurred within 2015 that identify the interaction of the offshore water masses and pathways across the MS shelf to the coast. Water mass exchanges across the MS shelf are highly variable and strongly associated with fresh water plumes. The influence of plumes from several rivers is clearly observed in the surface bio-optical signatures and is closely coupled with model circulation features. The uncertainty of the surface circulation was defined by daily comparison of several models and validated using the satellite surface bio-optical signatures. The location of plumes on the shelf was used to identify the locations for ship and glider sampling to examine the subsurface plume characteristics. Besides salinity, river plumes have unique water mass properties of chlorophyll, absorption, and backscattering signatures which were characterized in ship measurements. Surface and vertical bio-optical and physical properties from ship confirmed the satellite and models locations of the plumes. The Mississippi shelf exchange processes represent a strong interaction between physical and biological activity.

10:45 AM - 11:00 AM

How Far and How Much? Modeling Oil Weathering Using Comprehensive Composition to Constrain Transport and Pollutant Formation

G. T. Drozd[1], D. R. Worton[1], C. Aeppli[2], C. M. Reddy[3], H. Zhang[1], E. Variano[1], A. Goldstein[1]

[1]UC Berkeley, Oakland, CA, [2]Bigelow Laboratory for Ocean Sciences, East Boothbay, ME, [3]Woods Hole Oceanographic Institute, Woods Hole, MA

Releases of hydrocarbons from oil spills can have large environmental impacts in both the ocean and atmosphere. While evaporation of oil following a spill is mainly modeled simply as a mass loss mechanism, the resulting production of atmospheric pollutants can also be a major concern, particularly for continental releases, such as pipeline leaks. Following on observations of significant secondary organic aerosol (SOA) production from the Deepwater Horizon (DWH) spill, we modeled oil evaporation and the resulting potential SOA formation. Composition of surfaced oil indicates multiple transport pathways after release, and comparison of modeled SOA to observations of SOA during the DWH spill suggest high and rapid yields of SOA from intermediate volatility organic compounds (IVOC). Oil-spill conditions (e.g. sea-surface vs. sea-floor release) also affect the rate of evaporation and composition of oil-spill vapor plumes and pollutant formation. Novel bottom-up modeling of oil evaporation is based on unprecedented characterization of oil composition from the Deepwater Horizon (DWH) oil spill using GC×GC-VUV-HRTOFMS. Complete characterization was achieved for GC-amenable compounds from C10-C30 according to degree of branching, number of cyclic rings, aromatic character, and molecular weight. Such detailed and comprehensive characterization of the DWH oil allows for bottom-up estimates of the relationship between oil volatility and composition. We developed an evaporative model, based solely on our composition measurements and thermodynamic properties, rather than common boiling point parameterizations, which is in excellent agreement with published mass evaporation rates. Supporting experiments in a wind tunnel verify model accuracy and show that the

relative mass transfer of individual components depends on slick thickness and evaporation rate. With modeled evaporation rates, we model potential (maximal) SOA production as a function of wind speed, temperature, and oil composition. Yields of SOA are estimated to be 5% after 1-2 days of evaporation. Predicted composition of surface slicks suggests significant amounts of oil surfaced up to 100km away from the DWH site.

11:00 AM - 11:15 AM

New Approach to Dissolution Calculations in Oil Behavior Modeling

W. Lehr[1], D. Simecek-Beattty[1], L. Thibodeaux[2]

[1]National Oceanic and Atmospheric Administration, Seattle, WA, [2]Louisiana State University, Baton Rouge, LA

Traditionally, dissolution is treated as the lesser stepchild to evaporation in oil weathering models. For many surface spills, evaporative losses exceed dissolution losses by more than an order of magnitude. However, for large spills, particularly subsurface large spills such as Deepwater Horizon, dissolution can play an important role in both mass balance and toxicity affects. Most existing dissolution models treat spilled oil as a uniform substance with loss rates based upon general properties such as density and viscosity. However, chemical structure plays a dominant role in the dissolution rates of the various hydrocarbons. In particular, aromatics dissolve much more readily than saturates of the same molecular weight. Unfortunately, response weathering models will rarely have detailed information of hydrocarbon structure for a specific oil involved in a spill incident. Instead common structure groupings of saturate, aromatic, resin, and asphaltene fractions, plus distillation data are often available. Therefore the authors have constructed a dissolution model that considers everything but aromatics as insoluble and then constructs pseudo-components based upon aromatic distillation cuts. Based upon Biot number and experiments, dissolution is chiefly dependent upon the water-side resistance at the oil/water interface. Therefore, it is important to accurately estimate oil-water surface area. For subsurface spills, this means determining droplet size distribution of the source oil, usually as a function of oil viscosity, oil-water surface tension, and energy dissipation rate. For surface spills, there are two oil-water surface regimes; the bottom of the oil slick, and the subsurface droplets caused by breaking waves. The authors have constructed separate sub-modules to treat the two regimes individually. For the latter regime, a new approach to estimating the subsurface droplet distribution based upon wave spectrum and oil buoyancy is suggested.

11:15 AM - 11:30 AM

Spiked Mineral Oil Evaporative and Dissolution Weathering Plus Dense Residue Sinking: Laboratory Simulation Experiments and Process Model Analysis

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[1]Louisiana State University, Baton Rouge, LA, [2]Lousiana State University, Baton Rouge, LA

Two real oils, so-called dead oils, and one tar were tested using protocols developed in previous work with "model oils". These model oils were formulated with selected off-the-shelf pure chemicals. The real oils, used in the current set of weathering experiments reported here, were likewise spiked with off-the-shelf pure chemicals so too revive their dead characteristic and tested using the identical test protocols. The observed experimental outcomes and corresponding measured lapsed time to heavy residue sinking for both evaporation and dissolution experiments were very similar to the model-oil results. A one-to-one comparison of the data will be presented. The selected model parameters provided insights into attributing the pseudo-components and isolating the controlling transport resistances. The experiments confirmed that dissolution mechanism for oil droplets is essentially a water-side controlled process. The

presentation will conclude with addressing the role such testing plays in providing a better understanding of oil weathering and how to up-scale the laboratory derived results.

11:30 AM - 11:45 AM

Thermodynamic Modeling of Gas-Liquid-Water Partitioning and Fluid Properties for Macondo Reservoir Fluid at Deep-Water Conditions

J. Gros[1], C. M. Reddy[2], R. K. Nelson[2], S. A. Socolofsky[3], J. S. Arey[1]
[1]EPFL, Lausanne, Switzerland, [2]WHOI, Woods Hole, MA, [3]TAMU, College Station, TX

With the expansion of offshore petroleum exploration and extraction activities, validated models are needed to simulate the behaviors of petroleum compounds released in deep (>100 m) waters. We developed a thermodynamic model of the gas-liquid-water partitioning, densities, and viscosities of the Deepwater Horizon petroleum mixture with varying composition, pressure, and temperature, based on the Peng-Robinson equation-of-state and the modified Henry's law (Krychevsky-Kasarnovsky equation). We define pseudo-components based on comprehensive two-dimensional gas chromatography (GC×GC) measurements, which enable the modeling of aqueous partitioning for >n-C8 compound fractions not quantified individually. The resulting thermodynamic model was tested against available laboratory data on petroleum gas and liquid densities, gas/liquid volume fractions, and liquid viscosities. The model was applied to the Macondo reservoir fluid, represented with 279-280 components including 129-130 individual compounds. The model allows to predict the volume percent of gas and liquid at local conditions near the Macondo well (~150 atm and 4.4°C). These high pressure conditions dramatically increase the aqueous dissolution of petroleum hydrocarbons and also modify the buoyancies of gas bubbles and liquid droplets. Our results also affect published flow rate estimates of dead oil from the broken Macondo well stub.

11:45 AM - 12:00 PM

Assessing Oil Exposure in Gulf of Mexico Marshes

J. Holmes[1], **O. Garcia-Pineda**[2], M. Hess[3], M. Rissing[1], C. Wobus[1], R. Jones[1]
[1]Abt Associates, Boulder, CO, [2]Water Mapping LLC, Tallahassee, FL, [3]Ocean Imaging Corp., Littleton, CO

During the Deepwater Horizon (DWH) spill, Incident Command relied on Shoreline Cleanup Assessment Technique (SCAT) teams to assess shoreline oil exposure from boats and on foot. In marsh habitats, SCAT teams had difficulty assessing oil exposure; physically accessing interior marshes was challenging, if not impossible, and oil is less visible in a marsh than on a beach. Given these difficulties, DWH Natural Resource Damage Assessment Trustees explored alternative methods for assessing and quantifying oil exposure in marsh habitats using a combination of remote sensing technologies. In this presentation, we first present oil characterization data from Ocean Imaging's airplane-mounted digital multispectral scanner, which flew in tandem with a thermal infrared imaging camera. Next, we present synthetic aperture radar (SAR) imagery showing the presence of floating oil, which provided estimates of nearshore habitat intersections. We present examples of marsh oiling in 2010 that SCAT teams did not - and in some cases could not - detect. Finally, we present a method for quantifying marsh shoreline oiling, allocating oiling attributes initially compiled on a low-resolution SCAT shoreline to a high-resolution marsh shoreline with numerous embayments and crenulations. Overall, these data demonstrate that Gulf marsh habitats were repeatedly exposed to DWH oil, and that the extent of marsh exposure was greater than what response teams could observe at the marsh edge.

Animal Oil/Dispersant Exposure Trials Post-Deepwater Horizon: Design, Analysis and Interpretation of Results I

8:30 AM - 9:00 AM

Design and Interpretation of Laboratory-based Toxicology Exposures in the Aftermath of Deepwater Horizon

J. Griffitt

University of Southern Mississippi, Ocean Springs, MS

The 2010 Deepwater Horizon oil spill was a disaster of unprecedented magnitude for the ecosystem of the northern Gulf of Mexico. In the last few years, attempts to investigate the impacts of this event have been varied, and included both field surveys and laboratory-based exposures. While these have often proceeded independently of each other, ideally there would be feedback between field and laboratory based experiments, with the results from one informing the future research of the other. In particular, the ability to manipulate experimental conditions in the laboratory allows investigators to examine interactions between stressors and organisms on a finer scale than is possible in the field. Further, the ability to perform multiple experiments, with increased replication and water chemistry measurements affords a level of detail that is difficult to achieve in field sampling operations. In this talk, we will present certain issues influencing experimental design and interpretation of laboratory-based exposures, including interaction with environmental parameters such as temperature, salinity, and dissolved oxygen, different life stages of test organisms, and the potential for synergistic effects between oil exposure and other stressors, with an eye towards how the data from these experiments can provide useful information for researchers planning or conducting field operations.

9:00 AM - 9:15 AM

Status and Results of the Trustee Toxicity Testing Program Conducted in Support of the Deepwater Horizon Natural Resource Damage Assessment

J. M. Morris[1], C. R. Lay[1], M. O. Krasnec[1], H. Forth[1], R. Takeshita[1], A. McFadden[1], I. Lipton[1], M. Carney[1], D. Cacela[1], J. Lipton[1], M. Gielazyn[2], R. Ricker[3]

[1]Abt Associates, Boulder, CO, [2]NOAA, St. Petersburg, FL, [3]NOAA, Santa Rosa, CA

Since 2010, we have designed, implemented and managed the Trustee toxicity testing program for the Deepwater Horizon (DWH) Natural Resource Damage Assessment. This program includes over 500 toxicological bioassays and related chemical characterizations. The objectives of the program were to determine the toxicity of DWH oil, dispersed oil and dispersant to native and surrogate species in the Gulf of Mexico. To that end, we developed a large study matrix with over 35 species of fish and invertebrates and a variety of lethal and sublethal endpoints. Samples of DWH oil representing four distinct degrees of weathering and one dispersant (COREXIT 9500) were tested through a variety of different exposure routes including: water accommodated fractions, surface slicks and sheens, sediment and dietary. We also investigated the effects of additional environmental stressors including UV photo-induced toxicity. The studies were conducted by Abt Associates and NOAA scientists along with over 24 Principal Investigators from collaborating university, government, and private laboratories. Analyses of these data are ongoing but we will discuss effects levels for a range of species, exposure chemistry, testing methods, and our meta-analysis of this dataset to date.

9:15 AM - 9:30 AM

Photo-Induced Toxicity of Deepwater Horizon Oil to Native Gulf of Mexico Fish and Invertebrate Species

C. R. Lay[1], **J. M. Morris**[1], J. Lipton[1], A. McFadden[1], I. Lipton[1], R. Hall[1], C. Overturf[2], J. Oris[2], R. Garner[2], M. Alloy[2], A. Roberts[2]

[1]Abt Associates, Boulder, CO, [2]University of North Texas, Denton, TX

Exposure to ultraviolet (UV) light can increase the toxicity of compounds found in oil, but most toxicity tests are performed in the absence of UV light. To better understand how oil exposure in the presence of sunlight affected organisms during the Deepwater Horizon (DWH) disaster and support the DWH Natural Resource Damage Assessment, we conducted over 50 bioassays with species native to the Gulf of Mexico. We conducted tests combining exposure to oil followed by exposure to natural sunlight or indoor UV light on 10 different species of fish and invertebrates. These tests included a range of life stages spanning from gametes to gravid females. We performed a meta-analysis on effects levels obtained with and without UV light for a range of species including fiddler crabs, blue crabs, mahi-mahi, red drum, speckled sea trout, and bay anchovy. We found that exposure to both natural and artificial UV light greatly increased the toxicity of DWH oil during short-duration experiments (1-24 h). The increase in toxicity was more severe with higher daily UV exposure than with lower UV exposure.

9:30 AM - 9:45 AM

Characterization of the Various Sediment Preparation Techniques Used During Toxicity Testing in Support of the Deepwater Horizon NRDA

M. O. Krasnec, C. R. Lay, H. P. Forth, **R. Takeshita**, I. Lipton, A. McFadden, J. Lipton, J. M. Morris

Abt Associates, Boulder, CO

In support of the Deepwater Horizon (DWH) Natural Resource Damage Assessment, we designed, conducted, and managed numerous laboratory tests to evaluate the toxicity of DWH-oil contaminated sediments to ten different native and surrogate species found in the Gulf of Mexico. We conducted these studies in collaboration with NOAA scientists and Principal Investigators from university, government and private laboratories. During this sediment toxicity testing program we performed bioassays using various preparations of contaminated sediment: (1) direct exposure to contaminated sediment collected from areas that were directly exposed with oil during the spill, (2) direct exposure to reference sediments that we spiked with DWH oil in the laboratory, (3) indirect exposure to sediments that we spiked with DWH oil in the laboratory, and (4) exposures to oil/sediment slurries. The methods varied depending on the species that we tested. We describe the physical and chemical characterization of the sediments used during the toxicity testing program and discuss the effect levels for a range of species and preparation methods. The results from our sediment characterization work and toxicity testing provide key information for on-going and future tests using oiled sediments.

9:45 AM - 10:00 AM

Cross-taxonomic Consistency of Toxicological Effects of Deepwater Horizon Oil

R. Takeshita[1], J. M. Morris[1], K. Dean[1], M. Gielazyn[2], R. Ricker[3], P. Tuttle[4], J. Lipton[1]

[1]Abt Associates, Boulder, CO, [2]National Oceanic and Atmospheric Administration, St. Petersburg, FL, [3]National Oceanic and Atmospheric Administration, Santa Rosa, CA, [4]US Fish and Wildlife Service, Deepwater Horizon NRDAR Field Office, Fairhope, AK

As part of the Deepwater Horizon Natural Resource Damage Assessment (NRDA), the Natural Resource Trustees undertook a comprehensive toxicity testing program. The Trustees performed laboratory testing with fish, zooplankton, phytoplankton, amphipods, mollusks, crustaceans, birds, turtles, and mammalian cell lines. The Trustees found that test organisms responded consistently, showing toxic

responses such as cardiotoxicity, disruption of blood cells and their function (e.g., anemia), oxidative damage, immune system dysfunction, impairment of stress responses and adrenal function, and effects on locomotion. This consistency points to the conservation of mechanisms of action and disease pathways across a range of vertebrate and invertebrate species. A number of similar manifestations of toxicity effects were also observed in field studies. From a toxicological perspective, we observed a logical progression of physiological perturbation, from molecular and cellular effects that manifested as organ disease, to systemic effects that compromised fitness, growth, reproductive potential, and survival. From a clinical perspective, the breadth of adverse health effects and symptoms associated with exposure to Deepwater Horizon oil formed a coherent suite of symptomatic responses to petroleum toxicity.

10:30 AM - 10:45 AM

Quantifying Hydrocarbon Toxicity to Shallow-water Corals: Phenanthrene

A. Renegar[1], N. Turner[1], B. Riegl[1], R. Dodge[1], A. Knap[2], P. Schuler[3]
[1]Nova Southeastern University, Dania, FL, [2]Texas A&M University, College Station, TX, [3]Oil Spill Response USA Inc., Fort Lauderdale, FL

Shallow water coral reef ecosystems have an elevated chance of exposure to hydrocarbons due to their close proximity to the coastline. Previous research to evaluate hydrocarbon toxicity to corals and coral reefs has generally focused on community level effects, and results are often not comparable between studies. Thus, a significant data gap exists on the toxicity thresholds of hydrocarbons to corals, from the organismal to cellular level. Targeted hydrocarbon toxicity studies are therefore vital to accurate assessment of coral resilience to hydrocarbon exposures. Here, the toxicity of phenanthrene to the scleractinian coral *Porites divaricata* is assessed in a 48 hour constant exposure multi-concentration toxicity test utilizing a passive dosing system. Acute and sub-acute effects (color, polyp extension/retraction, mucus production, tissue loss/mortality, PAM fluorometry, and histologic cellular changes) are evaluated both during exposure and during a post-exposure recovery period. EC50 and LC50 estimates are based on sub-acute and acute effects at the end of the 48 hour exposure period. Relative sensitivity of this coral species to other marine species is a focus. The toxicity thresholds determined in this study will provide needed data for modeling impacts of potential hydrocarbon concentrations and exposures. This information can then be used in Net Environmental Benefit Analysis (NEBA) of predicted impacts and response methods in coral reef environments.

10:45 AM - 11:00 AM

Vulnerability of *Swiftia* Sea Fans to Oil and Chemical Dispersant

J. Frometa[1,2], P. J. Etnoyer[3]
[1]College of Charleston, Charleston, SC, [2]JHT, Inc., Orlando, FL, [3]NOAA, Charleston, SC

One outcome of the Deepwater Horizon oil spill was the realization that no well-established toxicity thresholds exist for benthic taxa in deep water (>50 m). Surveys of mesophotic reefs along the Pinnacle Trend in 2011 showed that *Swiftia sp*. octocoral colonies at these sites exhibited significantly more injury than previous years. *Swiftia exserta* is a gorgonian octocoral common in the West Atlantic at depths of 20-200 meters. In the northern Gulf of Mexico, *Swiftia sp*. has white polyps, as opposed to the red polyps typically reported. The current study aims to: a) determine the identity of *Swiftia sp*. samples collected from the northern GOMx and b) examine the effects of oil and chemical dispersant exposure on live *S. exserta*. Species diagnoses will be accomplished using scanning electron microscopy and amplification of two mitochondrial genes via polymerase chain reaction. Octocoral fragments will be exposed to varying concentrations of water-accommodated oil fractions (WAFs) using South Louisiana

Sweet Crude oil and Corexit® 9500 dispersant. A 96-hour exposure of fragments to three concentrations of chemical dispersant (10, 100, and 1000 mg/L) resulted in whole fragment mortality within 72 hours in all fragments of the "medium" (n=4) and "high" (n=4) dose treatments. Results from upcoming exposures to WAFs and chemically enhanced WAFs will also be presented. This is the first toxicity threshold established for a mesophotic coral species following the spill.

11:00 AM - 11:15 AM

Dispersant Exposure causes Generalized Shutdown at the Gene-level in Crabs

H. Vazquez Miranda[1], B. P. Thoma[2], J. M. Wong[1,3], D. L. Felder[2], K. Crandall[4], H. D. Bracken-Grissom[1]
[1]Florida International University, North Miami, FL, [2]University of Louisiana at Lafayette, Lafayette, LA, [3]University of California at Santa Barbara, Santa Barbara, CA, [4]George Washington University, Ashburn, VA

Oil spills are major environmental disasters. Dispersants are often added to control spills, as they quickly emulsify oil into droplets to speed bioremediation and prevent oil from reaching coastal habitats. Although dispersants are toxic, the effects of current formulations and gene-level damages are unknown. We looked at gene expression of flatback mudcrabs (*Eurypanopaeus depressus*) exposed to oil and oil-dispersant mixes using a Next-generation Sequencing method called RNA-Seq to identify the genetic response of crabs exposed to pollutants. We found over 4000 genes involved in general cellular differentiation and upkeep in primordial cellular components that were significantly suppressed in mudcrabs exposed to oil-dispersant treatments. This included six important immune response signaling pathways used to protect the organism from diseases. In contrast, three dozen genes were over-expressed in response to oil-dispersant mixes. The majority of these genes were identified to be involved in muscle production suggesting elemental structural repair. Oil-only effects were less severe. This provides evidence for oil-dispersant mixes causing a generalized shutdown of the cellular machinery and structural repair attempts. Our results indicate the current procedures applied to oil-spill cleanup is detrimental for marine life and better alternatives for spill control need to be investigated.

11:15 AM - 11:30 AM

Physiological and Molecular Responses of Oil and Dispersant Exposure in Blue Crab, *Callinectes sapidus*, Juveniles

S. C. Chiasson, C. M. Taylor
Tulane University, New Orleans, LA

We conducted experiments to evaluate if exposure to Louisiana sweet crude oil or oil/Corexit 9500 mixture for 24 hours had an effect on *C. sapidus* juveniles. Our response variables included physiological metrics (changes in weight, carapace size, carapace hardness, and intermolt duration) and mRNA expression of cyt p450 and vitellogenin, which is expressed in response to estrogenic compounds (such as some PAHs). We also used GCMS on hepatopancreas, muscle, and gill tissue to test for presence of petroleum hydrocarbons. Crabs selected for gene expression analyses were dissected immediately following exposure, and the remaining crabs were returned to aquaria for monitoring until the second molt. Exposure experiments revealed no effect on crab weight, carapace size or carapace hardness, and no mortality was observed. Also, no hydrocarbons were detected in the different tissue samples. However, vitellogenin expression was found to be elevated in crabs exposed to crude oil alone, but not the oil/Corexit 9500 mixture.

11:30 AM - 11:45 AM

Estrogenic Effects of CWAF Exposure on Sex Determination in the American Alligator

C. E. Williams[1], L. J. Guillette[2], D. D. Spyropoulos[2], S. Kohno[2]
[1]*College of Charleston, Charleston, SC,* [2]*Medical University of South Carolina, Charleston, SC*

The massive release of oil and dispersants into the environment following the Deepwater Horizon oil spill mandate investigation of the potential sublethal biological impacts of these compounds. CWAF, the Corexit 9500-enhanced water-accommodated fraction of oil, is likely to increase the bioavailability of many compounds. This study evaluates estrogenicity of CWAF by examining its effect on sex determination in the American alligator, *Alligator mississippiensis*. The American alligator is an ideal sentinel species due to its regional fidelity, long life as a top predator (bioaccumulation) and its temperature-dependent sex determination, which is exquisitely sensitive to estrogens. Indeed, exposure to 17β-estradiol (E2) and other estrogenic compounds in ovo results in sex reversal at male-producing temperatures. In our work, CWAF shows estrogenic activity at nearly 50% of the maximum induction by E2 in alligator estrogen receptor reporter gene assays in vitro. To determine whether this compound has the potential to affect gonadal sex determination, gonad-adrenal-mesonephric (GAM) tissue complexes were isolated from embryos one day prior to the sex determination period and exposed to 10-10-10-6 M E2, CWAF, 0.1% DMSO vehicle, or media control and cultured for 1-2 weeks. Gonadal sex is under investigation by multiple methods, including sexually dimorphic mRNA abundances using quantitative PCR. These results will reveal whether CWAF exposure has the potential to alter gonadal sex ratios in a sentinel species and impact other organisms in the ecosystem.

11:45 AM - 12:00 PM

Investigating Estrogenicity and Developmental Effects of the Dispersant COREXIT® EC9500A in the American Alligator

N. A. McNabb[1], D. D. Spyropoulos[2], L. J. Guillette Jr.[2], S. Kohno[2]
[1]*College of Charleston, Charleston, SC,* [2]*Medical University of South Carolina, Charleston, SC*

Millions of gallons of COREXIT® have been used to disperse oil at multiple oil spill events. This massive release mandates the evaluation of the long-term effects of COREXIT with a focus on endocrine disruption. Using luciferase transactivation assays, we found that COREXIT exhibited estrogenic activity via the American alligator estrogen receptor 1 in vitro. Alligators exhibit temperature-dependent sex determination (TSD), which is sensitive to estrogenic compounds during a thermosensitive period (TSP). Exposure to exogenous estrogens during TSP leads to sex reversal or skewed sex ratios by inducing ovarian development, even at male-producing temperatures. This sensitivity to estrogen, their long life, status as a top predator (bioaccumulator), and site fidelity makes the American alligator an ideal sentinel species to study long-term effects of exposure to estrogenic environmental contaminants. Alligator eggs were exposed to COREXIT at 0.25, 2.5, and 25 µg/g egg weight during TSP to investigate the effects on gonadal development in ovo. Gonadal tissues dissected from alligators at 1-week of age were analyzed using histological methods to understand the outcome of developmental exposure. Histological analysis showed a potential trend of slightly skewed sex ratios in COREXIT-exposed groups. Further investigation of gene expression will be reported and discussed. These results will assist in understanding effects of COREXIT exposure on the reproductive health of coastal aquatic reptiles and humans alike.

Wednesday, February 3, 2016
1:30 PM - 5:00 PM

Animal Oil/Dispersant Exposure Trials Post-Deepwater Horizon: Design, Analysis and Interpretation of Results II

1:30 PM - 1:45 PM

Effects of Deepwater Horizon Oil on Red-Eared Sliders (*Trachemys scripta elegans*) and Common Snapping Turtles (*Chelydra serpentina*) as Surrogate Species for Sea Turtles

C. Mitchelmore[1], C. Rowe[1], B. Stacy[2], L. Clayton[3], C. McDermot[3], S. Funck[1], G. Danvers[1], M. Strauss[1], H. Pie[1], N. Chigounis[1], N. Stacy[4], C. Cray[5], G. Ylitalo[6], B. Anulacion[6], D. Reavill[7], S. Lamb[8], D. Cacela[9], K. Dean[9], H. Forth[9], J. Lipton[9], J. Morris[9], R. Takeshita[9], B. Wallace[9]

[1]University of Maryland, Solomons, MD, [2]NOAA Office of Protected Resources, Gainesville, FL, [3]National Aquarium, Baltimore, MD, [4]University of Florida, Gainesville, FL, [5]University of Miami, Miami, FL, [6]NOAA Northwest Fisheries Science Center, Seattle, WA, [7]Zoo/Exotic Pathology Services, Carmichael, CA, [8]Cornell University, Ithaca, NY, [9]Abt Associates, Boulder, CO

Hundreds of externally and internally oiled juvenile sea turtles were rescued during the Deepwater Horizon (DWH) oil spill. Polycyclic aromatic hydrocarbon (PAH) metabolites in the bile and tissues of some individuals confirmed internal exposure and metabolism of oil; published data on potential effects of oil ingestion in sea turtles were limited. Therefore, we conducted a 14-day, controlled-dose ingestion study using DWH oil to examine the potential effects of internal oil exposure on red-eared sliders and common snapping turtles, which we used as surrogates for endangered/threatened sea turtles. We assessed numerous chemical, biological, and physiological endpoints, including those important for general clinical assessment, as well as additional endpoints known to respond to acute exposure to PAHs in other taxa (e.g., oxidative stress, DNA damage). Specifically, we investigated the effects on the hypothalamic-pituitary-adrenal (HPA) axis, which regulates stress response and other vital functions; researchers have observed potential HPA disruption in other vertebrate species exposed to crude oil, including DWH oil. We will present results from the full suite of physiological and toxicological endpoints examined in this study.

1:45 PM - 2:00 PM

Avian Flight Patterns, Behavior and Body Mass are Altered Following External Exposure to Deepwater Horizon Oil

C. Perez[1], J. Moye[1], K. Dean[2], K. McGlamery[1], B. Sage[1], K. Healy[3], P. Tuttle[3], C. Pritsos[1]

[1]University of Nevada, Reno, NV, [2]Abt Associates, Boulder, CO, [3]USFWS Deepwater Horizon NRDAR Field Office, Fairhope, AL

In support of the Deepwater Horizon Natural Resource Damage Assessment (NRDA), this study used the homing pigeon as a surrogate species for migratory birds to investigate the effects of a single external oiling event on their flight performance. Homing pigeons were trained out to 100 miles from their lofts and baseline flight characteristics were recorded. Following baseline flights, oil was applied to half of the birds (treated) and water was applied to the other half (control). Thereafter, all birds resumed 100-mile flights, with GPS data loggers attached. The one-time application of oil to the wing and tail feathers resulted in altered flight paths, increased flight times and increased flight distances. The oiled birds were also unable to regain body mass between flights to the same extent as control birds. These data suggest that birds exposed to oil would have experienced delayed arrival to breeding, wintering, or crucial stopover sites. Delays during avian migration are known to cause reductions in reproductive success and

survival. This work was funded in part by the Deepwater Horizon NRDA Trustees and the Nevada Agricultural Experiment Station.

2:00 PM - 2:15 PM

Method Development for Oil Toxicity Testing in Double-Crested Cormorant (*Phalacrocorax auritus*) Using Oral Dosing and External Oiling

B. Dorr[1], D. Cacela[2], **F. Cunningham**[1], K. Dean[2], K. Hanson-Dorr[1], K. Harr[3], K. Healy[4], K. Horak[5], J. Link[6], A. McFadden[2], P. Tuttle[4], S. Bursian[6]

[1]USDA APHIS NWRC, Starkville, MS, [2]Abt Associates, Boulder, CO, [3]Urika Pathology LLC, Mukilteo, WA, [4]USFWS Deepwater Horizon NRDAR Field Office, Fairhope, AL, [5]USDA APHIS NWRC, Fort Collins, CO, [6]Michigan State University, East Lansing, MI

Oral and external dosing methods replicating field exposure were developed using the double-crested cormorant (DCCO) to test the toxicity of artificially weathered Deepwater Horizon Mississippi Canyon 252 oil. The majority of previous oil dosing studies conducted on wild-caught birds used gavage methods to dose birds with oil and determine toxicity. However, rapid gut transit time of gavaged oil likely reduces oil absorption. In these studies, dosing relied on injection of oil into live feeder fish for oral dosing of these piscivorous birds, or applying oil to body contour feathers resulting in transdermal oil exposure and oral exposure through preening. Both oral and external oil dosing studies identified oil-related toxicity endpoints associated with oxidative stress such as hemolytic anemia, liver and kidney damage, and immuno-modulation or compromise. External oil application allowed for controlled study of thermoregulatory stress as well. Infrared thermal images indicated significantly greater surface temperatures and heat loss in treated birds following external oil applications; however, measurements collected by coelomically implanted temperature transmitters showed that internal body temperatures were stable over the course of the study period. Birds exposed to oil externally consumed more fish than control birds, indicating metabolic compensation for thermal stress.

2:15 PM - 2:30 PM

Weathered MC252 Crude Oil-Induced Anemia and Abnormal Erythroid Morphology in Double-crested Cormorants (*Phalacrocorax auritus*) with Light Microscopic and Ultrastructural Description of Avian Heinz Bodies

K. E. Harr[1], K. Dean[2], J. Link[3], F. Cunningham[4], D. Cacela[2], A. McFadden[2], B. Dorr[4], K. Hanson-Dorr[4], K. Horak[5], K. Healy[6], P. Tuttle[6], S. Bursian[3]

[1]URIKA, LLC, Mukilteo, WA, [2]Abt Associates, Boulder, CO, [3]Michigan State University, East Lansing, MI, [4]APHIS USDA National Wildlife Research Center, Starkville, MS, [5]APHIS USDA National Wildlife Research Center, Denver, CO, [6]USFWS Deepwater Horizon NRDAR Office, Fairhope, AL

Injury assessment of birds in the field following the Deepwater Horizon oil spill documented Heinz body formation. However, there is little information about the relationship between route and magnitude of oil exposure and induction of anemia in birds. Here we present two studies that induced anemia in wild-caught birds. In the first experiment, adult double-crested cormorants (DCCOs) were randomly divided into groups and fed oil-injected fish for up to 21 days. In the second experiment, adult DCCOs had oil (test) or water (control) applied to the breast and back feathers every 3 days, covering approximating 20% of the body surface. Whole blood samples collected during the exposure period were analyzed both by light microscopy using new methylene blue stain and by transmission electron microscopy. Oral and dermal exposure of DCCOs to weathered Deepwater Horizon crude oil induced hemolytic anemia as indicated by decreased packed cell volume, relative reticulocytosis with an inadequate regenerative response, and presence of degenerate hemoglobin, which is consistent with other reports of oil-exposed birds. Additionally, this study documented extravascular blood loss through hematochezia contributing

to the severity of anemia. Avian Heinz bodies may differ from those found in mammalian red blood cells by their cytoplasmic location and relatively consistent small size (2µm) possibly due to the nucleated cell and different cell cytoskeleton. Ultrastructural assessment of suspected Heinz bodies in birds is recommended as identification by light microscopy is challenging.

2:30 PM - 2:45 PM

Combined Effects of Polycyclic Aromatic Hydrocarbons and other Environmental Stressors on an Estuarine Fish Species

J. S. Serafin[1], M. Sepúlveda[1], T. Bosker[2], C. Perkins[3], R. J. Griffitt[4], S. De Guise[3]

[1]Purdue University, Lafayette, IN, [2]Leiden University College, DG Den Haag, Netherlands, [3]University of Connecticut, Storrs, CT, [4]University of Southern Mississippi, Ocean Springs, MS

In the spring of 2010, the Deepwater Horizon oil spill released > 3 million barrels of crude oil into the Gulf of Mexico. A major component of crude oil are polycyclic aromatic hydrocarbons (PAHs). Although the toxicity of PAHs to fish has been studied to a large extent, the combined effects of extreme abiotic factors and oil are poorly understood. *Fundulus grandis* larvae (< 24 hours post hatch) were exposed to varying environmental conditions (dissolved oxygen 6 ppm; temperature 20, 25, 30^{o}C; and salinity 3, 10, 30 ppt) combined with varying concentrations of high energy water accommodated fractions (HEWAF) (total PAHs 0 - 128 ppb) for a total of 48 hr. High temperature and salinity resulted in the lowest survival. Surviving larvae were photographed and videos of the heart at high magnification taken. There were notable abnormalities of the heart supporting previous studies showing PAH effects on the cardiovascular system. A subset of larvae will be processed for transcriptomics using next generation sequencing based on phenotypic cardiovascular changes and cyp1a expression levels. This data will be used to identify which combination(s) of environmental conditions and PAH levels are most likely to result in long-term physiological effects and therefore negatively affect population recruitment.

2:45 PM - 3:00 PM

Synergistic Effects of Deepwater Horizon Source Oil Exposures and Suboptimal Environmental Conditions during Early Life Development Stages in Sheepshead Minnow (*Cyprinodon variegatus*)

D. J. Simning

The University of Southern Mississippi, Ocean Springs, MS

Estuaries in the northern Gulf of Mexico (nGOM) are characterized by highly dynamic environments. During the summer months, seasonal hypoxic zones dominate benthic regions of the nGOM. The shallow waters of these estuaries are also subjected to high temperatures and salinity fluctuations. Many recreational and commercial species use the estuaries as nursery grounds and have adapted to withstand wide ranges of temperatures, salinities, and dissolved oxygen levels. During the summer of 2010, approximately five million barrels of crude oil were released into these environments as a result of the Macondo Deepwater oil rig explosion. The purpose of this project is to evaluate the synergistic effects of varying abiotic factors in combination with oil exposure on early life development of the sheepshead minnow (*Cyprinodon variegatus*). To examine these effects, early life stages were divided into three categories: embryonic, post-hatch, and post larval. Immediately after each transition period sheepshead minnow larvae were exposed to four concentrations of HEWAF (6.25%, 12.5%, 50% and 100% of 1g/L stock solution) under different oxic (2.5 mg/L and >5.0 mg/L) and salinity (10 and 30 ppt) regimes, while temperature was maintained at 30°C. After the 48 h exposure period, larvae were transferred to normoxic clean water to monitor growth and mortality for up to 10 days. Whole body tissue samples were collected directly after the 48 h exposure period and at experimental termination to assess gene expression. Increased cumulative mortality in the post-larval exposures under both oxide

regimes at 10 ppt salinity was observed when compared to the other developmental stages suggest that this developmental stage may be the most sensitive to the synergistic effects of oil contamination under suboptimal environmental conditions.

3:30 PM - 3:45 PM

Tracking Biologically Significant Endpoints in Oil Exposed Adult Fish of the Gulf of Mexico using Large Scale Mesocosm Systems

D. L. Wetzel[1], T. Sherwood[1], S. Murawski[2], K. Main[1]
[1]Mote Marine Laboratory, Sarasota, FL, [2]University of South Florida, St. Petersburg, FL

Short-term effects of oil spills are generally easily observed, but, long-term effects and recovery processes of impacted species and ecosystems are much more difficult to ascertain. Readily-observable endpoints that serve as measures of effect are normally not very pertinent in terms of biological or ecological relevance. To address this issue, we use a suite of biochemical endpoints that bridge exposure-related observations along a continuum of responses by using large mesocosm controlled exposure studies. Oil exposure studies are utilized to measure sublethal responses of such exposures in multiple pathways (dietary, water, and sediment) in marine fish. Adult fish are used to facilitate understanding of toxicokinetics of oil exposure pathways (e.g., dermal, gills, ingestion). To empirically assess effects of exposure to oil, biomarkers are being measured to determine biologically significant responses on immune system function, reproductive potential and genotoxicity. To establish causal linkages and relate molecular responses to fish health, we are interconnecting field, laboratory and mesocosm studies. These experiments are being carried out at Mote Aquaculture Park (Sarasota, FL) using hatchery reared pompano, red drum and southern flounder, which occupy three different GoM habitats. This study includes acute oil exposures and chronic low-level oil exposures followed by acute exposures. This presentation discusses exposure study design and results to date.

3:45 PM - 4:00 PM

Transcriptome Characterization of an IP Crude Oil Injected Non-model Fish Species; Red Drum (*Sciaenops ocellatus*)

T. A. Sherwood, D. Wetzel
Mote Marine Laboratory, Sarasota, FL

To better understand the biological mechanisms of fishes effected by exposure to oil, a study was conducted in which red drum were intraperitoneal injected (IP) with crude oil and then tissues removed for transcriptome analyses. Intraperitoneal injection is a common procedure in fish toxicity studies. Though this procedure does not simulate natural exposure to oil it can be useful in identify potential biological changes. In addition, RNA sequencing (mRNA-seq) is a technology that gives a snap shot of all the gene transcripts in a tissue at a given moment of time. One key advantage of this type of gene expression analysis is that no genome information is needed making it ideal for non-model wild species, such as red drum. For the transcriptome analysis 2 red drum fish were chosen, a non-injected control and one IP injected with 2 ml of crude Deepwater Horizon source oil per kg body weight. The injection procedure consisted of 2 injections 48hrs apart and the fish were sacrificed at 72hrs post first injection and the head kidney, liver and gonads were removed. RNA was extracted from the tissues of each animal and sequenced using the Illumina HiSeq2500 platform and bioinformatics done by Omega Bioservices (Norcross, GA). An average of 40 million reads per sample is generated and differential gene expression analysis of the reads for each tissue type of the 2 red drum will be presented.

4:00 PM - 4:15 PM

Species Specific Metabolic Capacity of PAHs in Three Species of Marine Teleosts Exposed to Deepwater Horizon Crude Oil

E. L. Pulster, S. A. Murawski
University of South Florida, St. Petersburg, FL

Understanding teleost metabolic capacity of the Deepwater Horizon oil is critical in gaining insight into their hepatic biotransformations and physiological resilience. Polycyclic aromatic hydrocarbons (PAHs) are metabolized and excreted rather rapidly through the hepatobiliary system, however the biotransformation process can result in immunotoxic PAH metabolites. The present study investigates the species specific metabolic capacity of PAHs in three species of fish representing various life-history patterns, southern flounder (*Paralichthys lethostigma*), red drum (*Sciaenops ocellatus*) and Florida pompano (*Trachinotus carolinus*). Biliary measurements were conducted on control fish and fish treated with an intraperitoneal injection of 2mL MC252 crude / kg body weight using a 2:1 crude oil to corn oil matrix. Fish were sacrificed after 24 hour exposures and 72 hour exposures with a 48 hour re-injection. Biliary PAH estimates were measured using high performance liquid chromatography with fluorescence detection (HPLC-F) and gas chromatography coupled to tandem mass spectrometry (GC-QQQ) for metabolite quantification and confirmation.

4:15 PM - 4:30 PM

Development and Validation of Toxicokinetic Models for Evaluating PAH Impacts on Gulf of Mexico Fishes

S. A. Murawski
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Field-oriented sampling studies and controlled exposure trials have revealed the degree and consequences of polycyclic aromatic hydrocarbon (PAH) contamination of Gulf of Mexico fishes in the wake of Deepwater Horizon incident. PAH contamination can have lethal and sub-lethal impacts depending on the concentration, specific constituents, duration, and modality of exposure. To ascertain the population-level consequences of both chronic, low-level PAH exposures and the associated impacts of an acute event, either alone or in synergy, a series of increasingly detailed models of exposure, uptake, depuration and impact were developed. Unlike many previous approaches, model impacts were evaluated on the basis of population fitness of wild stocks potentially exposed to PAHs. Lethal impacts include those to eggs, larvae, juveniles and adults. Sub-lethal impacts on reproductive output, growth, productivity and genotoxicity are included in model outcomes. This paper identified key model parameters determining population outcomes as a basis for ongoing exposure experimentation and field data collections.

4:30 PM - 4:45 PM

EPA's New Oil and Dispersant Testing Program

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The U.S. EPA Office of Research and Development has initiated a new component of its oil spills research program to develop baseline data on the ecotoxicity of selected petroleum products, and to evaluate the ecotoxicity and efficacy of several oil-dispersant mixtures. Two diluted bitumens (dilbits) from the Alberta Tar Sands are being tested for acute and chronic toxicity to standard freshwater and marine

organisms given their spill potential during shipment within the United States. Separately, testing with two potential reference crude oils representing a range of characteristics, and their mixtures with four representative dispersants, are being tested to evaluate acute and chronic toxicity to marine organisms in support of Subpart J of the U.S. National Contingency Plan. Water accommodated fractions (WAF) of oil are prepared using traditional slow-stir methods and toxicity tests generally follow U.S. EPA standard effluent testing guidelines. WAFs are characterized for petroleum hydrocarbons including alkyl PAH homologs. Dispersant efficacy is tested with oil-dispersant mixtures of the two crude oils and four dispersants using the baffled flask test. The results of these studies will assist the U.S. EPA to assess toxicity data for unconventional oils (dilbits), establish baseline toxicity data for selected crude oils, and evaluate efficacy of oil-dispersant mixtures in support of planning and response activities.

Data Portals, Integrated Datasets, and Tools Supporting Researchers Synthesizing Gulf of Mexico Oil Spill and Ecosystem Science

1:45 PM - 2:00 PM

BCO-DMO: A Resource for NSF Funded Marine Research Data

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Oceanography is an interdisciplinary science requiring access to a vast array of different types of data. Many of the data types represent in situ environmental measurements that can only be collected once in space and time. Both of these factors point to an increased need for stewardship of marine research data. Marine research under normal conditions requires comprehensive data management procedures that address all phases of the research data life cycle from 'proposal through preservation'. The occurrence of an episodic event, whether due to natural or anthropogenic causes, often highlights the gaps in data management as stakeholders realize the difficulty in locating and retrieving essential data. The Deep Horizon event was such an occurrence. Following the event, researchers and policy makers were frustrated at the lack of baseline data. Ability to assess the impact of an episodic event and subsequent recovery over time is compromised if baseline data are not available. In addition to being made freely available, research data must be accompanied by discipline-specific documentation that describes the full provenance of those data. Documentation, or metadata, is essential to support efficient discovery of the resources and accurate re-use of the data. The Biological and Chemical Oceanography Data Management Office (BCO-DMO; bco-dmo.org) has been funded since late 2006 to manage data from research projects supported by the Polar Programs and Ocean Sciences Divisions of the National Science Foundation (NSF). BCO-DMO personnel work closely with NSF funded PIs and their associates to provide data stewardship services from 'proposal through preservation'. As a result of this partnership the BCO-DMO data system now provides access to more than 7600 data sets from more than 580 projects, 2100 deployments, and 1900 researchers. The data from research conducted in coastal regions, oceans, Great Lakes and the Gulf of Mexico include the full range of marine ecosystem related measurements including: in situ data from cruises, moorings, floats and gliders; results from laboratory experiments and models; and synthesis products from data integration efforts.

2:00 PM - 2:15 PM

Managing and Accessing Integrated Natural Resource Damage Assessment (NRDA) Data from the Deepwater Horizon Oil Spill

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The Deepwater Horizon oil spill in the Gulf of Mexico in 2010 and the ongoing Natural Resource Damage Assessment have generated unprecedented amounts of environmental data and analysis. As a trustee for Natural Resources, NOAA's Office of Response and Restoration faced the challenge of managing and integrating many datasets from many separate scientific studies and collection systems with varying levels of documentation and different structures. Our team addressed this challenge by leveraging "big data" techniques and developing a data warehouse and information portal built with Open Source tools for ingesting, integrating and organizing information. We have organized data holdings into "data models" including Samples, Observations, Photographs, Telemetry, and Oceanographic data directly connected to field collected information with lab results and supporting information. We further developed custom query tools which facilitate searching across all data holdings with an interactive

dashboard of charts, tables and a map. This novel data management and query approach is called DIVER (Data Integration, Visualization, Exploration, and Reporting), and forms a primary portal for searching the data on which the injury assessment is based. We recently released a massive amount of environmental data through the publicly accessible Deepwater Horizon DIVER application (https://dwhdiver.orr.noaa.gov), providing the scientific community with the ability to explore and export a vast amount of data, analysis and results.

2:15 PM - 2:30 PM

NOAA's National Database of Deep Sea Corals & Sponges: A Resource to Inform Conservation and Management, and Baseline Habitat Conditions in the Gulf of Mexico

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Corals and sponges are key structural components of deep-sea benthic habitats, but their community and ecosystem dynamics remain poorly understood. The Gulf of Mexico is a cradle of activities, such as oil and gas development, fishing, and land-based pollution that can affect these communities, and has become a focus for science, and exploration. NOAA's Deep Sea Coral Research and Technology Program is compiling a national database of deep-sea corals and sponges, with data ranging from historical trawl records to recent submersible or ROV observations. With 15,000 records within the Gulf of Mexico, this tool will provide managers and researchers access to location-based data and associated reports. Records are compiled continuously, analyzed for taxonomy, accuracy, and ecological significance. Depth distribution, condition, and habitat composition. Data across 215 Gulf coral and sponge genera, will provide a baseline for predicting ecosystem impacts from oil spills, climate change, and commercial fishing. To apply this concept, we will present data on the distribution of a select group of octocoral species known to be affected by the spill. The map-based portal, which went live September 2015, is a result of collaboration between NOAA and Regional Fishery Management Councils, other federal agencies, and international, non-governmental, and academic scientists.

2:30 PM - 2:45 PM

A Geospatial Tool for Discovery and Access of Bureau of Ocean Energy Management's Gulf of Mexico Ocean Science

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The Environmental Studies Program of the Bureau of Ocean Energy Management (BOEM) has been conducting ocean research for more than 40 years to guide responsible management of offshore energy and minerals resources. The results of this research, largely study reports, have historically been made available through the Environmental Studies Program Information System (ESPIS). BOEM has partnered with the NOAA Office for Coastal Management to redesign ESPIS building on the success of another BOEM/NOAA partnership, MarineCadastre.gov. The new system allows unprecedented discoverability of historical and current research results. Relevant research findings distributed across the Internet such as conference proceedings, online datasets, and scientific journals articles are all linked within an architecture that allows the user to search and discover information using text and map based geospatial searches. We will present a demonstration of this tool and discuss how researchers, managers, and policymakers can access and discover the results of BOEM's oil spill and ecosystem science information in the Gulf of Mexico.

2:45 PM - 3:00 PM

An Inventory of Long-term Monitoring Efforts in the Gulf of Mexico: A Tool for Data Integration

M. Love[1], **A. Baldera**[2], C. Robbins[2], B. Spies[3]

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As restoration from the BP oil disaster continues, long-term ecosystem monitoring is essential for understanding if resources are recovering and how changes in the Gulf of Mexico ecosystem are influencing their rate of recovery. With this context and in order to assist in the development of a robust ecosystem monitoring network, Ocean Conservancy compiled an inventory of long-term monitoring efforts in the Gulf. Our goal was to catalog long-term monitoring efforts for 13 natural resource categories, from animals to abiotic conditions. Through our work we identified over 800 monitoring surveys and are planning to develop an online portal where users can access and update metadata. The inventory and eventual online tool could benefit researchers or resource managers by helping them leverage and integrate existing datasets into studies or restoration activities, potentially avoiding costly duplication of work. We will present an overview of our methods and a synthesis of information included in our monitoring inventory, as well as our plans to create an online portal to facilitate data sharing and improve monitoring coordination.

3:30 PM - 3:45 PM

Integrated Biogeographic Assessments: Objective Approaches for Synthesis of Multidisciplinary Data and Applications for Supporting Management, Restoration, and Conservation of Marine Ecosystems

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This paper presents the Biogeographic Assessment Framework (BAF) as a multi-faceted process for integration and synthesis of complex socio-ecological-oceanographic data. BAF was developed to compile, evaluate, integrate and analyze a broad range of multi-disciplinary data for characterizing ecosystem patterns and processes and to support marine spatial planning. Since the Deep Water Horizon Oil Spill, scientific research and data collections in the Gulf of Mexico region have focused not only on characterizing short-term impacts but also on developing baselines from which longer-term impacts, benefits from ecosystem restoration efforts, and ultimately coastal resilience - defined as the capacity of human and environmental systems to adapt to and recover from change - could be measured. These priorities already have resulted in a vast wealth of biological, oceanographic and social science data and information being collected across at varying spatial scales for the Gulf region. We suggest that there is a dire need for strategic management and synthesis of scientific data and other information to support future Gulf-wide marine planning and ecosystem restoration efforts. Here we present three case-studies demonstrating data integration and geospatial analyses through regional biogeographic assessments that provide objective information frameworks for marine planning, coastal management, ecosystem restoration, and long-term conservation. In the Florida Keys archipelago, we integrated data on a suite of marine resources and human-uses to provide coral reef managers of the Florida Keys National Marine Sanctuary with a systematic review of existing zoning regulations and make conservation decisions based on the best-available and most comprehensive science. For the U.S Atlantic and Gulf of Mexico, we integrated spatial information and used statistical spatial models that combine databases of known deep-sea coral beds with information about key habitats to predict and map suitable habitat for deep-sea corals in the U.S. Atlantic and Gulf of Mexico. These case-studies

demonstrate that integrated biogeographic assessments can offer a suitable framework for data synthesis and analysis to meet ecosystem management, restoration, and conservation needs in the Gulf of Mexico region.

3:45 PM - 4:00 PM

Influence of Physical Processes on the Concentration of Suspended Particulate Matter Derived from MODIS Reflectance at 645 nm in the Mississippi Sound

S. J. O'Brien[1], P. Fitzpatrick[2], B. Dzwonkowski[3], D. J. Wallace[1], I. Church[1], J. D. Wiggert[1]
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The Mississippi Sound is influenced by a high volume of sediment discharge from the Pearl River, Wolf River, Biloxi River, Pascagoula River, Mobile Bay via Pas aux Herons and Lake Pontchartrain through the Rigolets. The river discharge, variable wind speed, wind direction and tides have a significant impact on the transport and resuspension of sediments in the Sound. Level 1 Moderate Resolution Imaging Spectroradiometer (MODIS) data is processed to extract the remote sensing reflectance at the wavelength of 645 nm and binned into an 8 day composite at a resolution of 500 m. The study uses an algorithm to compute suspended particulate matter (SPM) concentration based on the composite image. The MODIS-based SPM will be compared with suspended sediment concentration (SSC) measurements obtained during Coastal River Dominated Ecosystems (CONCORDE) small boat operations. Mechanisms underlying the observed spatiotemporal distribution of SPM will be explored using 2-D Real-Time Mesoscale Analysis, and time series of tides, wind, turbidity and river discharge measured at federal and academic institutions' stations and moorings. The results are incorporated into the CONCORDE consortium's efforts to acquire a comprehensive understanding of potential pathways for oil and dispersants to enter the coastal waters Mississippi Sound.

4:00 PM - 4:15 PM

Uniform Data Access through Distributed ERDDAP/TDS

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We use two popular web-accessible standards-based data servers in tandem to catalog and serve oceanographic data in a way that makes adding data to our holdings easy and offers the data consumer an efficient and uniform way to access and acquire data using OPeNDAP enabled software packages such as Matlab, IDL and Python. The two servers are ERDDAP (Environmental Research Division's Data Access Program) and TDS (Thematic Real-time Environmental Distributed Data Services Data Server). ERDDAP is a standards-based data server which provides many additional services including format transformation, remote sub-setting, change notification, graphics and more. ERDDAP supports machine-to-machine exchanges through constrained URLs and has an effective human interface. TDS is efficient, can build catalogs dynamically and can create virtual aggregations to make numerous related files appear as one. ERDDAP and TDS are in widespread use and are used to serve many different types of data including biological. Our challenge was to offer remote sub-setting of collections of files (e.g., selecting individual CTD profiles by date-time and location) rather than subsets of a padded monolithic file containing all of the data contained in the individual files. This presentation will demonstrate how very simple codes can select and import remote data into popular scientific software programs with or without downloading the files to local disk storage.

4:15 PM - 4:30 PM

Digital Object Identifier: Evolving Standard as a Persistent Identifier

F. Gayanilo

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The needs and requirements for an effective persistent identifier (PI) have evolved since it was initially introduced in the mid-1990s. Traditionally, Unified Resource Locators or URLs were used but challenges to keep URLs current has led to the introduction of many other PIs designed to be unique and direct investigators to the digital object. The Digital Object Identifier or popularly known as DOI has evolved as the industry standard and has become a requirement for many digital object repositories like journal and book publishers and increasingly, data centers. This paper evaluates the organization behind the DOI and elements that make its utilization an industry preference. A review of the workflow, from securing an identifier to using it to locate a digital object and to other functions available from DOI providers not commonly used will also be presented.

4:30 PM - 4:45 PM

Integrating Multi-Source Biophysical Data through a Virtual Antenna System

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In recent decades, the technology used to observing ocean biophysical variables has improved considerably. These include observations from satellites and ships as well as numerical models. A remaining challenge is effective delivery of the information generated from these observations in a user-friendly way to a diverse group of stakeholders. Here we demonstrate the data integration and information delivery through a Virtual Antenna System (VAS) and Virtual Buoy System (VBS) through two examples: one focused on near real-time tracking of red tides caused by the toxic dinoflagellate Karenia brevis, which annually threatens human and environmental health in the eastern Gulf of Mexico, and the other on coastal water quality state and long-term trend. The systems integrate three different data products through a custom-made web interface: 1) near real-time satellite ocean color data tailored bloom and water quality assessment; 2) K. brevis cell abundance determined by sample analysis; and 3) ocean currents from numerical models. These products are integrated and made available to users in Keyhole Markup Language (KML) format, which can be navigated, interpreted, and overlaid with other products in Google Earth. Furthermore, the data extracted from virtual stations in both graphical and ASCII formats may be used to assess the current water quality state and long-term trends.

4:45 PM - 5:00 PM

Case Study Analysis of the Real-Time Mesoscale Analysis (RTMA) in the Northern Gulf of Mexico

P. Fitzpatrick, Y. Lau

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Atmospheric forcing of high-resolution ocean models is an important component to address CONCORDE's ocean plume studies along coastal Louisiana, Mississippi, and Alabama. Deliverables include determining the optimal use of reanalyses fields, and the best model background to use. One candidate is NOAA's Real-Time Mesoscale Analysis (RTMA) with 2.5-km grid fields. We will examine RTMA's ability to replicate mesoscale wind and thermodynamic fields for two week periods in Summer and for Fall 2015. The evaluation will include subjective comparisons of RTMA versus mesoscale maps and standard metric validation. Understanding RTMA's properties is a necessity for the 1-km synthetic

atmospheric forcing dataset being developed for CONCORDE's high-resolution ROMS' ocean modeling efforts in the Mississippi Sound, in which 2DVAR and OI methodologies are being explored. The atmospheric dataset is synthesized from various sources:

a. Radar data provided by NOAA's National Climate Data Center Hierarchical Data Storage System: for hourly accumulated rainfall

b. High-resolution AVHRR SST data provided by NOAA's Atlantic Oceanographic & Meteorological Laboratory.

c. Model background data provided by RTMA and the North American Model (NAM) from NOAA's Operational Model Archive and Distribution System; for momentum and thermodynamic fields

d. Observations are provided by NOAA's Meteorological Assimilation Data Ingest system and WeatherFlow's coastal mesonet, including a new platform near Ship Island funded by CONCORDE

Momentum stress and fluxes are computed using the COARE flux algorithm 3.0.

Large Marine Vertebrates as Indicators of Ecosystem Recovery, Resilience and Restoration Success

1:30 PM - 1:45 PM

Assessment of Large Marine Vertebrate Monitoring in the Gulf of Mexico - the Foundation for a Deepwater Horizon Oil Spill Recovery Monitoring Program

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Restoration and recovery of the marine ecosystem from the BP oil disaster will require a system of integrated assessment programs to track the status and recovery of injured resources and coordinate across restoration efforts. In the absence of integration to guide decision makers, fiscal restoration investments in the Gulf will be made with a high degree of uncertainty regarding desired outcomes. There is a foundation of monitoring infrastructure in the region that gathers information on different components of the marine ecosystem. Ocean Conservancy has assessed long-term monitoring activities in order to identify those that could track recovery of injured resources and critical ecosystem drivers. During our analysis we identified important gaps based on identified monitoring priorities and needs. In addition to identifying monitoring efforts and priorities for natural resources in the NRDA injury categories, we documented the spatial and temporal coverage of the monitoring programs along with their sampling frequency and other related information. Our hope is that a science-based evaluation of resource information needs will lay the foundation for recovery planning, which could be integrated with supplemental research and monitoring to support a comprehensive ecosystem assessment framework. We will present results of this gap analysis for marine vertebrates, with conclusions on long-term monitoring needs under a DWH Damage Assessment and Restoration Program.

1:45 PM - 2:00 PM

Testing the Genomic Impacts of the DWH Oil Spill on Red Snapper

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Red snapper (*Lutjanus campechanus*) historically has supported extremely important commercial and recreational fisheries in U.S. waters, but the long-term ecological and evolutionary impacts of the Deepwater Horizon oil spill on red snapper remain relatively unknown. The advent of next-generation sequencing technology has transcended fishery genetics from a simple approach (survey of a handful of genetic markers) to a complex genomics approach where thousands of loci across the genome can be assayed. Using restriction-site associated DNA tags (RAD tags), we surveyed variation in >4,000 single nucleotide polymorphisms (SNPs) from red snapper sampled at two geographic localities: one near the originating wellhead and one at a control site. We used Bayesian outlier detection to look for strongly differentiated loci between the two sites that may be potential targets for direct selection. Additionally, measurements of contaminant load derived from the tissue of each fish was used with a random-forest algorithm to detect loci that show a small correlated response to pollutant load which may be evidence for polygenic selection. Finally, loci putatively under selection were searched against genetic databases to infer gene ontology pathways and potential mechanisms for selection.

2:00 PM - 2:15 PM

Development of a Gulf-wide Monitoring Scheme for Breeding Tidal Marsh Birds

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More than 50% of North American tidal marshes are found along the Gulf of Mexico [GoM], making them critical resources for marsh birds inhabiting this region. In the northern GoM studies of breeding marsh birds have occurred primarily in Mississippi and Alabama. The GoM is currently the focus of a broad-range of restoration, recovery, and conservation activities and the birds that breed in these habitats figure prominently in these programs. A recent effort to develop a GoM-wide Bird Monitoring framework is focused around three fundamental objectives across the region: (1) develop status assessments for bird species or guilds, (2) understand the impacts of management practices on GoM bird populations, and (3) understand the effects of ecological processes as drivers of bird populations in the GoM. Our presentation will illustrate the application of a Gulf-wide two-stage cluster sampling design for breeding tidal marsh birds and highlight key elements of the Standardized North American Marsh Bird Monitoring Protocol. Examples of current marsh bird monitoring efforts will emphasize the utility of this approach toward informing both species-specific and ecosystem-based response to Gulf activities. The proposed approach is flexible, allowing incorporation of historic data, integration with other local and regional monitoring programs, and application to adaptive management programs at multiple scales.

2:15 PM - 2:30 PM

Establishing Explicit Biological Objectives to Guide Strategic Habitat Conservation for the Gulf of Mexico Coast: Case Study with the Brown Pelican

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Wildlife losses were some of the most conspicuous effects of the Deepwater Horizon oil spill. In the wake of numerous settlements and judgments, many restoration efforts direct benefits toward impacted species. Success of these efforts requires clear objectives that represent the many partners involved in Gulf restoration. Thus, the USFWS and USGS are collaborating with gulf conservation partners to define (1) focal conservation areas, (2) population objectives for species that are representative of these areas, and (3) habitat objectives necessary to achieve those population objectives. To date, the team has defined and mapped fifteen biological planning units (BPU) on or adjacent to the Gulf Coast, identified 108 species representative of BPU habitats, and gathered population objectives for each species from the literature. For a subset of species, the group is deriving habitat objectives from spatially explicit Bayesian networks (i.e., models of the relationships between habitat characteristics and population objectives). When coupled with the established population objectives, the model outputs provide insight into how much habitat is available, how much more is needed, and where conservation or restoration efforts most efficiently achieve established objectives. A case study of the Brown Pelican (*Pelecanus occidentalis*) will be used to demonstrate the benefits of this approach for informing restoration and monitoring efforts, including for large marine vertebrates.

2:30 PM - 2:45 PM

Determining Pre-Disaster Baselines after the Disaster: Impact of the Deepwater Horizon Oil Spill on Sea Turtle Foraging

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Assessments of the impact of large-scale disastrous events, such as the Deepwater Horizon oil spill, on animal populations have been plagued by a lack of baseline data. Here, we use stable isotope analysis of long-term biological tissue records to provide critical pre-disaster data for endangered marine vertebrates. Keratin samples from the carapace of loggerhead sea turtles record the foraging history for up to 18 years, which allowed us to evaluate the effect of the oil spill on sea turtle foraging patterns. Samples were collected from 76 satellite-tracked adult loggerheads in 2011 and 2012, approximately one to two years after the spill. Of the ten individuals that foraged in areas exposed to surface oil, none demonstrated significant changes in foraging patterns following the oil spill. The observed long-term fidelity to foraging sites indicates that loggerheads in the northern Gulf of Mexico likely remained in established foraging sites, regardless of the introduction of oil and chemical dispersants. Additional research is needed to address potential long-term health consequences to turtles in this region. Mobile marine organisms present challenges for researchers to monitor effects of environmental disasters, both spatially and temporally. We demonstrate that biological tissues can reveal long-term histories of animal behavior and provide crucial pre-disaster baselines following natural or anthropogenic disturbance.

2:45 PM - 3:00 PM

Recent Decline of the Kemp's Ridley Sea Turtle-An Oil Spill Impact on Age Structure or Density Related Change in Vital Rates?

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Following over a decade of an exponential increase, Kemp's ridley nesting at their key index nesting beaches reflected a marked decline in 2010, rebounded in 2011 to a level somewhat below the 2009 peak and has declined since that time. Some suggest that the observations may reflect an unprecedented mortality in subadult and adult females that occurred between the ends of the 2009 and 2010 nesting seasons. However, the recent downturn in nests could also be explained by changes in reproductive rates (i.e. clutch frequency and remigration intervals). A mark/recapture study was initiated at the index nesting beaches in 2014 to address these issues. During 2014, 910 nesting females were examined for tags and/or tagged at the Rancho Nuevo nesting beach. Of these, 89% were classified as putative "neophytes" based on the absence of tags or tagging scars, and their general appearance. One "old" previously tagged female and 27 females tagged in 2014 nested twice; all others were observed nesting only once. In 2014, 70% of the turtles were tagged in June and July. In 2015, the surveys were expanded and 989 turtles were tagged. Of these, 86% were considered neophytes. Of the total, 942 were observed to nest only once, 46 twice and 1 nested 3 times. A total of 88% were tagged in April and May. One turtle tagged in 2014 was recaptured in 2015. The nesting population appears dominated by neophytes and future data will yield information on changes in reproductive rates.

3:30 PM - 3:45 PM

Long-term, Consistent Data Sets from Stranded Marine Mammals are an Important Tool for Understanding the Impacts of and Monitoring Recovery from the Deepwater Horizon Oil Spill

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The northern Gulf of Mexico (NG) cetacean unusual mortality event (UME) includes the highest number of common bottlenose dolphin (*Tursiops truncatus*) strandings associated with a UME in the Gulf of Mexico (GOM) and overlaps in time and space with the Deepwater Horizon (DWH) oil spill. Detailed sample collection protocols were implemented and a review of data from previous UMEs in the GOM showed differences in this event. A comparison of 20 years of historical stranding records to the NGUME strandings through June 2013 identified four clusters of elevated bottlenose dolphin mortalities. Three out of four clusters occurred after the spill, within coastal areas that received the heaviest oiling. In addition, histologic lesions in dolphins stranded during the NGUME from June 2010 to December 2012 were compared to lesions in reference dolphins stranding outside of the NGUME area and timeframe. Compared to references, NGUME dolphins larger than 115 cm were more likely to have primary bacterial pneumonia (22% vs. 2%), severe pneumonia (15% vs. 2%), and thin adrenal cortices (33% vs. 7%). These investigations highlight the importance of long term, consistent collection of demographic and necropsy data from stranded animals to allow spatial and temporal comparisons when investigating anomalous events. Continued, consistent data collection from stranded marine mammals will be critical to evaluate whether animal health is improving and populations are recovering from the DWH oil spill.

3:45 PM - 4:00 PM

Gulf of Mexico Pelagic Dolphin Density Trends from Passive Acoustics

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Passive acoustic monitoring (PAM) recordings were used in the Gulf of Mexico (GOM) to assess the effects of the Deepwater Horizon (DWH) oil spill on offshore dolphin populations. Single sensor, High frequency Acoustic Recording Packages (HARPs) were deployed for five years at five sites in the GOM, beginning in May 2010, during the DWH event. A framework for long-term, high-resolution, quantitative monitoring of dolphin population densities based on echolocation clicks was developed to analyze this dataset. Density estimates were produced by bringing together click detections, associated detection probabilities, and species-specific click rates. Results include time series of weekly site-specific density estimates for Risso's dolphin (*Grampus griseus*), short-finned pilot whales (*Globicephala macrorhynchus*) and *Stenella* spp. Distinct annual cycles in animal density in the northern GOM are found, with peak densities for most species in spring and summer months. Seasonal cycles are less pronounced at southern GOM sites. Species composition differs between continental slope and shelf sites. Long-term

increases in local densities were observed for *Stenellid* dolphins and pilot whales at sites east of the DWH site.

4:00 PM - 4:15 PM

Temporal and Seasonal Trends in Deep-Diving Cetacean Presence in the Gulf of Mexico following the Deepwater Horizon Oil Spill

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The Gulf of Mexico (GOM) is known to provide habitat for seven species of deep-diving cetaceans including sperm whales, pygmy and dwarf sperm whales, and four species of beaked whales. Long-term passive acoustic monitoring began in May 2010 at three sites along the GOM continental slope, providing records of cetacean presence during and following the Deepwater Horizon oil spill. Echolocation clicks produced by deep-diving cetaceans were detected and classified to species. Using echolocation click characteristics and detection ranges, time-series of local population density estimates were made by species for each site. Higher densities of sperm whales and pygmy/dwarf sperm whales were found in the northern GOM than in the southern GOM, whereas beaked whales were found at higher densities in the southern GOM. Gervais' beaked whales were present at all sites throughout the monitoring period, but Cuvier's beaked whales were present in the northern GOM only seasonally, with periods of low density during summer and higher density in winter. Density of Gervais' beaked whales increased in the northern GOM and decreased in the southern GOM from 2010-2013. By identifying temporal and seasonal changes in the presence of these species and relating them to anthropogenic and natural forces through environmental modeling, we aim to test for potential impact of the oil spill on deep-diving cetaceans.

4:15 PM - 4:30 PM

A Gulf-Wide Population-Habitat Model for Bottlenose Dolphins Reveals Strongest Response to Moderate Levels of Oil and Gas Rig Density

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The largest cetacean Unusual Mortality Event is occurring in the northern Gulf of Mexico (nGOM) with bottlenose dolphins (BD) comprising the largest fraction of strandings. Knowledge of BD spatial variation in the nGOM's continental shelf at fine scale is limited. Conventional abundance models for BD over large areas of the nGOM, lack environmental factors that may help identify preferred habitat in a changing environment. Availability of GOM data at fine scales allows modeling population-habitat relationships and predicting distribution for various environmental scenarios. We used vessel transect and environmental data to: 1) determine significant predictors of BD abundance in the nGOM, 2) characterize BD response to predictors at fine scale. Predictors included: oil/gas rigs; distance to the Mississippi River delta; depth and chlorophyll among other attributes. We used GIS, density surface and GAM techniques to fit the BD abundance-habitat model on the nGOM shelf. BD abundance was larger than 50,000 (CV=0.16) yielding higher precision than previous design-based models. On a prediction grid (20x20 km cells) for summer conditions, BD distribution was highly patchy. Dolphin responses to environmental predictors were non-linear. The largest positive response to depth occurred at approximately 25 meters. Moderate rig density triggered maximum response. This approach is useful to evaluate potential impacts of human activities, such as oil spills, on BD stocks. This study highlights the

need to incorporate anthropogenic factors in abundance models of species inhabiting human-modified environments such as the nGOM.

4:30 PM - 4:45 PM

Monitoring the Foraging Behavior of Sperm Whales as Apex Predators Reveals Likely Changes in Benthic Communities Affected by Oil around the Macondo Spill

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We used Argos satellite radio tags to document sperm whale movements in the Gulf of Mexico pre-Macondo oil spill (2001-2005) and post-spill (2010-2013). In 2011 and 2013 we used 11 Advanced Dive Behavior (ADB) tags with time-depth-recorder, Fastloc-GPS and tri-axial accelerometer to describe movements and body orientation, including lunges as a proxy for foraging effort. ADB tags detach from the whale at pre-set times and float to the surface to download complete records. GPS position gave us water depth. Sperm whales eat squid. Tags reported lunges almost exclusively at the deepest part of dives up to 45d. Whales covered large areas with highly variable lunge events/dive, suggesting a patchy distribution of squids. An oblong of ~4,000 sq.km, including the spill site, was identified from tag movements between females in deeper waters and those on the upper slope as low-use habitat (LUH) and coincides with benthic oil-contaminated sediments. We identified three dive types: deep foraging near the bottom, mid-water foraging, and transiting (no lunges). Five of six whales with the most data, preferred feeding near the bottom. One such whale averaged 9 lunges/dive on the continental slope and then circumnavigated the LUH over 3 days with 90% fewer lunges/dive along the deep-water (south) side. Further, 85% of dives on the south side were categorized as “transit”, suggesting very few squids were present. Sperm whales may prefer bottom foraging because squids there are more abundant, are preferred species or can be more easily captured, making longer and deeper dives more “cost effective”. Near-bottom dwelling squids likely forage on demersal fish. We hypothesize sperm whales are not feeding in the LUH because bottom contamination has reduced bottom-dwelling fish, thus affecting the distribution of squids. Our data suggest tracking whales periodically can effectively estimate the size and duration of habitat effects from oiled sediments on the benthic community. Establishing the consequences of this trophic cascade is essential to estimating long-term Impacts and cumulative effects from this and subsequent spills that could lead to population-level consequences throughout the food web.

Determination of the Oil Droplet Size Distribution and Its Impact on the Fate and Transport of Oil: Consequences on Public Health and Ecology I

1:30 PM - 2:00 PM

Oil Droplet Production: Significance on Oil Persistence and Ecological Impacts

K. Lee[1], M. Boufadel[2], L. Zhao[2], X. Geng[2], T. King[3], B. Robinson[3]

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The formation of oil droplets by physical and chemical enhanced dispersion processes has gained a lot of interest since the Deepwater Horizon blowout. Oil droplet formation has been linked to transport of the spilled oil and its persistence in the marine environment. While there is evidence that the impact of the spill within coastal regions may have been mitigated by the formation of oil droplets, concern has also been raised that chemically dispersed oil within the Gulf of Mexico may have caused detrimental impacts on both pelagic and benthic biota, as well as the health of oil spill responders and the communities. A greater understanding of the interactive physical, chemical and biological processes controlling oil droplet formation, its fate and effects (at an ecosystem level) is required for Net Environmental Benefit Analysis (NEBA) for the selection of oil spill countermeasure options to be taken in the event of an accidental spill. These data have been provided by the conduct of laboratory experiments, mesocosm (wave tank) studies, and post-spill incident monitoring programs. We provide a brief review on the state of science of oil dispersion focusing on their impact on the ecology and public health.

2:00 PM - 2:15 PM

Interaction of Oil Droplets and Gas Bubbles in Blowouts: New Development of VDROP Model

L. Zhao[1], M. Boufadel[1], T. King[2], B. Robinson[2], K. Lee[3]

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The interaction of oil droplets and gas bubbles in the near field of a blowout was investigated numerically in this work using the model VDROP-J, whose droplet size distribution (DSD) was thoroughly calibrated. For this purpose, a new numerical scheme is developed in VDROP-J to account for the interaction of gas bubbles and oil droplets in the blowout, giving simultaneous simulation of bubble and droplet size distribution along the discharged plume. Preliminary validation shows improvement of the modeling results compare with the one without considering the gas bubble and oil droplet interactions. The model was then used to predict the DSD and bubble size from the Deepwater Horizon blowout without and with dispersants, and for live and dead oil properties. The new model development will enhance the knowledge in subsea oil and gas blowouts.

2:15 PM - 2:45 PM

Overview of the American Petroleum Institute (API) Joint Industry Task Force Subsea Dispersant Injection Project

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ExxonMobil, Houston, TX

Oil spill response is a challenging task, especially in the case of deep water well releases. The efficiency of mechanical recovery equipment deployed at the sea surface may be reduced due to low oil encounter rates as a result of minimum oil thickness after oil slick spreading. In-situ burning may also have similar limitations. The ability to use dispersants as an oil spill response option could provide significant benefits when other response techniques have reduced efficiency. Subsea injection of dispersants offers some significant benefits for oil spill response, including access to the freshest and non-emulsified oil in a high turbulence environment, ability to reduce the volume of required dispersant by injecting it directly into the oil stream, ability to operate day and night under a wider range of weather conditions, and availability of a large water volume to rapidly decrease the concentration of a dispersed oil plume. The American Petroleum Institute has sponsored research on subsea dispersant injection for over 4 years. Project teams are looking into subsea dispersant injection effectiveness, fate and effects, subsea plume monitoring, and numerical modeling. As a result of this research, the body of knowledge regarding subsea dispersant injection has grown. Laboratory studies have demonstrated the utility of directly injecting dispersants at the source of a blowout. Work has begun to understand the biodegradation potential and toxicity of a subsea plume to deep water organisms. Additionally, progress has been made on enhancing numerical models to predict the fate of oil dispersed subsea. This presentation provides an update of the recent progress made on this research.

2:45 PM - 3:00 PM

Dispersant-to-Oil Ratio and Temperature Limitations on Droplet Size Distribution in a Subsurface Oil Release

B. J. Robinson[1], T. King[1], S. Ryan[1], P. Toole[1], C. McIntyre[1], M. Boufadel[2], R. Conmy[3], H. Niu[4], K. Lee[5]
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The fate and behaviour of oil from a subsurface release was studied in a 32 m rectangular flume tank that is capable of producing current velocities of up to 5 cm/s. A series of experiments were conducted using four oil products (SLC, ANS, IFO 120, and gas condensate) and two dispersants (Corexit 9500 and Finasol OSR 52) at various dispersant-to-oil ratios (DOR: 0, 1:20, 1:100, and 1:200). Oil or oil/dispersant premixes were released into the tank using a subsurface injection system to investigate the effects of DOR and water temperature on oil droplet size distributions (DSD) measured using LISST-100x particle size analyzers. For all oil products except IFO-120, a DOR of 1:20 produced DSD plots that were bimodal shaped and the majority of the droplets were < 70 µm in size. The two dispersants, applied at DORs of 1:100 and 1:200, produced similar DSD patterns in most cases, with the exception of IFO 120. The effects of water temperature were most notable in the IFO 120 treatment, the more viscous oil. Without dispersant application, the DSD pattern revealed droplet sizes >70 µm for all oil products, where most of the submerged oil rose to the water surface. Small but non-negligible differences were observed in the dispersed oil DSD generated by the two different dispersants.

3:30 PM - 3:45 PM

Subsea Oil Plume Simulations: Tracking Oil Droplet Size Distribution and Fluorescence within High Release Jets

R. N. Conmy[1], B. Robinson[2], T. King[2], M. Abercrombie[3], S. Ryan[2], C. McIntyre[2], M. Boufadel[4], K. Lee[5]

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Optical measurements have been used during oil spill response for more than three decades to determine oil presence in slicks and plumes. Oil surveillance ranges from simple (human eyeball) to the sophisticated (sensors on AUVs, aircraft, satellites). In situ fluorometers and particle size analyzers were deployed during the Deepwater Horizon (DWH) Gulf of Mexico oil spill to track shallow and deep subsea plumes. Uncertainties regarding instrument specifications and capabilities necessitated performance testing of sensors exposed to simulated, dispersed oil plumes. Presented here are results of 72 wave tank experiments conducted at the Bedford Institute of Oceanography. Examined were simulations of subsea releases with varying parameters such as oil release rate, oil temperature (reservoir temp ~ 80 ^{o}C), water temperature (<8 ^{o}C and >15 ^{o}C), oil type, dispersant type (Corexit 9500 and Finasol OSR52) and dispersant to oil ratio (DOR). Plumes of Alaskan North Slope Crude, South Louisiana Crude and IFO-120 were tracked using in situ fluorescence, droplet size distribution (DSD; LISST 100X), total petroleum hydrocarbons (TPH), benzene-toluene-ethylbenzene-xylene (BTEX) and excitation-emission matrix spectroscopy. Results offer valuable information on the behavior and dispersibility of oils over a range of viscosity and composition. Findings have implications for fate & transport models, where DSD, chemistry and fluorescence are all impacted by release variables. Research supported by the Bureau of Safety and Environmental Enforcement.

3:45 PM - 4:00 PM

Numerical Simulation of Oil Jet Underwater-CFD simulation and Trace of Individual Droplets by Lagrangian Method

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Computational Fluid Dynamics (CFD) was used to evaluate the hydrodynamic of the horizontal oil jet experiments conducted at Ohmsett wave tank facility in USA and the Bedford Institute of Oceanography in Canada. The standard model was used to model turbulence and the Volume of Fluid (VOF) was used to model the two phases (oil and water). The profiles of the holdup (ratio of oil volume to total volume), velocity magnitude, eddy diffusivity and turbulent dissipation rate were presented. It was found that the holdup drops significantly within a close range to the jet orifice, indicating a large amount of water entrainment into the plume. The energy dissipation rate drops by orders of magnitude along the centerline, starting from 104 watt/kg to 10-4 watt/kg. Both holdup and energy dissipation values have important consequences on oil droplet breakup and coalescence. In addition, the movement of individual droplets in the discharged oil plume is tracked by coupling CFD simulations and a Lagrangian approach in which we accounted for the effect of individual oil droplet buoyancy and inertia. Accounting for the inertia of oil droplets has not been done in the oil spill literature. We found that neglecting the inertia of the droplets overestimates their rise rate as the inertia from a horizontal jet tends to propel the droplet more horizontally, and thus their rise gets delayed also by turbulent mixing. We also found that small oil droplets (e.g. d<100 µm) would mix uniformly in the plume, while those close to 500

microns tend to be above the centerline of the plume. This provides a clear guideline for interpreting the results of the LISST when measuring the droplet size distribution.

4:00 PM - 4:15 PM

Verifying Algorithms for Initial Droplet Formation (Modified Weber Scaling) by Performing Experimental Subsea Releases of Oil Generating Full-scale Droplet Sizes

Ø. Johansen[1], **P. Brandvik**[1], E. Davies[1], R. Belore[2]
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Experiments performed at SINTEFs Tower basin in 2011-12 lead to the development of a modified Weber scaling algorithm (Johansen et al., 2013). The main advantage with this new approach is that it also includes contributions from;

1. oil properties including viscosity
2. turbulence created by the buoyancy flux and
3. the gas void fraction

This simple numerical algorithm was quickly implemented in most operational models used to predict fate and effect of subsea oil releases for the oil industry (Socolofsky et al., 2015). After the introduction in 2013, generating additional laboratory data to verify and further develop modified Weber scaling over a wider spectrum of parameters have had a high priority. Experimental work has been performed both as a part of industry funded projects (API) and as a part of the DROPPS GOMRI consortium. This paper presents an overview of recent experimental data generated by SINTEF covering a wide range of experimental parameters: Release diameters (0.5 - 50 mm), oil flow rates (0.5 - 400 L/min), gas-void fraction (0-90%) and oil droplet sizes (untreated oil: d50: 0.03 - 6 mm, treated oil d50: 0.03 - 500 mm). Large-scale experiments performed at Ohmsett in March 2015 gave oil droplet sizes comparable to what expected from subsea release with low release velocity and low Gas to oil ratios (multiple millimetres for untreated oil). This new comparison shows a very high correlation with predictions from the modified Weber algorithm. This finding is opposed to earlier studies predicting significantly smaller droplets e.g. Paris *et al*. (2012), using a similar approach for estimating droplet sizes, but with calibration coefficients not representative for the high turbulence present in these combined oil and gas releases.

4:15 PM - 4:30 PM

An Oil Droplet Size Model under Subsurface Blowout Release Conditions including Application of Chemical Dispersants

Z. Li[1], M. Spaulding[2], D. P. French McCay[1], D. Crowley[1]
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Accurate simulation of oil droplet size distribution is of critical importance in oil spill fate and transport modeling. A novel oil droplet size model was developed that estimates oil droplet size distributions under subsurface blowout release conditions (with or without dispersant application). The oil droplet size prediction formula was developed based on non-dimensional analysis of the balance of the oil dispersion forces and the restorative forces. This new universal oil droplet size model was calibrated and validated with available oil droplet size distribution data based on comprehensive review and synthesis of available data and literature. The dispersant treated and non-treated oil droplet size data were obtained from both controlled laboratory experimental studies, such as the API- and BSEE-supported subsea dispersant injection projects, and field measurements, including the Deep Spill field trial (in Norway) and Deepwater Horizon oil spill field data. Favorable comparison of the measurement data and

modeling results demonstrates that the new model provides a robust algorithm to predict blowout release oil droplet size distributions that can be used in subsequent oil fate and transport modeling.

4:30 PM - 4:45 PM

Oil Droplet Formation and Effectiveness of Subsea Dispersant Injection as a Function of Hydrostatic Pressure

P. Brandvik[1], E. Davies[1], C. Storrey[2], F. Leirvik[1]
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Experimental work described in this presentation was performed in two specialised facilities for studying subsurface releases of oil. Oil and gas were released from the base of a tower basin and oil droplets and gas bubbles were monitored by novel particle imaging techniques (Silhouette camera). The shift in oil droplets sizes towards smaller sizes was used to quantify the effect of SSDI (Subsea Dispersant Injection). The main objective of these experiments was to study possible pressure dependency of initial droplet formation and the SSDI. The first facility consists of a six meter high tower basin containing 42 000 Litres of natural sea water and is located at SINTEF in Trondheim, Norway. All experiments in this facility are performed at near ambient conditions (6 m depth). Parallel studies have been performed in a hyperbaric chamber with similar dimensions at SouthWest Research Institute (SwRI) in San Antonio, TX, USA. Comprehensive data generated at both SINTEF and SwRI will be presented and discussed. Oil droplets from comparable experiments (nozzle, oil type, flow rates, injection techniques and dispersant dosages & product) at ambient and high pressure conditions show no significant difference in sizes as a function of pressure (ambient and 175 bar or 1750 meter depth). This lack of a pressure effect was observed for both formation of large droplets from untreated oil and formation of smaller droplets by dispersant injection (1 and 2% dispersant dosage). These experiments were performed in February 2015 and were focusing on oil droplet formation versus pressure and the effectiveness of dispersants injection. Combined releases of both oil and gas (LNG) under similar pressure conditions and dispersant injection are planned for October 2015. Initial results from these experiments might also be included in this presentation. This study was funded by the American Petroleum Institute.

4:45 PM - 5:00 PM

Experimental Determination of Oil Droplet Size Distribution in "Live Oil" under Artificial Deep Sea Conditions

K. Malone, K. Laqua, M. Schlüter, D. Krause
Hamburg University of Technology, Hamburg, Germany

In the past years, many experiments and numerical simulations have been conducted in order to determine the oil droplet size distribution of a deep sea blowout. Though there is by now a sound understanding of the evolving size distribution of a jet of pure, “dead” crude oil, the influence of the large amounts of gasses dissolved in the oil on the droplet formation as well as the influence of high pressure is neglected in almost all experimental approaches known to date. To cover this issue, experiments were conducted the high pressure labs at the Institute of Product Development and Mechanical Engineering Design (Hamburg University of Technology) where the droplet size distribution of a “live” oil jet entering into seawater was determined under artificial deep sea conditions (high pressure up to 150 bar). The live oil consisted of Louisiana Sweet Crude oil previously saturated with methane at 160 bar. Droplet size distributions were analyzed using an endoscopic high-definition camera system. Oil droplet size distributions determined in these experiments are presented and compared to similar experiments with “dead” oil. Possible mechanisms of drop formation influenced by the dissolved methane are discussed. Preliminary results suggest that the pressure drop at the vent,

which has been estimated to have been around 86 bar (1250 psi) over the DwH Blowout Preventer, might strongly influence the final droplet size in live oil while having a neglectable influence on dead oil.
This research was made possible by a grant from BP/The Gulf of Mexico Research Initiative, C-IMAGE

Human Functioning and Adaptation to Stress: Implications of Prolonged Exposure for Individuals and Communities I

1:45 PM - 2:00 PM
Opening Remarks
M. Brymer
National Center for Child Traumatic Stress, Los Angeles, CA

An abstract for this presentation was not available.

2:00 PM - 2:15 PM
Planning for Societal Impacts from Oil Spills: Lessons Learned From the Past and Suggestions for the Future
E. Levine[1], B. Benggio[2]
[1]*NOAA, Silver Spring, MD,* [2]*NOAA, Miami, FL*

The impacts of oil spills and the psychological/sociological effects they have on populations at local, regional, and national scales are issues to be acknowledged, planned for, and effectively addressed as part of contingency planning, response, and recovery. Planning should consider and include effective ways to address the public's fears and uncertainties, communicate response strategies, desired and expected outcomes, and timescales for recovery. These objectives can be met if planning includes public assistance options, public outreach, including risk communication and two-way education about issues through meetings and social media to address questions and concerns. These efforts should be designed to help people understand what has happened, what is being done to return to a pre-incident status and what it does and doesn't mean for their future livelihood. Outreach should also focus to address uncertainties, discount misleading material, unwarranted concerns about risks, and the ethics of behavior designed to cash in or take unfair advantage of the situation for monetary or other personal gain. Decades of spill response experience has revealed numerous examples of these impacts and consequences. Citing several seminal incidents (Heibi Spirit, Prestige, Athos I, DWH, and Cosco Busan) this presentation and panel discussion will identify specific large-scale human dimension impacts and suggest multi-disciplinary activities to assist in minimizing future impacts from large-scale incidents. The area committee planning process allows a forum for response communities to share expertise among stakeholders at all levels. This collaboration and relationship-building among agencies and individuals having the authorities, responsibilities, capabilities, and expertise to address issues in the planning stage is the logical starting point.

2:15 PM - 2:30 PM
Gulf Oil Spill Stress Affects Telomere Length in Children
A. Dismukes, K. Esteves, K. Theall, E. Harville, J. Wickliffe, M. Lichtveld, S. Drury
Tulane, New Orleans, LA

Telomeres are protective caps on the ends of chromosomes, and telomere length is an emerging marker of cellular senescence and global attunement to the environment. This important biomarker is environmentally responsive across a number of domains including childhood stress, chronic stress, environmental toxins (unpublished data), and mental health status. In addition, telomere length is related to adverse health outcomes including increased mortality rate, cardiovascular disease, cancer and obesity. Understanding the relationship between stress, telomere length, and health outcomes has emerged as an important, novel goal in neuroscience, especially in early life. We hypothesized that

stress due to the effects of the 2010 gulf oil spill would be associated with telomere length in infants of mothers exposed to the spill. In this analysis, a subset of 51 infants of mothers with comprehensive assessment of oil spill exposure from a larger longitudinal study of infant development at Tulane University provided bloodspots for telomere length. Telomere length in infants was shorter for families who had more than two direct exposures to oil spill related stressors at a trend level (F=3.427, p=.07). In addition, we report novel data on other mechanistically relevant exposures related to infant telomere length including maternal cigarette smoking (F=7.85, p=.01) and maternal lead exposure (F=3.47, p=.06) in this cohort. This association demonstrates an impact of maternal stress and toxin exposure on infant telomere length, supporting a trans-generational impact of maternal exposures to toxins and stress.

2:30 PM - 2:45 PM

Factors Contributing to Mental and Physical Health Care in a Disaster-Prone Environment

H. Osofsky, T. Hansel, A. Speier, J. Osofsky
Louisiana State University Health Sciences Center, New Orleans, LA

Environment as a contextual factor plays an important role in southeastern Louisiana, as this area represents a major economic hub for the United States port, petroleum, and fishing industries. The location also exposes the population to both natural and technological disasters, including Hurricane Katrina and the Gulf oil spill. This paper presentation will discuss a study exploring associations among hurricane loss, oil spill disruption, and environmental quality of life on mental and physical health on over 1,000 residents using structural equation modeling. Results showed that oil spill distress was associated with increased symptoms of mental and physical health; Hurricane Katrina loss; and decreased environmental quality of life. Results also indicate that mental health symptoms explain the association among oil spill distress and physical health symptoms--specifically, those that overlap with somatic complaints. These findings provide important information on factors contributing to mental and physical health care in disaster-prone areas. If a main determinant of physical health complaints stems from mental health issues, then available and well-informed mental health treatment is warranted. The findings from this study provide substantial evidence indicating that the addition of mental health is part of a public health movement that will not only improve disaster recovery and preparedness, but also the well-being of individuals.

2:45 PM - 3:00 PM

The Adaptation and Resilience Initiative on the Mississippi Gulf Coast: Findings and Implications for Social Work Practice

B. J. Blackmon[1], J. Lee[2], D. M. Cochran[2], B. Kar[2], T. A. Rehner[2]
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Little research has examined how Mississippi's Gulf Coast residents have coped with and adapted to multiple disasters occurring in a short time span, including Hurricane Katrina in 2005 and the Deepwater Horizon Oil Spill in 2010. In this session, the presenters will discuss Mississippi Gulf Coast residents' long-term adaptation to these disasters within the framework of personal resilience, community resilience and depression. Data were collected in two survey administrations in 2010 (n = 358) and 2015 (n = 379) by an interdisciplinary team of social work and geography researchers. Stratified random sampling procedures using GIS software were employed to survey residents living south of Interstate 10 in the three Mississippi coastal counties. The presenters will compare depression rates between 2010 and 2015, and identify socio-demographic risk factors associated with depression. Relationships among post-disaster economic status, exposure to disasters, personal resilience, perceived community resources and

depressive symptoms will also be explored. The presenters will highlight the major findings from this research study and discuss implications for behavioral health interventions in the wake of disaster. Finally, the presenters will describe a resilience building treatment model that was implemented on the Mississippi Gulf Coast following Hurricane Katrina.

3:30 PM - 3:45 PM

Untangling the Disaster-Depression Knot: The Role of Social Ties after Deepwater Horizon

A. L. Rung, S. Gaston, W. T. Robinson, E. J. Trapido, E. S. Peters
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Evidence shows that social capital is inversely associated with common mental disorders, but less is known about this relationship within a disaster context. This presentation will examine how social capital influences the relationship between exposure to the Deepwater Horizon Oil Spill and depression among 2852 women participating in the baseline administration of the Women and their Children's Health Study in 7 southern coastal Louisiana parishes. We hypothesize that social capital, in the form of structural social capital, cognitive social capital, and social support play a mechanistic role in the relationship between oil spill exposure and depression. Telephone interviews conducted between 2012 and 2014 assessed depression (measured through the CESD), oil spill exposure (9 self-reported items), structural social capital (participation in neighborhood organizations and church attendance), cognitive social capital (social cohesion and informal social control), and social support (received and perceived support). 28% of women exhibited depressive symptoms, and depression was associated with increased levels of economic and physical exposure to the oil. All forms of social capital and social support were negatively associated with depression and had differing associations with oil spill exposure. This presentation will examine the mediating and moderating roles of social capital and social support on the relationship between oil spill exposure and depression.

3:45 PM - 4:00 PM

The Gulf Coast Behavioral Health and Resiliency Center: A Strategic Plan to Promote Wide-Spread Resilience

J. Langhinrichsen-Rohling, J. Aull, C. Wornell, J. Friend
University of South Alabama, Mobile, AL

Residents of lower Alabama (LA) have endured both acute (hurricane-related) and prolonged (oil spill and economic) stressors. The Gulf Coast Behavioral Health and Resiliency Center was developed to strengthen the resilience of LA residents in the face of pre-occurring and potential disasters. The GCBHR Center functions as part of the overall Mental and Behavioral Health Capacity Project located within the Gulf Region Health Outreach Program. The GCBHRC strategic plan includes education and outreach activities, direct service delivery to under-resourced residents seeking primary care services, promotion of coordinated school care, and evidence based methods to improve individual and community well-being. This four pronged approach is interdisciplinary, intra-agency, and informed by ongoing needs assessment. This presentation will articulate the logic model underlying the center, briefly describe the GCBHRC scope of work, and then present specific evidence related to the reach and effectiveness of the education and outreach activities. The necessity of sustaining an embedded infrastructure that facilitates disaster preparedness, promotes wide-spread resiliency, and facilitates an evidence-based approach to mental health interventions will be demonstrated. The ongoing need to connect similar infrastructures across the region will also be discussed.

4:00 PM - 4:15 PM

Risk Assessment from Beach Sands Impacted by Oil Spill Chemicals

J. Black[1], **H. M. Solo-Gabriele**[1], B. Buckley[2], K. D. Mena[3], P. Gurian[4], J. Welday[1], A. Ferguson[5]
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The objectives of this study are to evaluate which contaminants are of highest risk to children who recreate in sands along the shoreline of oil spill impacted beaches. Sediment quality data were evaluated from the U.S. Environmental Protection Agency database to identify the highest levels of contaminants measured in Alabama, Florida, Louisiana, and Mississippi shoreline sediments within the year after the BP oil spill. These maximum values were then compared to regulatory guidelines (Florida's Soil Clean up Target Levels) to identify a focus list of contaminants. This focus list consisted of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene. The highest levels of these contaminants were all measured in Louisiana. A risk assessment was then conducted for this subset of contaminants using best estimates of exposure factors from the literature specific to recreational beach use. Assumptions used included an exposure duration of 12 days per year over a period of 7 years. Oral ingestion rates corresponded to those typical of a pica child. Dermal exposure was based upon typical child surface areas of face, hands, forearms, lower legs and feet. Among the focus list of contaminants the risk assessment showed that non-cancer exposure doses were below minimum risk levels. Cancer risks were at 10⁻⁷ or less with the exception of benzo(a)pyrene which was computed at 10⁻⁶ for oral and dermal routes.

4:15 PM - 4:30 PM

NIEHS/SAMHSA Gulf Responder Resilience Training Initiative: Lessons Learned

J. T. Hughes[1], S. A. Sarpy[1], J. Langhinrichsen-Rohling[1,2], J. Rosen[1]
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The National Institute of Environmental Health Sciences (NIEHS) Worker Training Program (WTP) has been involved in the response to multiple disasters in the Gulf and has identified the need for a training that discusses stress, trauma, mental health effects, and resiliency following disasters. To address the mental health needs identified by communities, NIEHS developed a three part Disaster Resilience Training Program in partnership with the HHS Substance Abuse and Mental Health Services Administration (SAMHSA. The program focuses on introducing mental health to communities, workers, supervisors and care providers. Each audience faces a unique set of stressors in a disaster and this new program addresses these concerns. Program materials have been designed and pilot tested with communities in Louisiana, Alabama and New York. Modifications to meet the unique stressors for disaster case workers and English as a second language learners have been made by participating communities. The ability to modify trainings for unique audiences allows for wide-spread use of materials in disaster prone areas. Core program components may be added as a stand-alone 'module' to existing trainings, allowing for basic mental health and coping skills to be introduced to an audience which may not otherwise receive them. This presentation will explore the role of communities in program development and the specific need for mental and occupational health training during disasters. Additional discussion will include new audiences and barriers identified through the two year pilot testing.

4:30 PM - 4:45 PM

Using Integrated Research and Outreach to Build Community Resilience

M. Finucane[1], R. Ramchand[2], C. Bond[2], S. Nataraj[3], N. Clancy[2], M. Lee[4], T. Slack[4], T. Blanchard[4], K. Venable[5], K. Luu[5], R. Ferreira[5], J. Edwards[5], K. Nicholls[6], S. Picou[6], B. Gilliam[6], J. Curtis[6], G. Hobor[7]

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Complex environmental health challenges such as major oil spills require innovative responses by communities in the Gulf of Mexico. The GoMRI-funded Consortium for Resilient Gulf Communities is supporting such innovation by using "integrated" research and outreach to assess and address the impacts of the Deepwater Horizon oil spill. Integrated research and outreach aims to bridge the gap between science and society by identifying vulnerabilities and strengths, addressing knowledge gaps, supporting the use of best practices, and helping communities to be prepared for and responsive to uncertainty. The impacts of a major oil spill are cross-cutting in nature and, therefore, necessitate a transdisciplinary effort that combines diverse fields such as public health, sociology, economics, political science, ecology, computer science, decision science, artificial intelligence, and evaluation. Combining this scientific expertise with a robust and iterative process that incorporates continuous feedback from stakeholders enhances the likelihood of developing information and processes directly relevant to a range of community leaders and risk managers in government and non-government organizations. In this talk we will explain the rationale and methods underlying our integrated approach. We will explore the challenges and opportunities facing our transdisciplinary team as we collaborate with local stakeholders and institutions to develop comprehensive, real-world solutions. We will draw on examples from the first year of our Consortium's work to describe how we are addressing several key objectives:

1. Integrating research disciplines and joining researchers and communities via a use-inspired, problem-focused, and iterative approach;
2. Closing current knowledge gaps by estimating the medium- and long-term social, economic, and public health effects of the Deepwater Horizon oil spill;
3. Building capacity for community action planning using data and findings with on-the-ground support from field teams;
4. Providing training for graduate and undergraduate students and community leaders to learn about best practices in community disaster risk resilience in the Gulf States; and
5. Evaluating Consortium activities by using metrics derived from an action-logic model.

Extending the Use of Information from Oil Spills: Synthesis and Application of Research and Observations from Regions along the US Outer Continental Shelf I

1:45 PM - 2:15 PM

Opportunities for Scientific Synthesis and Research to Improve Planning for Offshore Oil and Gas Development Including Management of Spills

J. W. Farrington
Woods Hole Oceanographic Institution, Woods Hole, MA

The breadth, quantity and quality of research focused on the fate and effects of the DWH oil spill provide several significant opportunities to improve planning for offshore oil and gas development and the response to spills. The DWH research needs to be placed within the context of world-wide knowledge of fates and effects of chronic oil and spilled oil inputs, fates and effects and strategies for response to oil spills. Opportunities will be outlined for key scientific syntheses and for future research and continuing assessments. Missed opportunities for better pre-DWH spill assessments of deeper water Gulf of Mexico ecosystems will be discussed briefly as lesson for other offshore areas. The intent of the paper is to be diplomatically provocative and to stimulate productive discussion.

2:15 PM - 2:45 PM

Understanding Community Aspects of Oil Spills: Social Science as a Foundation for the Future

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Since the late 1960s, a large body of social science research has advanced knowledge regarding societal dimensions of hazards and disasters. Within this broader context, empirical research on social impacts of marine oil spills has also increased—improving our conceptual and theoretical understanding of the effects of toxic environmental contamination on communities that experience them, as well as practical implications of this information in the wake of such events. In fact, we know a great deal about the impacts of oil spills on individuals, groups, and communities. We know less, however, about how specific preparedness, response, and compensation processes associated with oil spills affect community resilience and long-term recovery prospects. This presentation will begin by providing a brief overview of documented effects of marine oil spills on communities, highlighting factors associated with vulnerability and resilience. The presentation will then turn to a discussion of ways in which research findings have been used to develop programs in communities that have experienced oil spills. We will conclude by offering recommendations about ways to address current gaps in this arena, including approaches to long-term monitoring.

2:45 PM - 3:00 PM

Resources at Risk from Coastal Oil Spills Over the last 30+ Years - Evolving Information Needs for Oil Spills in the Outer Continental Shelf

A. Walker
SEA Consulting Group, Cape Charles, VA

Large marine oil spills can be disastrous for coastal habitats, resources, and communities dependent upon those resources. Accidental spills from blowouts, such as the 2010 Deepwater Horizon incident, may be of longer duration and greater volume than vessel spills. The 1979 Ixtoc I blowout was a catalyst for oil spill scientists to document and synthesize field observations and research regarding the value, vulnerability and sensitivity of resources at risk, e.g., both ecological and socio-economic-cultural

resources, to spilled oil, and to incorporate lessons learned about resource resilience into the way spills are managed. Since passage of the Oil Pollution Act of 1990, the identification of sensitive areas and priorities for protection has become a routine component of the US oil regulatory framework. This presentation is an overview of systematic approaches developed by oil spill scientists for use by the oil spill community, how this information in being incorporated into government contingency plans, industry response plans, and how it is used to guide decisions during spill response. In the context of potential worst-case discharges from outer-continental shelf (OCS) platforms, the presentation also highlights emerging information needs that became evident during the Deepwater Horizon incident. These needs represent opportunities to improve preparedness, response and recovery from potential future spills in the US OCS for both ecosystems and coastal communities.

3:30 PM - 3:45 PM

Ocean Circulation Modeling Efforts in Support of Offshore Oil and Gas Leasing at Bureau of Ocean Energy Management

Z. Li[1], W. Johnson[1], H. Crowley[2]
[1]*Bureau of Ocean Energy Management, Sterling, VA,* [2]*Bureau of Ocean Energy Management, Anchorage, AK*

Bureau of Ocean Energy Management conducts the oil-spill risk analysis (OSRA) prior to a lease sale for oil and gas exploration on the U. S. Outer Continental Shelf (OCS). The goal is to estimate the probability of oil spill occurrence and contact with biological, social and economic resources located on the U.S. OCS and surrounding waters. The OSRA uses model-simulated surface currents and reanalysis winds to drive the oil-spill trajectory model for estimating the probability of potential oil spill contacts with environmental resources. The OSRA model provides important information for the analysis required by the National Environmental Policy Act (NEPA) and for oil-spill response plans. Ocean circulation models and ocean-sea ice models provide critical inputs to the OSRA model, and improving hydrodynamic modeling on a recurring schedule across all the OCS regions remains one of the top priorities of BOEM's oil-spill risk analysis. In this talk, we will discuss BOEM's recently completed ocean modeling and ocean-sea ice modeling studies and upcoming modeling efforts, as well as the observations, both in-situ and satellite-based, which are needed to validate and improve the ocean circulation and ocean-sea ice models.

3:45 PM - 4:00 PM

The Interplay of Data Needs and Data Analysis Frameworks to Optimize the Collection and Use of Data from Oil Spills

P. Boehm, **A. Morrison**
Exponent - Environmental, Maynard, MA

Understanding the relationship between the fate and transport of oil, observed ecological conditions, and oil exposure is essential after a spill. The use of disparate big environmental datasets along with oil spill-specific collections also provides for optimization of data assets. A formal analysis framework examining multiple alternatives for observed perturbations, similar to USEPA's CADDIS approach, is ideal for developing transparent, inclusive, and objective assessments of potential causes of observed or hypothesized stressors using all available data. This framework can also serve as a guide for identifying data needs for future oil spills. We used a causal analysis framework and experience from past oil spills to examine the major data needs that must be considered to determine the weight of evidence for any cause. Key causal criteria include the interaction and plausible mechanism between the oil spill and the effect, the time order of the cause and effect, evidence of exposure, specificity between the cause and effect, spatial and temporal co-occurrence of the cause and effect, and sufficiency of the cause to

produce the effect. The results of this analysis underscore the importance of (1) high-quality, field-collected measurements of exposure, (2) data demonstrating the cause-effect relationships in relevant exposure conditions, and (3) robust time series data at relevant temporal and spatial scales to characterize baseline and post-spill conditions.

4:00 PM - 4:15 PM
An Overview of Data Requirements for Net Environmental Benefit Analysis in Spill Response Decision-making
V. Broje
Shell Exploration & Production Company, Houston, TX

Spill response efforts are always focused on protecting health and safety of public and responders and on minimizing environmental impacts from an oil spill. Net Environmental Benefit Analysis is a process which allows resource trusties, environmental specialists, response specialists, and decision-makers to compare efficiencies and impacts of various response options and select those that provide better environmental protection and can facilitate fastest ecosystem recovery. NEBA process has been used around the world for decades. It relies on a variety of scientific information from different disciplines. Some of the critical data streams include spill trajectory modeling; impact of oil spill and response techniques on various organisms; health, distribution and population dynamics of various ecosystem components; recovery rates of local populations and their habitats, and many others. Holistic approach to this information is essential for successful integration of scientific data from various disciplines in order to conduct an ecosystem-based analysis allowing timely selection of response options and appropriate prioritization of resources. It's important for scientists to understand NEBA process as well as the type and format of scientific data required for successful integration of their data into response decision-making.

4:15 PM - 4:30 PM
Scientific Data Integration into Net Environmental Benefit Analysis
V. Broje
Shell Exploration & Production Company, Houston, TX

Net Environmental Benefit Analysis relies on a variety of scientific information from different disciplines. Some of the data require additional processing in order to be successfully integrated into this analysis. For example, standard LC50 acute toxicity data may not add value to decision-making as the scale and the format of this information is not consistent with realistic exposures at sea and ecosystem-based impact analysis. Such values need to be converted into higher level ecosystem impacts, integrated with other relevant data and presented in a format which can be understood by a wide range of stakeholders and decision-makers. Important information types for NEBA include: understanding oil fate and transport with and without response techniques translated into exposure regimes to different organisms and habitats, valuable ecosystem components population dynamics and their recovery rates, species sensitivity distribution curves translated into population level impacts, information on impacts of untreated oil to various ecosystem components and habitats which can be directly compared to potential impacts from treated oil, etc. This presentation will review an example of scientific data integration into NEBA using population-level impact analysis, point out some typical challenges with scientific data interpretation and integration into decision-making, and suggest research areas which could facilitate decision-making during spill response in the future.

4:30 PM - 4:45 PM

Evaluating Oil Spill Science Communication Using Social Network Analysis

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Social network analysis (SNA) is a tool for measuring and visualizing relationships and communication. Commonly, by means of survey data, this type of analysis maps the connections among individuals to show how information flows, and illustrates which people within a communication network are essential for connectivity. A graphic representation of these social links, called a sociogram, reveals important attributes of the network, such as the leaders and connectors, cliques or subgroups of communication, those who may be on the periphery of the communication network, and those who are isolated and disconnected from the network. A partnership between the Mississippi-Alabama Sea Grant Consortium and the NOAA Office for Coastal Management conducted an SNA in the spring of 2014. People who conduct oil spill research in the region and those who would directly benefit from oil spill research results were sent the SNA survey. The SNA results are informing the Sea Grant oil spill outreach team, supported by the Gulf of Mexico Research Initiative, so that the team understands the extent of communication across states, within specific areas of expertise, and between agencies and organizations. In addition, the SNA survey and follow-up meetings with more than 500 people identified oil spill science topics that are of interest to target audience members. Finally, the 2014 SNA findings are being coupled with additional formative evaluation data, including key informant interviews and a planned 2016 SNA, to assess the effectiveness of the Sea Grant oil spill outreach program.

Ecological Impacts of the Deepwater Horizon Oil Spill across Multiple Scales I

1:30 PM - 2:00 PM

Isotopic Tracers: Documenting Ecosystem Effects of the DWH Oil Spill

J. Chanton[1], S. Bosman[1], J. Cherrier[2], A. Fernandez[3], D. Hollander[4], A. Mickle[1], J. Montoya[3], W. Patterson[5], K. Rogers[1], P. Schwing[4], J. Tarnecki[5], S. Weber[3], R. Wilson[1]

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The natural tracers δ13C, δ15N and δ34S and α14C have been key tools for determining the fate and ecosystem effects of the massive slug (210 million gallons of oil and 250 metric tons of gas) of reduced carbon input into the Gulf in 2010. Petrocarbon was traced into fine particulate organic carbon, and methanotrophy appeared to be a particularly important in this process. Isotopically-depleted suspended particles were found at the same depth of the deep hydrocarbon plume, 1000-1200m, in summer 2010 as far as 190 km SW of the DWH well head. Relatively low δ15N values in these particles indicate stimulation of N-fixation linked to methane oxidation. Diazotroph N accounted for up to 40% of the particulate N in the water column. In 2010 and 2011, plankton were observed to be depleted in 13C and 14C and these decreases were linearly related. Higher trophic levels were affected as well. Reef fish species shifted their feeding patterns towards higher trophic levels following the spill, leading to an increase in methyl mercury content in some species. Evidence consistent with the hypothesis that hydrocarbons entered the foodweb was found in deep water foraminifera and in an assortment of fish and invertebrate tissue and shell samples collected within a year of the spill at 7 sites from across the northern Gulf Coast. More depleted radiocarbon values were found in Terrebonne Bay, LA, with more enriched radiocarbon values in organisms collected at sites to the east. These diverse biogeochemical indices provide a direct measure of the movement and effects of petrocarbon on the Gulf ecosystem in both shallow, nearshore communities and offshore waters.

2:00 PM - 2:15 PM

Hydrocarbons and Deepwater Nitrogen Fixation: Who's Doing it, Where, and Why?

J. P. Montoya[1], S. C. Weber.[1], A. Vogts[2], M. Voss[2], M. Saxton[3], S. B. Joye[3]

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Nitrogen availability frequently limits marine primary production and N2-fixation plays an important role in supporting biological production in surface waters of many oligotrophic regions. Although subsurface waters typically contain high concentrations of nitrate and other nutrients, measurements from a variety of oceanic settings show measurable, and at times high rates of N2-fixation in deep, dark waters below the mixed layer. We have explored the distribution of N2-fixation throughout the water column of the Gulf of Mexico (GoM) during a series of cruises beginning shortly after the Deepwater Horizon (DWH) spill in 2010 and continuing at roughly annual intervals. These cruises allowed us to sample oligotrophic waters across a range of depths, and to explore the connections between the C and N cycles mediated by release of oil and gas (petrocarbon) from natural seeps as well as anthropogenic sources (e.g., the DWH). We used stable isotope abundances (15N and 13C) in particles and zooplankton in combination with experimental measurements of N2-fixation and CH4 assimilation to assess the contribution of oil- and gas-derived C to the pelagic food web, and the impact of CH4 releases on the pelagic C and N cycles. Our isotopic measurements document the movement of petrocarbon into the pelagic food web, and our experiments revealed that high rates of N2-fixation were widespread in deep water immediately after the DWH incident, and restricted to the vicinity of natural seeps in subsequent

years. Unfortunately, these approaches provided no insight into the organisms actually responsible for N2-fixation and CH4-assimilation. Therefore, we used nano-scale Secondary Ion Mass Spectrometry (nanoSIMS) to image the organisms responsible for these processes, and molecular approaches to explore the diversity of methanotrophs and diazotrophs present in the system. The ability to resolve isotopic distributions on the scale of individual cells is a critical part of bridging the gap between molecular approaches that identify organisms, and biogeochemical techniques that allow us to measure the activity of communities exposed to oil and gas released into oceanic environments.

2:15 PM - 2:30 PM

Carbon and Nitrogen Stable Isotopes in Plankton in Mississippi Canyon MC118 from 2010 to 2012: Insights into Nutrient Sources.

A. Fernandez[1,2], A. G. Clavere-Graciette[1], S. C. Weber[1], K. A. Goehring[1], D. A. O. Lee-Patterson[1], J. P. Montoya[1]
[1]Georgia Institute of Technology, Atlanta, GA, [2]Universidade de Vigo, Vigo, Spain

Mississippi Canyon Federal Lease Block 118 (MC118) is a gas-hydrate and cold-seep field located 15km northwest of the Deep Water Horizon (DWH) wellhead, which has served as observatory for monitoring natural gas hydrates in the Gulf of Mexico (GoM) for more than 10 years. After the DWH spill, we conducted several research cruises between 2010 and 2014 to study the impact of petrocarbon (carbon derived from oil and gas) released both from anthropogenic and natural sources on the marine ecosystem of the northern GoM. Here, we present the $\delta^{13}C$ and $\delta^{15}N$ of 5 plankton compartments (i.e. suspended particles and zooplankton 200, 500, 1000 and >2000 µm in size) at MC118 from 2010 to 2012. We observed a general trend of decreasing $\delta^{13}C$ through time in all compartments, which was matched by an increase in the C:N ratio. This pattern suggests a continuous movement of a ^{13}C-depleted source of carbon into the food web, likely petrocarbon released by the Deep Water Horizon in combination with local releases from the the MC118 hydrate deposits. The contribution of oil-derived carbon to suspended particles, estimated by an isotopic mass balance using marine-produced biomass ($\delta^{13}C$ = −22‰) and Macondo oil ($\delta^{13}C$ = −27‰) as endmembers, was substantial in 2011 and 2012 (0-20% and 0-40%, respectively), but almost negligible in 2010, a pattern consistent with low baseline inputs of petrocarbon and a slow penetration of DWH-derived petrocarbon into the foodweb. The $\delta^{15}N$ in our plankton compartments showed similar vertical distributions from 2010 to 2012. In the upper 100m of the water column, the $\delta^{15}N$ of suspended particles ($\delta^{15}N_{sp}$) ranged from 0 to 8‰, reflecting the influence of a mix of nitrogen sources (deep nitrate, atmospheric N_2 and/or riverine discharge). In deeper waters, $\delta^{15}N_{sp}$ appears to reflect primarily deep nitrate ($\delta^{15}N_{sp}$ > 5‰).

2:30 PM - 2:45 PM

Impacts of Oil on Population Dynamics and Community Composition of Ammonia Oxidizers and Relationships with Nitrification Rates in Louisiana Salt Marshes

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Many studies have been conducted on the impacts of oil on microbial communities, but few have investigated impacts on nitrifiying communities specifically, and fewer still on nitrifiers in salt marshes. We studied the effects of oiling on ammonia-oxidizing archaeal (AOA) and bacterial (AOB) communities and their relationship to nitrification rates and soil properties in Louisiana marshes impacted by the Macondo oil spill. Sediments were collected at paired oiled and unoiled sites from three coastal regions in Louisiana in July 2012. DNA fingerprinting (TRFLP) and sequence analyses of ammonia monooxygenase genes (amoA) revealed significantly different AOA and AOB communities among the three regions, but few differences between oiled and unoiled sites. Nitrifier community composition was

best explained by soil moisture and nitrogen. Despite no detectable differences in overall nitrifier communities, individual populations displayed different correlations with nitrification rates between oiled and unoiled sites that help explain previously published correlation patterns of AOA and AOB abundances with rates in these marshes. Our results suggest that although we did not detect significant differences in overall nitrifier community composition two years post-spill, exposure to oil did lead to more subtle changes in population dynamics that may impact ecosystem function in the marshes for multiple years after initial exposure.

2:45 PM - 3:00 PM

Horse Fly Population Crashes Show Impact of 2010 Gulf of Mexico Oil Spill on Marsh

C. Husseneder, L. Foil
LSU Agcenter, Baton Rouge, LA

The greenhead horse fly, *Tabanus nigrovittatus*, is found in coastal marshes of the Eastern United States. Its larvae are apex predators in the marsh and thus vulnerable to changes in the environment. Therefore, this horse fly could serve as a bioindicator of toxic effects of oil intrusion. We describe the impact of the 2010 Deepwater Horizon oil spill in the Gulf of Mexico on *tabanid* populations. Adults and larvae were sampled from oiled and unaffected locations immediately after the oil spill. Abundance estimates showed severe population crashes in oiled areas. Microsatellite genotyping detected genetic bottlenecks in most of the oiled populations in association with fewer breeding parents, reduced effective population size, lower number of family clusters and fewer migrants among populations compared to unaffected populations. This is the first study assessing the impact of oil contamination at the level of a top arthropod predator of the invertebrate community in salt marshes.

3:30 PM - 3:45 PM

Post-Spill Monitoring of Coastal Marshes in Barataria Basin, LA

Y. Mo, M. Kearney, J. Riter
University of Maryland, College Park, MD

The 20 April 2010 Macondo oil spill was the largest accidental marine oil spill in recorded history, and it may pose a serious long-term threat on Louisiana coastal marshes. This study used moderate resolution satellite data (30 m2-spatial resolution Landsat imagery) to monitor the marshes conditions before and after the oil spill. The study area was located in the Barataria Basin of southeastern Louisiana, where large amount of oil was deposited on the marshes after the oil spill. We identified heavily oiled sites and sites without oil based on the Scientific Support Coordinators Teach ground surveys performed in 2010. We acquired and processed Landsat imagery to produce Normalized Difference Vegetation Index (NDVI) data for five years from 2009 - 2013. Landsat imagery processing was performed using ENVI 4.8 software. ANCOVA was conducted using SAS 9.4 software. In 2009, the reference year before the oil spill, NDVIs of the study sites were similar. In 2010, the year of the oil spill, NDVIs of heavily oiled sites were significant lower than those of sites without oil ($p=0.0006$). In the following years, 2011, the oil effect was still significant ($p=0.0025$). In the next two years, 2012 and 2013, NDVIs of heavily oiled sites were not significantly different from NDVIs of unoiled sites. This suggests that the oiled marshes did sustain some damage from oiling, whether directly on physiological functioning and/or the covering of culms, limiting near-infrared reflectance and photosynthetic activity for at least two years. While some literature reported the full recovery of the oiled marshes plant in 2012, some suggested that it would take more than two years to document the effects of heavy oiling on the marsh shoreline. Incidentally, Southeast Louisiana experienced a severe drought in 2011 (based on the Palmer Drought Severity Index) and a Category 1 hurricane Isaac in 2012, which had potential effects so dominated the NDVI response

that whatever lingering oiling impact on marshes could not detected with any degree of confidence. Future investigations of the impacts of the Macondo oil spill on Louisiana coastal marshes require a longer time frame and satellite sensors with a higher spatial resolution to identify finer-scaled damage.

3:45 PM - 4:00 PM

Living on the Edge: Understanding Seaside Sparrows in the Wake of the Deepwater Horizon Oil Spill

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The 2010 Deepwater Horizon accident affected hundreds of hectares of salt marsh along the northern coast of the Gulf of Mexico. Relative to oil effects in the water column, oil effects on salt marsh birds may be less direct, but longer lasting and are important for demonstrating processes occurring outside of the marine system. Seaside Sparrows (*Ammodramus maritimus*) are an excellent indicator of marsh ecosystem processes because they are restricted to--but often abundant in--this habitat. Preliminary data from 2011 indicated elevated gene expression in sparrows related to detoxifying PAHs in plots that had been heavily oiled. In 2012 we observed fewer birds, and found fewer nests in oiled plots. In subsequent years we found relatively little evidence of plot-level differences (oiled vs unoiled), but noted considerable year-to-year variation in sparrow abundance, nest success, detoxifying gene expression, and diet. Our results suggest that Seaside Sparrows were negatively affected by the Deepwater Horizon oil spill, but that they also responded to other conditions that varied among years, particularly storms. Seaside Sparrows serve a useful role in monitoring, but a full understanding of how multiple natural and anthropogenic stressors affect individuals and populations will require years of baseline data.

4:00 PM - 4:15 PM

Shifting Baselines and Slippery Slopes: The Oil Spill Signal and Long-Term Trends in Fishery-Independent Monitoring Data

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Data from fishery-independent monitoring surveys conducted by the Louisiana Department of Wildlife and Fisheries, before, during and after the 2010 Deepwater Horizon Oil Spill were examined for anomalies associated with the oil spill and for long-term trends. Despite large inter-annual fluctuations, many of the 20 fish and invertebrate species included in the analysis exhibited multiyear trends in catch-per-unit-effort (CPUE) before the oil spill. CPUE increased for many species for one or two years following the oil spill, which could be the result of fishery closures prompted by the oil spill. For most species, CPUE returned to pre-spill levels within a few years. In some cases, the effects of other factors could be distinguished from those of the oil spill by analyzing patterns on finer temporal or spatial scales. The results highlight both the challenges and potential for assessing the effects of a single impact on a dynamic ecosystem with strong, confounding factors.

4:15 PM - 4:30 PM

New Forensic Methods for Describing the Histories of Fish

A. A. Wallace, G. S. Ellis, J. E. Granneman, D. J. Hollander, E. B. Peebles
University of South Florida, St Petersburg, FL

In the wake of disasters such as the Deepwater Horizon oil spill, we can now gather data from individual fish to determine if, when, and where they were exposed to oil, as well as how their movement, growth rate, or trophic position may have changed in response to exposure. We previously developed novel methods using carbon and nitrogen stable-isotope records of fish eye lens laminae to describe lifetime trends in the geographic histories and trophic positions of individual fish. More recently, we have separated trophic growth and migration patterns in individual fish using compound-specific isotope analysis of amino acids in isolated laminae from eye lenses. These trophic effects can be subtracted from the overall isotopic trends in the lens laminae, thereby revealing the geographic histories of individual fish. We are currently determining the relationship between eye lens diameter and otolith-based age, which will allow us to assign calendar dates to events in the lives of fish ascertained from stable isotope and/or otolith microchemistry anomalies. These events include exposure to oil, which we can now detect by examining trends in oil-associated trace metals within otoliths. New forensic methods provide a relatively low-cost approach that has general application to studies of fish life history, habitat use, trophic relationships, migration, and other information needed for fisheries management.

4:30 PM - 4:45 PM

Assessment of Nearshore Crude Oil Contamination in the Gulf of Mexico Using Gulf Menhaden: "Menhaden Watch"

G. M. Olson, R. J. Portier, B. M. Meyer
Louisiana State University, Baton Rouge, LA

Gulf menhaden were studied in order to understand the overall effects of the Deepwater Horizon spill on the fishery as a means to assess the health of the northern Gulf of Mexico. Tissue samples were extracted to identify key persistent components of crude oil (polycyclic aromatic hydrocarbons, or PAHs), and a subsequent evaluation of the mutagenicity and carcinogenicity was carried out by means of standardized benzo[a]pyrene toxic and mutagenic equivalents. Significant decreases were evident in PAHs from 2011 to 2013 along with significant decreases in benzo[a]pyrene toxic equivalents and mutagenic equivalents. It was also identified that the portion of the menhaden population that originally contained high levels of heavier PAHs were not in sample years past 2011. This is attributed to depuration, however loss of individuals due to exposure impacts was also a factor. Total non-polar lipids increased in the 2013 harvest season, suggesting an increase in overall menhaden health. Also, a significant increase in condition was observed in the 2013 harvest season, with standard condition calculated by determining a standard weight equation for pre-spill Gulf menhaden collected from 2000-2010 (Courtesy of NOAA South East Fisheries Science Center, Beaufort Laboratory, NC). Based on the results of this study, the Gulf menhaden fishery appears to be in recovery after the DWH spill event, however it is only useful as an acute measure of impact.

4:45 PM - 5:00 PM

Variability in Larval Red Snapper (*Lutjanus campechanus*) Abundance and Condition in Relation to the Deepwater Horizon Oil Spill

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Red snapper (*Lutjanus campechanus*) is one of the most economically important reef fishes in the northern Gulf of Mexico, and among the many species with pelagic early life stages at risk during the Deepwater Horizon oil spill (DWHOS). The extensive temporal and spatial overlap of red snapper spawning and the DWHOS is cause for concern, and suggests that at least some portion of the egg and larval pool was exposed to oil and dispersant. To investigate potential impacts of the DWHOS on larval red snapper, we used data collected during a long-term ichthyoplankton survey off the coast of Alabama within a region that was frequently exposed to oil during the summer of 2010. We compared larval red snapper abundance and proxies for larval condition (size-adjusted morphometric relationships and dry weight) among pre-impact, impact, and post-impact periods. Larval abundances during the oil were similar to pre- and post-impact periods. However, red snapper larvae collected during and after the DWHOS were in poorer body condition (i.e., were skinnier and weighed less at length) as compared to those collected before the spill. This trend was driven by especially poor larval body condition in 2010 and 2013. Within years, larval body condition increased as the summer progressed by month and with distance from shore. These results are discussed in relation to the DWHOS, natural variability encountered in the region, and recent red snapper stock assessments which found evidence of poor red snapper recruitment during 2010 and 2011 in the eastern Gulf of Mexico (including Alabama waters).

5:00 PM - 5:15 PM

Disturbance of Northern Gulf of Mexico Reef Fish Communities: The Deepwater Horizon Oil Spill and the Lionfish Invasion

K. Dahl[1], W. Patterson[1], J. Tarnecki[1], M. Allen[2], D. Chagaris[3]

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A 10-year dataset of northern Gulf of Mexico (nGOM) reef communities revealed widespread declines in fish abundance following the Deepwater Horizon Oil Spill (DWH). Declines in abundance of 30 to >90% were observed for a broad range of species from large (>30 cm) piscivores (e.g., snappers and groupers) to small (<10 cm) demersal fishes (e.g., damselfishes and wrasses). While many species or trophic guilds began showing signs of recovery by year three post-spill, small demersal fish densities continue to be depressed in some habitats. However, the invasion of red lionfish, *Pterois volitans*, which were first documented in the nGOM in summer 2010, is a confounding factor for interpreting chronic oil spill effects on these fishes. For example, by 2013, lionfish densities on nGOM artificial reefs were among the highest reported in the western Atlantic (~20 fish 100 m-2), although their densities on natural reefs remain an order of magnitude lower. We will report trends in lionfish density, diet, and trophic position, as well density-dependent effects on their condition, growth, and the incidence of cannibalism, in the context of interpreting acute and chronic effects of the DWH on reef fish communities. Lastly, we will discuss ongoing ecosystem modeling simulations currently being conducted to evaluate lionfish effects on the ecology of the nGOM as well as the effect of different mitigation strategies aimed at decreasing lionfish impacts.

The Evolution of the Deepwater Horizon Oil Spill: Updates on Fate and Transport of the Oil I

1:30 PM - 1:45 PM

Towards an Understanding the Evolution (Fate and Transport) of the 2010 Deepwater Horizon Oil Spill

P. Boehm
Exponent - Environmental, Maynard, MA

While examinations of the question "what happened to the oil?" have been undertaken before on other oil spills, the wealth of data from the 2010 Deepwater Horizon accident present a unique opportunity to deeply examine this question. In order to do so, several investigation threads need to be pulled together. In this session the presentations will analyze and summarize several relevant data sets pertaining to the behavior and fate of oil released from the Macondo well during the accident. These data sets include: 1- an analysis of the weathering processes, changes in chemistry, and partitioning of oil components that occurred, and 2- data on the movement of oil in the water, on the surface, and to the shoreline that created various "footprints" over time. The available data on: water column chemistry, distributions, and partitioning; water chemistry related to surface oil distributions over time; biodegradation; sediment chemistry and distributions; and fate of the oil on the shoreline, are all essential to this effort. This introductory presentation will present a summary of available data and suggest a systematic synthesis of the available information to address the fate of the oil.

1:45 PM - 2:00 PM

Weathering of MC252 Oil from Release to Shoreline: Stages of Weathering

L. L. Cook, L. Benton, J. S. Brown
Exponent, Maynard, MA

Weathered oil is a term that is often used without communicating the degree of weathering and components that still remain. The subjective use of weathering terms often leads to misperceptions about potential persistence and toxicity of oil residues observed in the environment. The weathering of MC252 oil started immediately after release; during its 1,500 meter ascent to the sea surface most of the water soluble components partitioned into the water column. Once on the sea surface, the oil continued to weather via evaporation, dissolution, photo-degradation, and biodegradation. After reaching the shoreline, weathering continued and biodegradation became more pronounced. Extensively weathered and biodegraded MC252 oil samples have been collected on the shoreline and in some cases show a complete loss of resolved n-alkanes and near complete loss of PAH components, while still maintaining identifiable MC252 characteristics. At the same time that compounds have been lost due to degradation, others (e.g., some oxygenated compounds) have been formed as part of the weathering processes. The hydrocarbon chemistry data associated with more than 800 weathered MC252 oil samples were evaluated and quantitative metrics were developed to aid in defining the weathering stages. Together, the chemistry and chromatograms were analyzed to develop a data-driven model to provide researchers with an objective means of defining the degree of weathering for MC252 oil in the environment.

2:00 PM - 2:15 PM

Spatial and Temporal Extent of PAHs Associated with Surface Waters during the Deepwater Horizon Spill

K. J. Murray, L. L. Cook, P. D. Boehm
Exponent, Maynard, MA

The scope and scale of data collection during the Deepwater Horizon (DHW) accident presented a unique opportunity to obtain high-quality laboratory chemistry data on surface water exposures resulting from the release and mixing of oil from the surface in to the upper water column. The data sources used included 1038 samples from 0 to 10m water depth that characterized polycyclic aromatic hydrocarbon (PAH) concentrations and depth of surface oil entrainment. Overall the highest mean concentrations of all water samples were found within approximately the top meter. The buoyant nature of the released oil caused larger droplets to rise to the surface. Once on the surface, a slick was formed, and the water chemistry data indicate that oil was distributed through the upper surface layer through physical entrainment due to wave action as well as the use of chemical dispersants. As part of the data set, an examination of water at 1 and 10 meters depth before and after dispersant application showed that concentrations 1 meter below the slick were more affected and were overall higher than those measured 10 meters below the slick, consistent with mean values seen in the larger data set. Concentrations of TPAH in samples taken outside of the area of active chemical dispersant use were as high or often higher than those where chemical dispersants were used. In the surface layers, the individual PAH compositional data indicate the presence of both dissolved and weathered droplet oil-related PAHs, as might be expected in the vicinity of entrained surface slicks.

2:15 PM - 2:30 PM

Polycyclic Aromatic Hydrocarbon Concentrations in the Upper Water Column during the Deepwater Horizon Oil Spill

C. Travers, H. P. Forth, M. Rissing, D. Cacela
Abt Associates, Boulder, CO

Following the 2010 Deepwater Horizon (DWH) oil spill in the Gulf of Mexico, floating oil covered tens of thousands of square kilometers of the ocean's surface. Oil droplets and dissolved oil constituents from these slicks were dispersed into the upper water column through wave action, turbulence, and, in some cases, through the application of chemical dispersants. To evaluate the distribution of oil concentrations, we analyzed available water chemistry data from the upper water column (≤50 m) collected from April through August 2010. Using daily synthetic aperture radar (SAR) images to estimate the location and extent of floating oil, we identified samples that were collected within floating oil, within 1 km of floating oil, within 1-20 km of floating oil, and beyond 20 km of floating oil. We found that polycyclic aromatic hydrocarbon (PAH) concentrations correlated well with the proximity to floating oil; elevated concentrations of PAHs were more common within the floating oil "footprint" than outside the footprint. In addition, we found that PAH concentrations decreased with sample depth; the PAH concentrations of samples collected from depths below 20 m were typically at or near detection limits. As part of the DWH Natural Resource Damage Assessment, the vertical and spatial distribution of PAH concentrations from this analysis were used to estimate exposure of water column resources to oil constituents and to help quantify the fate and transport of the oil in the upper water column.

2:30 PM - 2:45 PM

Weathering of MC252 Oil Dramatically Decreases both the Amount of PAH in the Oil and the Ability of the Residual PAH to Partition from Oil to Water

D. Shea, X. Kong, X. Xia
NC State University, Raleigh, NC

Current risk assessment guidelines describe the sorption of polycyclic aromatic hydrocarbons (PAHs) to particle phases as equilibrium partitioning between water and particulate organic carbon (OC), where the PAHs partition between the hydrophobic OC and the dissolved aqueous phase. However, in the presence of oil, the oil itself can control the dissolved phase PAH via partitioning between the oil and water. To quantitatively account for this partitioning, we measured the oil-water partition coefficient (Koil) of PAHs by creating a water accommodated fraction (WAF) of fresh and weathered crude oil with samples collected following the Deepwater Horizon oil spill in the Gulf of Mexico in 2010. Samples representing a wide range of weathering from fresh riser oil to highly weathered oil that had lost 96% of the PAH content were archived for these experiments. We found dramatic increases in the Koil values as the spilled oil weathered, especially for the lower molecular weight PAH. If one were to estimate dissolved PAH based on the concentration of PAH in the oil using the Koil values, the use of "weathered" Koil values results in up to a 200-fold decrease in estimated dissolved PAH compared to using Koil for the fresh, unweathered oil. For example, for parent naphthalene at 86% weathering we estimate the dissolved concentration is 93 ng/L using the Koil for fresh oil versus only 1 ng/L using the Koil we actually measured for the 86% weathered oil. Similarly, for the methyl phenanthrenes at 97% weathering state we find a 200-fold decrease in estimated dissolved exposure using the Koil we measured at 97% weathering versus the Koil we measured with fresh MC252 oil. The significance of these results is that weathering can dramatically increase the affinity of the residual PAH for the oil and by using Kow or Koil for fresh oil, instead of Koil for the weathered oil, one can substantially overestimate dissolved PAH in the presence of the oil and thus greatly overestimate the potential risk associated with the spilled oil.

2:45 PM - 3:00 PM

Biodegradation of Crude Oil in the Gulf of Mexico: From the Water Column to the Shorelines--What We Learned from the Deepwater Horizon Accident

R. Atlas
University of Louisville, Louisville, KY

The Deepwater Horizon oil release resulted in an unprecedented number of biodegradation studies. Collectively these studies show that the microorganisms in the Gulf of Mexico are well adapted to biodegrade oil that is naturally or accidentally released. Even in cold deepwaters, microorganisms rapidly degraded most hydrocarbons with half lives of less than a week. Oxygen dips and elevated microbial populations followed the path of the dispersed oil in the deepwater. Laboratory studies confirmed that dispersed oil in the cold deepwater was rapidly degraded, including BTEX, alkanes, and 2-3 ring PAH. Approximately 90% of the dispersed DWH oil in the deepwater would have been degraded within 50 miles of the wellhead. *Oceanospirillales*, including a novel DWH *Oceanospirillaceae*, *Colwellia* and *Cycloclasticus* were exceptionally important in degrading alkanes and aromatics in the dispersed oil in the water column. Oil that reached the surface and formed slicks did not undergo significant additional biodegradation as it moved toward the shores, but underwent extensive chemical weathering. Microbes in sand beaches, including *Alkanavorax*, biodegraded contaminating oil. Oil that entered marshes underwent slower but significant biodegradation, including by anaerobes such as *Desulfococcus*. In conclusion, naturally occurring microbes of the Gulf of Mexico limit the extent and

duration of oil contamination and help decontaminate environments, including those that may be heavily oiled.

3:30 PM - 3:45 PM

Sources of Carbon to Particulates in the Gulf of Mexico

K. L. Rogers[1], J. P. Montoya[2], S. Weber[2], S. Bosman[1], J. Chanton[1]
[1]Florida State University, Tallahassee, FL, [2]Georgia Tech, Atlanta, GA

The Deepwater Horizon blowout released 5.0x1011g C from gaseous hydrocarbons and up to 6.0x1011g C from oil into the water column. Another carbon source, adding daily to the water column, leaks from the natural hydrocarbon seeps that pepper the seafloor of the Gulf of Mexico. How much of this carbon from the DWH and natural seeps is assimilated into particulate organic carbon (POC) in the water column? We filtered seawater collected in 2010, 2012 and 2013 from seep and non-seep sites, collecting POC on 0.7µm glass microfiber filters and analyzing the POC for stable and radiocarbon isotopes. Mixing models based on carbon isotopic endmembers of methane, oil, and modern production were used to estimate the percentage of hydrocarbon incorporated into POC. Significant differences were seen between POC from shallow and deep waters and between POC collected from seep, non-seep, and blowout sites; however yearly differences were not as evident. Preliminary evidence thus suggests the GOM has a consistent supply of isotopically depleted carbon. Stable carbon isotope signatures of POC in the Gulf averaged -23.7±2.5‰ for shallow samples and -26.6±2.9‰ for deep POC samples, while radiocarbon signatures averaged -100.4±146.1‰ for shallow and -394.6±197‰ for deep samples. Deep POC in the northern Gulf varies from 23-91% modern carbon, 2-21% methane, and 0-71% oil. Oil inputs appear to play a major role in the POC composition of the GOM, especially in the vicinity of the natural seep GC600.

3:45 PM - 4:00 PM

Marine Aggregates - Material Transport in the Deep Gulf of Mexico

A. R. Diercks[1], C. Dike[2], V. Asper[2], K. Ziervogel[3], U. Passow[4]
[1]University of Southern Mississippi, Abbeville, MS, [2]University of Southern Mississippi, Stennis Space Center, MS, [3]University of New Hampshire, Durham, NH, [4]University of California Santa Barbara, Santa Barbara, CA

The formation of marine aggregates, a known pathway for the transport of material from the surface ocean to the deep sea, has become the focus of recent studies that address the fate of the missing oil in the oil budget of the 2010 BP oil spill. Data from digital camera systems that capture time series pictures of a known volume of water either moored at a specific depth in the water column or lowered at a constant rate through the water column, reveal the complex structure of this material delivery process to the deep sea. This study reports on the data collected by these cameras that record point source vertical profiles of aggregate abundance and year-long time series measurements of accumulation and settling speeds of these aggregates. Combined with ADCP and time series data from sediment traps deployed in the same mooring, a high resolution record of the vertical transfer of material to the sea floor unfolds. Resuspension events, evident as increased lithogenic material flux collected in the sediment traps, are documented as “snow storms” of material arriving in the settling chamber of the moored camera. From time series images of the material settling through the water column, size specific settling speeds are measured. Material densities, estimated based on size and settling speed, combined with the material composition of the time series sediment traps, allow a first insight in the delivery process and the dynamic behavior of the transport of oiled and natural aggregates near the seafloor.

4:00 PM - 4:15 PM

Seasonal and Interannual Patterns of Marine Snow in the Region of the Deepwater Horizon Oil Spill: Impacts on Oil Sedimentation

K. L. Daly, A. Remsen, K. Kramer
University of South Florida, St Petersburg, FL

Sedimenting oil-associated marine snow was a significant pathway by which oil reached the seafloor during the Deepwater Horizon (DWH) and Ixtoc-I oil spills. This process, however, was not specifically considered by the DWH Oil Budget Calculator. Marine snow occurs throughout the world's oceans and at all depths; thus, marine snow processes will likely impact future oil spills. A camera imaging system (SIPPER) was used to determine particle characteristics between 0-300 m on 10 cruises. Spatial, seasonal, and interannual particle abundance and distributions were variable in the NE Gulf of Mexico during and after the DWH oil spill, which undoubtedly influenced the variability of oil sedimentation. Maximum particle concentrations (integrated 0-140 m, Aug. 2010: 866,863/m2; Aug. 2013: 1,493,059/m2) usually occurred during summers of high Mississippi River flow. Particle sizes ranged from 0.124 - 28.7 mm in diameter, with peak concentrations ranging from 0.389 to 0.518 mm. Particles > 1mm (sinking rates 10s to 100s of meters d-1) were 5-7 % of the total particles during winter, 7-47% during spring, and 5-14% during summer. Peak abundances were shallower during summer (8 m), than during winter (28 m) or spring (45 m). Elevated concentrations also occurred in deeper water (71 to 281 m), possibly from suspended sediments advecting off the shelf/slope. Overall, marine snow processes would likely have the greatest impact on future oil spills during spring and summer, especially during years of high river flow.

4:15 PM - 4:30 PM

Continuous Sedimentation of Spilled Oils in the Northern Gulf of Mexico after DwH Oil Spill

B. Yan[1], U. Passow[2], M. Pitiranggon[1], V. Guarnnaccia[1], A. Juhl[1], A. Subramaniam[1]
[1]Lamont-Doherty Earth Observatory, West Nyack, NY, [2]University of California Santa Barbara, Santa Barbara, CA

Crude oil enters the Gulf of Mexico (GOM) through catastrophic spills, such as the Deepwater Horizon Oil Spill, and through numerous natural oil and gas seeps. Fully characterizing and unambiguously distinguishing hydrocarbons from these different sources remains a challenge. To compare oil originating from a spill to that from a natural seep, samples were collected from bottom sediments and water column sediment traps from 2010 to 2014 at several locations, including a site close to the Deepwater Horizon well head (OC26) and a natural oil seep site (GC600). The levels and molecular distributions of alkanes, alkenes (olefins), PAHs, and hopanes were characterized. Through these samples, the hydrocarbon inputs from spilled and seeped oil were calculated, and the molecular difference between these types of oil was characterized. In these samples, independent source-sensitive markers consistently indicated that the amount of spill-related hydrocarbons in the site of OC26 decreased slowly in the first several months after the spill and then tailed off until March 2011. Except at the sites affected oil spills and oil seeps, riverine hydrocarbons is a dominant hydrocarbon source, which alters substantially year to year.

4:30 PM - 4:45 PM

Four Years of Chemical Measurements from the Deepwater Horizon Oil Spill Define the Deep Sea Sediment Footprint and Subsequent Recovery

K. J. Murray, L. L. Cook, J. S. Brown, P. D. Boehm
Exponent, Maynard, MA

Chemical data acquired during and after the DWHOS showed that several mechanisms were responsible for transport of oil from the water column to the sediments in the deep sea off the continental shelf. Three primary pathways were identified: Sorption onto and sinking of drilling mud particles during "Top Kill" response activity, highly scattered deposition of residues from in situ burns, and deposition of oil from diffuse oil plumes via sinking microbial organic matter ("marine snow"). Data collected during 2010, 2011 and 2014 were used to define the oil footprint and estimate time to recovery. More than 1200 stations were sampled. Of these, 27 stations were visited all three years, providing a time series from which recovery rates were calculated using the loss of total polycyclic aromatic hydrocarbons (TPAH) over time fit to first order kinetics. Results showed that the footprint of the oil was limited to the area around the wellhead and in patches to the southwest. Most samples had returned to background levels by 2015, with some exceptions close to the wellhead. Deposition to the northeast (DeSoto Canyon) was minor as evidenced by the absence of oil in sediments in that area. Samples with the longest recovery times were within 2 nautical miles of the wellhead, and often contained drilling mud, as shown by olefin signatures on the GC/FID chromatogram. Detailed chemistry data evaluation and chemical fingerprinting provided evidence that oil was being degraded in situ.

4:45 PM - 5:00 PM

Chemical Evidence for the Presence and Distribution of Macondo Oil in Deep-sea Sediments following the Deepwater Horizon Oil Spill

S. A. Stout[1], J. R. Payne[2]
[1]*NewFields, Rockland, MA,* [2]*Payne Environmental Consultants, Inc., Encinitas, CA*

Sediment layers (2782) from 729 high resolution cores collected in 2010/2011 from the deep-sea following the Deepwater Horizon oil spill were chemically analyzed to (1) determine the presence of spilled Macondo oil on the seafloor, (2) assess the spilled oil's range of weathering, and (3) distinguish the spilled oil from natural seep oil and background hydrocarbons. A forensic method reliant upon multiple lines of evidence (chemical fingerprinting, lateral and vertical hydrocarbon concentration trends, proximity to the well and known or apparent seeps, and the character of proximal samples - including novel "slurp gun" seafloor floc samples) met these objectives and affirmed that liquid Macondo oil widely distributed by the deep-sea plume(s) was deposited in deep-sea sediments. Macondo oil and synthetic-based drilling mud (SBM) were deposited by direct fallout within ~1 mile of the well. Macondo oil-bearing floc, which experienced severe dissolution and biodegradation during transport within the deep-sea plume prior to being deposited on the seafloor (e.g., via marine oil snow or impingement) was found in surface sediments (mostly top 1 cm) up to 19 miles southwest of the well, less in other directions. The distinct features of the oily floc beyond a few miles from the well allowed it to be recognized at low concentrations and distinguished from pervasive background hydrocarbons and seep oils, the latter of which had retained susceptible hydrocarbons that were removed from the Macondo oil due to the severe dissolution and biodegradation that the (chemically and physically) dispersed Macondo oil experienced during its transport throughout the deep-sea.

Thursday, February 4, 2016
8:30 AM - 12:00 PM

Determination of the Oil Droplet Size Distribution and Its Impact on the Fate and Transport of Oil: Consequences on Public Health and Ecology II

8:30 AM - 9:00 AM
Processes and Considerations Associated with Aerosolized Oil
J. Katz, D. Murphy, C. Li, X. Xue
Johns Hopkins University, Baltimore, MD

Breakup of oil slicks by waves, rainfall or popping bubbles generates aerosolized droplets on the surface of the ocean, which can then be transported by winds. The present knowledge on the environmental impact of aerosolized oil is quite limited. This presentation will discuss and demonstrate several mechanisms affecting the generation of airborne droplets near the ocean surface along with available data on their size distribution. Some of the data for breaking waves and raindrop impact have been measured in recent experiments performed in our laboratory, and others have been compiled from the wealth of available information about oceanic aerosols. Introduction of dispersants drastically reduces the oil-water interfacial tension, causing a substantial decrease in the characteristic size and an increase in the number of both subsurface and airborne droplet. Continuous exposure to breaking waves also aerosolizes a fraction of the suspended subsurface droplets that have been generated by previous waves. Based on available models for particle transport in the atmosphere, under normal/moderate wind conditions, while droplet with size of 100 µm or larger are likely to settle rather quickly, a 1 µm diameter or smaller droplet is likely to remain suspended for longer periods, and carried for longer distances. Hence, plans to apply dispersants should consider the potential environmental and health impacts of aerosolized oil on communities located downstream of the oil spill.

9:00 AM - 9:15 AM
Impacts of Waves on Particulate and Gaseous Emissions from Oil and Oil-Dispersant Contaminated Sea Waters
N. Afshar-Mohajer, K. Koehler, A. Rule, C. Li, J. Katz
Johns Hopkins University, Baltimore, MD

Crude oil spill incidents occur frequently, leaving seawater bodies with a verity of occupational, ecological and environmental issues from the local to global scale. Application of sub- surface dispersants to the oil contaminated water in order to break up the oil into smaller droplets has been gaining popularity in recent years as an intervention strategy. However, the use of dispersants may also have impacts on the generation and transport of aerosolized droplets, as well as changes in emitted gases due when subjected to natural processes such as rains, winds and waves.

In this study, systematic real-time measurements of total VOC (TVOC), particle-bound polycyclic aromatic hydrocarbons (PAH), and aerosol size distribution from 10 nm to 20 µm were conducted over a wave tank containing seawater, seawater plus crude oil, or seawater with crude oil and dispersant. All experiments were performed in triplicate using a wave tank (L = 6 m, W = 0.3 m and D = 0.6 m) and wave generation system, and sensitivity analyses were conducted on key parameters including wave type, wave frequency, dispersant to oil ratio (DOR) and crude oil contamination concentration inside the water. Results indicated that the majority of the aerosolized particles when the wave tank contained seawater only and sea water plus oil-dispersant were smaller than 15 nm (both before and after the

wave generation). However, the particle mode size for the seawater plus crude oil slick was averagely 85 nm after the wave generation. Increasing the total amount of added oil-dispersant mixture from 3.5 to 10 mL led to an approximately twofold increase in the total number concentration of nano-sized particles. No obvious changes in particle mode or median sizes for both nano- and micron-sized particles was detected, but the total number concentration of nano-sized particles increased 10 to 50% after the wave was created in all contamination case scenarios. An average of 10 times increase in TVOC concentration was observed after contaminating the sea water by 3.5 mL oil-dispersant mixture (DOR = 1:25) compared to seawater alone. Wave creation led to another 40 times increase in TVOC concentration (~ 400 times higher than the non-contaminated calm sea water). This indicates possible formation of secondary organic aerosol (SOA) in presence of the sunlight.

9:15 AM - 9:30 AM

Using the Baffled Flask to Test Dispersant Effectiveness with 23 Crude Oils and Comparison with Other Testing Protocols

E. L. Holder[1], R. N. Conmy[2], A. D. Venosa[3]

[1]Pegasus Technical Services, Inc., Cincinnati, OH, [2]U.S. Environmental Protection Agency, ORD, Cincinnati, OH, [3]U.S. Environmental Protection Agency, ORD (retired), Cincinnati, OH

A laboratory study using the Baffled Flask Test (BFT) was conducted to measure the dispersion effectiveness of Corexit 9500 on 23 different crude oils (viscosities from 7 - 31,000 cP) as a part of a larger project initiated by the Bureau of Safety and Environmental Enforcement (BSEE). The laboratory BFT dispersant effectiveness results were then compared to BSEE's large-scale test conducted at the Ohmsett National oil spill response wave tank test facility located in Leonardo, NJ and 2 other laboratory-scale testing procedures. The BFT is planned for adoption as U.S. EPA's official testing protocol for listing commercial dispersant products on the National Contingency Plan Product Schedule, replacing the current Swirling Flask Test (proposed decision-rule to the federal register). The temperature used for the tests was 15°C, matching the temperature used at Ohmsett. Energy input was 200 rpm on an orbital shaker which equates to the energy of a moderate sea 57 - 64 μm on the Kolmogorov scale, and similar to the size of oil droplets observed at sea (50-400 μm). Dispersion effectiveness of the tested crude oils ranged from 3.4% to 93%. Findings indicate that BFT dispersant effectiveness is inversely correlated with oil viscosity and therefore has predictive value in the decision to use a dispersant in the event of a spill. This research was funded in part by the Oil Spill Liability Trust fund and BSEE.

9:30 AM - 9:45 AM

Simulation of Oil Dispersion under Breaking Waves

Z. Wei, R. A. Dalrymple, C. Li, J. Katz

Johns Hopkins University, Baltimore, MD

Water waves play an important role in the dispersal of oil in the water column and the transport of oil droplets across the air-sea interface. Although numerical studies of oil transport due to non-breaking waves were reported in literature, existing research on oil dispersion under breaking waves is still very limited. The primary focus of this study is to replicate and further analyze an oil dispersion under breaking waves laboratory experiment, which was conducted in Department of Mechanical Engineering at Johns Hopkins University by Li & Katz, by using a mesh-free Smoothed Particle Hydrodynamics model, GPUSPH. The waves in the laboratory were generated by a piston wave maker driven by different trajectories, resulting in both spilling and plunging breakers. We first validate our numerical model by comparing the breaking wave profile with the laboratory measurements, including water surface

snapshots and time-series free surface profiles at individual wave gauges. Then we investigate the impact of breaking wave forcing on oil dispersion by placing a very thin layer of oil under the waves. It is seen that: (1) qualitative agreements on the distribution of oil droplets along the water column are obtained by the numerical model, and (2) the transport of oil droplets is also influenced by the breaking wave patterns (e.g., spilling and plunging breakers). Finally, we apply the model to examine the oil dispersion difference due to the interfacial tension forces, which are varying among different types of oils.

9:45 AM - 10:00 AM

The Role of Oil Viscosity and the Oil-water Interfacial Tension in the Formation of Oil Dispersion under Breaking Waves: Experiments and Simulations

R. Golshan[1], B. Robinson[2], T. King[2], M. Boufadel[1], R. Conmy[3], K. Lee[4]

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We report experimental results of oil dispersing due to breaking waves in the 32 m long wavetank of the Department of Fisheries and Oceans, Canada. Three oils were considered: Alaska North Slope, Osberg, and Cold Lake Blend (a diluted bitumen) with dispersant to oil ratios of 1/20. Wave hydrodynamics was quantified using high resolution submerged cameras and two acoustic Doppler velocimeters. The oil droplet size distribution was measured using a LISST at two locations in the tank. The dispersant COREXIT9500 was used. The experiments were simulated numerically using the computational fluid dynamic model Fluent with 12 million nodes on the average. The CFD simulations compared favorably with the water profile and water velocity at various locations. The CFD model was coupled to the model VDROP, and the predicted droplet size distribution (DSD) was compared to that measured from the LISST; the agreement was reasonable. We compare our findings to formulas aimed at predicting the dispersion of oil due to waves, and our preliminary results suggest that the present mathematical formulations used in oil spill models are too detailed for the intended purpose.

10:30 AM - 10:45 AM

Formation of Oil Particle Aggregates (OPA): Experimental Studies and Development of the OPM model

L. Zhao[1], M. Boufadel[1], T. King[2], B. Robinson[2], K. Lee[3]

[1]New Jersey Institute of Technology, Newark, NJ, [2]Bedford Institute of Oceanography, Department of Fisheries and Oceans, Dartmouth, NS, Canada, [3]Flagship of Wealth from Oceans, Commonwealth Scientific and Industry Research Organization (CSIRO), Perth, Australia

Oil-particle interactions can result in oil particle aggregates (OPA), which move differently from oil droplets or particles alone. This may alter drastically the fate of oil. We conducted laboratory studies in the EPA baffled flask to evaluate the impact of the particle concentration and properties on their trapping efficiency by oil. OPA were analyzed by epifluorescence microscopy to reveal their structures. We also developed a new OPA model that requires the input of particle and oil properties and the mixing intensity. A new parameter is introduced in OPM model to account for the shape of the particles and the packing on the oil droplets, as it was found that the packing efficiency does not depend only the areas of the oil droplets and particles, but also on the particle concentration. Also a new conceptual formulation of oil-particle coagulation efficiency is introduced in the model to account for the overall behavior of the coated area on the droplet surface. Based on the new formulation, the OPM was able to closely reproduce the oil trapping efficiency both in suspended and negatively buoyant OPA. To our knowledge, the OPM is the first predictive OPA model, and thus could be used for mitigating oil spills.

10:45 AM - 11:00 AM

Formation, Transport, and Breakup of Submerged Oil Particle Aggregates in Freshwater Riverine Environments

F. Fitzpatrick[1], M. H. Garcia[2], Z. Zhu[2], D. Waterman[2], E. Hayter[3], M. C. Boufadel[4], J. Hassan[5]
[1]United States Geologic Survey, Middleton, WI, [2]University of Illinois, Urbana-Champaign, IL, [3]US Army Corps of Engineers, Clemson, SC, [4]New Jersey Institute of Technology, Newark, NJ, [5]US EPA, Chicago, IL

The July 2010 Enbridge Pipeline release of diluted bitumen into the Kalamazoo River was one of the largest freshwater oil spills documented in the United States. In the early stages of the response, recovery efforts focused on the removal of floating diluted bitumen. However, as the diluent volatilized and bitumen mixed with sediment, a large amount sank and settled out in depositional areas. In 2013, the U.S. Environmental Protection Agency (EPA) estimated at least 80,000 gallons of weathered bitumen still remained in the Kalamazoo River. A majority of the remaining oil was in the form of oil-particle aggregates (OPA) submerged in bed sediment. Throughout the response and continuing through 2014, resuspension of OPAs and spontaneous release of submerged oil from bottom sediment caused visible sheen throughout the 38 miles of impacted waterway. The complex nature and conditions associated with the release of oil from bottom sediment provided the impetus for development of a hydrodynamic model to simulate migration of submerged oil and OPAs throughout the river. A simple OPA transport model was developed to represent OPAs as unique particle classes in existing sediment transport modules. These models were used for Kalamazoo River oil-spill response and clean-up operations, determination of clean-up endpoints, and containment. Additional laboratory tests and numerical modeling are continuing in order to fully apply OPA formation, transport, and breakup models to freshwater environments to help responders in planning, recovery, and containment of future diluted bitumen spills in freshwater environments. The study uses the combined experimental and modeling knowledge in the fields of sediment transport and oil droplet formation. Results from the work will enhance and expand the current state of knowledge of bitumen spills and will build off of existing numerical modeling work underway by EPA and Environment Canada for marine coastal environments. We will give an overview of what's been accomplished for the Kalamazoo River spill to date and describe plans for additional experiments and modeling in 2016-17.

11:00 AM - 11:15 AM

Biosurfactant Based Dispersants: Isolation of Biosurfactant Producers, Economic Production and Enhanced Oil Dispersion

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Memorial University of Newfoundland, St. John's, NL, Canada

This research tackled the generation and application of biosurfactant-based dispersants for oil spill response. Comparing to the chemical equivalences, biosurfactants are less toxic, biodegradable, resistant to environmental changes, and can be biologically produced from waste streams. Crude oil, formation water, drilling mud, treated produced water and seawater samples were collected in an offshore oil and gas platform for bacterial screening. Through using n-hexadecane or diesel as the sole carbon source, biosurfactant producers were identified and characterized. They belong to 4 genera, namely, *Bacillus*, *Rhodococcus*, *Halomonas*, and *Pseudomonas*. Diverse isolates were found with featured properties such as reduction of surface tension, production of biosurfactants at high rate, and stabilization of water-in-oil or oil-in-water emulsion.

Among the producers, the *Rhodococcus erythropolis* SB-1A strain was with a proper HLB value to disperse crude oil. It was selected to conduct UV mutagenesis for generating hyper producing mutants so as to decrease the production cost. Based on the data of dispersion efficiency determined by Baffle Flask Test (BFT), a biosurfactant production rate increase of 35% was achieved using the mutant #47 when comparing to the wild SB-1A strain. The process of biosurfactant production was further optimized using different carbon and nitrogen sources. Biochemical composition analysis and the stability characterization of the crude biosurfactants were then conducted.

The obtained biosurfactant product was mixed with the selected solvent at optimum ratio to generate bio-dispersant. When applying it to treat oil in water, the oil dispersability of the new bio-dispersants was comparable with or even higher than that of Corexit products. The bio-dispersed oil mixture had shown a much higher biodegradability than that dispersed by the Corexit products.

11:15 AM - 11:30 AM

Controlled Oil-in-Water Droplet Size Distributions via Environmentally Compatible Dispersants

Z. M. Aman[1], C. B. Paris[2]

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Dispersants represent a chemical pathway to control oil-in-water droplet size, where adsorbed surfactants reduce water-oil interfacial tension. In the limit of low tension, minimal shear stress is required to generate small and neutrally-buoyant oil droplets in the water column. As highlighted in recent years, the current generation of dispersants primarily uses ionic surfactants to increase adsorption effectiveness, which may increase environmental toxicity with limited chemical biodegradability. The current study focuses on the use of nonionic surfactants to generate oil-in-water dispersions, with a variety of hydrophilic functional groups, including carboxylic, sulphuric and acetic. Each nonionic surfactant was added to an oil-in-water dispersion at high pressure (100 bar methane) and low temperature (4 °C). Oil droplet size distributions were measured visually in a high-pressure sapphire autoclave apparatus, captured using a 2000 fps high-resolution camera. Each surfactant was compared to cases without any dispersant, and with 0.5 and 2 wt% of an ionic dispersant. The results demonstrate that nonionic surfactants may provide a pathway to control the size distribution of oil droplets in water, with decreased environmental risk relative to their ionic counterparts.

11:30 AM - 11:45 AM

Oil in Water Fluorescence and Backscattering Relationships

I. D. Walsh[1], B. J. Robinson[2], J. Koegler[1], R. N. Conmy[3]

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Oil in water exists as a mixture of dissolved and droplet fractions in natural waters. Fluorometers are effective in detecting oil in water, and recent improvements in optics, electronics and instrument design have enabled a factor of five increased sensitivity in fluorescent dissolved organic matter (FDOM) sensors which respond to crude oil. The fluorescence intensity scales with oil concentration and linear calibration relationships can be derived between the fluorescence signal and oil concentration from grab samples. Because the fluorescence intensity is a function of the concentration of oil modulated by the dissolved to droplet mass ratio and the droplet size distribution, precise calibration relationships must be determined for a given oil and water mixture and will change with time. Using multiple sensors can constrain the expected calibration relationships. In particular, backscattering is an effective tool for measuring the droplet fraction of oil. We describe a series of experiments in a flume in which oil and oil

and dispersant mixtures were injected under pressure into the flume. We measured backscattering with an instrument that combines backscattering with fluorescence sensors. We evaluate the combined fluorescence and backscattering signals to investigate their relationship and compare the backscattering results with the most common current methodology of single channel fluorometers and forward scattering sensors.

11:45 AM - 12:00 PM

Detection and Quantification of Submerged Oil Droplets by a Broadband, High-frequency Echo Sounder

S. C. Loranger, T. C. Weber
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The evolution and fate of dispersed oil droplets in the marine environment is crucial to the development of response protocols and to the assessment of risk for areas surrounding a spill. Current models of the movement of submerged oil droplets suffer from a lack of in-situ data for verification. Current in-situ measurement depends on short range instrumentation that is only capable of evaluating small segments of a spill at a time. Very high-frequency acoustics (few MHz), mass spectrometers, fluorometers and water sampling systems have very small fields of view, creating observational challenges when trying to generate a synoptic view of a spill. As an alternative, the use of broad-band high-frequency acoustics (100-500 kHz) is being explored. Broad-band high-frequency acoustics are capable of measuring and quantifying oil droplets at ranges of tens to hundreds of meters in a single measurement. The frequency-dependent acoustic response of oil droplets is dependent on the size, sound speed and density of oil droplets. Broadband high-frequency acoustic measurements of a variety of oils have been measured in the laboratory setting to quantify the droplet size dependent acoustic response of oils of varying density and sound speed. This instrumentation was able to differentiate between droplets with different radii. Results indicate that broadband high-frequency acoustics can be used to map the location of submerged oil droplets and to evaluate changes in the physical properties of oil for large areas of a spill.

Human Functioning and Adaptation to Stress: Implications of Prolonged Exposure for Individuals and Communities II

8:45 AM - 9:00 AM

Trajectories of Posttraumatic Stress Symptoms for Children and Adolescent with Prolonged Exposure to Disasters

J. Osofsky, T. Hansel
Louisiana State University Health Sciences Center, New Orleans, LA

Disasters and their subsequent recovery can result in negative behavioral health outcomes, with youth being particularly vulnerable. Trauma symptoms in children and adolescents tend to decrease over time; however, with prolonged exposure, such as extended periods of recovery, increased stressors, and additional traumas, negative psychological symptoms may persist, develop, or increase. These complex recovery patterns represent both immediate and chronic consequences of trauma as well as characteristics of the individual's social environment. This presentation will examine outcome trajectories in posttraumatic stress symptoms following exposure to hurricanes and the Deepwater Horizon Gulf Oil Spill. A total of 4,619 youth were evaluated for behavioral health symptoms, hurricane exposure, and oil spill stress over four years. Results suggest that the largest group exhibited stable low symptoms, a second group showed steep declines, a third group showed stable high symptoms, and a fourth group exhibited increasing symptoms. Results identified an effect of oil spill stress and hurricane exposure on symptom levels and trajectories of exposed youth. Regardless of trajectory outcome, over 50% of youth reported concerns for animals, the environment, eating local seafood and other food sources, and loss of water activities. These results demonstrate local youths' connection to their ecosystem and increase understanding of resilience and chronic reactions to disaster.

9:00 AM - 9:30 AM

Health among Two Cohorts of Women Following the DWH Disaster (DWHD)

E. J. Trapido[1], l. C. Perez[2], A. B. Rung[1], E. T. H. Fontham[1], D. Harrington[1], M. Brashear[1], E. Oral[1], E. S. Peters[1]
[1]LSU Health Sciences Center-New Orleans, New Orleans, LA, [2]Univeristy of Virginia, Fayettesville, VA

After the DWHD, 2 cohorts of women were assessed for exposure, and physical, mental, and behavioral health problems. The 1st cohort consisted of wives of clean-up workers (WoW study), identified through index male clean-up workers in the NIEHS GuLF Study, and residing in 7 SE Louisiana parishes. The 2nd cohort was a quasi-random sample of women living in the same parishes, who were not part of the GuLF study. We hypothesized that the WoW cohort would have had greater "exposure" (using several indicators of exposure); would experience more physical and mental health effects than those in WaTCH, and that greater exposure in both cohorts would be associated with more health effects. The WoW cohort (n=245) was ≈50% more likely to have had high physical exposure to the oil spill, and more likely to have had greater economic impact than the WaTCH cohort (n=2584). In both, the risk (odds ratios-ORs) of having health symptoms was higher in women with exposure to the spill/oil than the risk associated with having economic losses. Both cohorts had significantly elevated ORs of shortness of breath, watery/burning/itchy eyes; severe headaches, nausea, and sore throats associated with exposure to the oil spill. The WoW cohort also had elevated ORs of diarrhea and constipation associated with exposure to the spill/oil than less exposed women; while the WaTCH cohort had elevated ORs of nasal symptoms, skin rashes, dizziness, burning in the throat/lungs, vision problems, and fatigue.

9:00 AM - 9:30 AM

Post-Traumatic Stress Disorder (PTSD) among Women in Southeast Louisiana Impacted by the Deepwater Horizon Oil Spill (DHOS)

E. S. Peters, S. Gaston, A. Rung, M. Brashear, E. Trapido
LSU School of Public Health, New Orleans, LA

The Women and Their Children's Health (WaTCH) study examines physical health effects from the DHOS among a cohort of 2800 women in Louisiana. A telephone interview, begun in 2012, obtained data on physical/mental health and exposure to the oil spill. In 2014, a 2nd interview collected follow up information and assessed PTSD using the PTSD Checklist (PCL). Exposure to the DHOS was assessed measuring an individual's physical and economic experience of the spill. Generalized linear models were fit to estimate the association between DHOS exposure and PTSD severity. 1143 women completed the follow up to date. Mean age is 57 years, 55% of the women are white, and 23% of the women reported high exposure to the oil spill. Mean PCL score was 16.2 (range: 0-79). 15% of the women scored >=38 indicating probable PTSD. Preliminary analysis suggests that high DHOS exposure may be associated with PTSD severity. In addition to the numerous traumatic events experienced by this population in their lifetime, the DHOS may further exacerbate severity of PTSD symptoms. Although additional work is necessary to disentangle this single event from other natural disasters and traumatic events that have occurred in this population, this technologic disaster has had long-lasting negative effects on the psychological well-being of a vulnerable community.

9:00 AM - 9:30 AM

Discordant Reports of Psychological Distress, Behavioral Problems, and Serious Emotional Disturbance among Mothers and Children in the WaTCH Study

D. Abramson[1], L. Peek[2], S. Friedman[1], E. Peters[3], A. Rung[3], R. Whyatt[4], V. Rauh[4], A. Merdjanoff[1], **S. Friedman**[1]
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The majority of pediatric disaster mental health research is predicated on parental reports of children's mental health status. A recent meta-analysis of agreement between parents and children who were administered mental health and behavioral checklists found considerable variation across 25 societies, and little concordance for internalizing symptoms such as feeling depressed, anxious, or afraid. This analysis indicated that more often than not, children were more likely to report problems than parents perceived. Our ongoing Women and Their Children's Health Study, a population study conducted in seven oil-spill-exposed Louisiana parishes, has afforded our team the opportunity to test concordance among 633 mother-child dyads, at baseline and at a subsequent interview two years later. Mothers and children (10-17 years old) were administered the Strengths and Difficulties Questionnaire, representing emotional issues, conduct and peer problems, hyperactivity, and pro-social behavior. On the overall score, mother and child agreed 70% of the time. When there was a discrepancy, mothers were more likely to report problems than were their children. Concordance was greatest for pro-social behavior (88% concordant) and lowest for peer problems (67%). This study examines how concordance varied by child's age, race, and gender, and by household socio-economic characteristics, parental mental health, and by disaster exposure associated with the oil spill and other natural hazard events.

9:30 AM - 10:00 AM

Ten Years after Katrina, Five Years after Deepwater Horizon: Risk Perception and Resilience among Residents of the Mississippi Gulf Coast

D. M. Cochran, B. Kar, B. Blackmon, J. Lee, T. Rehner
University of Southern Mississippi, Hattiesburg, MS

Communities of the U.S. Gulf of Mexico coast are susceptible to frequent and intense tropical cyclones. Despite their exposure to storms, as well as other hazards, Gulf Coast counties have experienced impressive demographic growth and rising property values in recent decades. Between 1970 and 2010, for example, the population of the region increased by 109 percent. In 2012, coastal counties from Texas to Maine had an estimated $10.6 trillion in insured properties. The synergistic effect of frequent exposure to storms and other hazards, alongside population growth, is increased risk to loss of property and human life. This study examines resilience and risk perception - a precursor to an individual's decision to take mitigating actions - among residents of the Mississippi Gulf Coast ten years after Hurricane Katrina. An interdisciplinary team of researchers from geography and social work at the University of Southern Mississippi developed and administered a survey in 2015. Focusing on Mississippi Gulf Coast residents living south of Interstate 10, the team obtained a representative sample (n = 379) of the study area population. After the survey was administered, responses related to risk perception and resilience were integrated with spatial data to answer the following questions: (1) To what extent is risk perception influenced by socioeconomic characteristics, prior experience with, and awareness of coastal hazards? and (2) Do risk perceptions of Mississippi Gulf Coast residents vary with regard to natural hazards (tropical cyclones like Hurricane Katrina) versus anthropogenic hazards (BP Oil Spill)?

9:30 AM - 10:00 AM

A Critical Analysis of Technological Disaster Resilience Literature: Recommendations and Lessons Learnt for Addressing Hydrocarbon Events

K. Luu[1], R. J. Ferreira[1], L. Haas[1], M. L. Finucane[2], T. Zwanziger[1], A. E. Kalnik[1], T. Morath[1], K. Davis[1], J. Murphy[1]
[1]Tulane University, New Orleans, LA, [2]RAND Corporation, Pittsburgh, PA

Communities worldwide are at a severe risk of manmade disaster, yet the impact of technological disasters on resilience remains a neglected area of research. The 2010 Deepwater Horizon (DWH) disaster provides a unique opportunity to gain a scientific understanding of systems level (e.g. individual, household and community) disaster resilience dimensions associated with hydrocarbon events. The purpose of this paper is to present findings from a systematic literature review that seeks to identify how communities affected by and/or vulnerable to oils spills can increase resilience to future hydrocarbon events. NVivo was used to organize and analyze the literature. Review questions addressed four dimensions of resilience (social, economic, infrastructure and environmental) within the context of hydrocarbon events. Of the 11,028 documents collected and screened, 97 documents were coded and analyzed by research scientists at Tulane University's Disaster Resilience Leadership Academy. Several unique themes were identified among the four dimensions. Contributing factors to resilience within the context of hydrocarbon events are leadership; social, economic, political and human capital; family business and social support. Much of disaster research has focused on community resilience from a natural hazards perspective. This study is unique by contributing new knowledge on disaster resilience to the understudied field of technological disaster research.

9:30 AM - 10:00 AM

The Deepwater Horizon Oil Spill's Health Impacts on Vulnerable Residents in the Alabama Gulf Coast

R. Xie, J. L. Blackburn, B. Sen

University of Alabama at Birmingham, Department of Health Care Organization and Policy, Birmingham, AL

Introduction: This study examined the health impact of the 2010 Deepwater Horizon oil spill on residents from Alabama's gulf coast region. We used the Behavioral Risk Factor Surveillance System (BRFSS) to measure the change in population-based health and behaviors after the oil spill, and discussed potential improvement for allocating resources and targeting populations for health education. **Method**: We used 2008-2012 data from the BRFSS, a nation-wide annual survey of health and behaviors conducted by the Centers for Disease Control and Prevention. We estimated multivariate logistic regression models and the Differences-in-Differences statistical approach to investigate health effects on the residents in Alabama counties directly affected by the oil spill compared to other Alabama counties with similar socioeconomic characteristics yet not from the Gulf area. **Results**: After the oil spill, the probability of smoking every day among the residents from coastal counties who smoked increased by 7.45 percentage-points (p=0.031), and the probability of being obese increased by 4.56 percentage-points (p=0.088). Overall, the percentage of residents from the affected area self-reporting health status as very good or excellent decreased by 5.03 percentage-points (p=0.082). All models controlled for a set of socio-economic factors associated with health outcomes. **Conclusions**: Secondary data analyses suggest worsening health outcomes due to exposure to the oil spill. This will help inform policymakers on public health costs of such crises.

10:30 AM - 11:00 AM

An Emerging Lexicon for Cross Discipline Communication: Integrated Behavioral Health and Primary Care

A. Speier, J. Wells, K. Kaliebe

Louisiana State University Health Sciences Center, New Orleans, LA

Examples of Integrated primary care and behavioral health programs are rapidly developing across the health care landscape. While many emerging programs may share common treatment goals and similar organizational challenges, there is a recognized need for standardization of terms and concepts specific to programs specified as Integrated Primary and Behavioral Health Care. A consensus approach for developing a common language or lexicon of conceptual definitions and practice parameters has been developed by the Agency for Healthcare Research and Quality (AHRQ, 2013). Current collaborations between the Mental and Behavioral Health Capacity Project (MBHCP-LA) and participating community health clinics include the initiation of integrated primary and behavioral health care. This presentation will report on unique features of the different Community Health Clinic (CHC) programs. Challenges to integrated care models include recognizing and accommodating to the various practice styles of primary care and behavioral health practitioners, patient expectations, routine clinic operations and business models. Using the Patient Centered Integrated Behavioral Health Care Principles and Tasks Checklist, the presenters will discuss the current status of implementation within specific CHCs, and how progress toward a common language/lexicon is an important factor for long-term sustainability and success in addressing the "Triple Aim" (Institute for Health Improvement, 2010) of population health; enhancing the patient care experience; and reducing, the per capita cost of care. The challenges and benefits of building cross-discipline language frameworks that benefit human health following major technological disasters affecting the ecosystem will be examined.

10:30 AM - 11:00 AM

The Electronic Health Record: The Nexus of Integrated Mental and Behavioral Health Care

J. Langhinrichsen-Rohling[1], C. Wornell[1], S. Francois[2]
[1]*University of South Alabama, Mobile, AL,* [2]*Louisiana Public Health Institute, New Orleans, LA*

Integrated healthcare is when both primary care and behavioral healthcare providers deliver coordinated, patient-centered care for a defined population. Health information technology is the bedrock of effective care coordination for populations needing both primary healthcare and mental health/substance abuse care. "Meaningful use" of health information technology through electronic health records (EHRs) demonstrates the ability of healthcare systems to capture and access necessary patient data to allow for quality, coordinated, patient-centered care. EHRs are also a primary component of effective post-disaster intervention. The Gulf Region Health Outreach Program consists of five integrated projects designed to strengthen healthcare in Gulf Coast communities. Two of these, the Primary Care and the Mental & Behavioral Health Capacity Projects, aim to build the capacity of community primary care clinics while increasing the mental/behavioral health bandwidth and expertise in targeted communities. Through a collaborative clinic reporting tool, both projects identified limitations in existing clinics' abilities to capture and access behavioral health data through their EHRs. This presentation will describe the work of the Mental & Behavioral Health Capacity Project in Alabama's coastal counties to facilitate: integrated behavioral healthcare; meaningful use of EHRs for behavioral health data collection and access; and optimal clinic workflow for coordinated integrated care.

10:30 AM - 11:00 AM

The Role of Community Health Workers in Emergency Management: Conceptions of Community

K. Nicholls, S. Picou, J. Curtis, B. Gilliam
University of South Alabama, Mobile, AL

Community Health Workers (CHWs) have the potential to contribute significantly to disaster preparedness, response, and recovery efforts in the communities they serve. They can enhance preparedness directly through educational outreach activities and indirectly by helping to improve the overall health of their communities. They can serve as "boots on the ground," both in times of crises and in post-disaster recovery efforts, and they can act as intermediaries between emergency response officials and affected communities. As trusted representatives of their communities, CHWs may have advantages over other emergency management personnel in terms of public perceptions of legitimacy and credibility. Maximizing their potential utility and effectively directing the efforts of CHWs requires a functional definition of "community," as well as a recognition of the geographic limits and cultural identities of the target areas in which they operate. These issues, however, have received scant attention in academic literature. In this paper, we review previous research efforts that utilize the concept of community as it relates to emergency management, and find that there is extensive variation in its definition and application. We report the results of a survey of community health workers on these topics and compare CHW conceptions of community with those prevailing in the literature. These comparisons reveal potentially problematic incongruities. We then discuss the implications of our findings for both the training and the field activities of CHWs. Finally, we offer recommendations to enhance the effectiveness of CHWs in the area of emergency management.

11:00 AM - 11:30 AM

Multi-Hazard Risk Analysis by Segmentation of Gulf of Mexico Coastline: Natural and Man-Made Hazards

B. Tansel, D. Boglaienko
Florida International University, Miami, FL

Coastline of Gulf of Mexico is a vulnerable geographic area for both natural and manmade hazards. The marine ecosystems as well as communities along the coastline present fragile dynamics due to (1) quality of diversity of marine resources, (2) aging infrastructure of the oil rigs and pipelines near coastal areas, (3) frequency of natural hazards (hurricanes, floods), and (4) increasing coastal population. Therefore, multi-hazard risk assessment is necessary for developing the necessary disaster resilience capacity. In this study, historical patterns of natural and manmade disasters which have impacted the Gulf of Mexico are analyzed. Vulnerability and changes in vulnerability and risks are evaluated in terms of individual hazards and synergistic effects of hazards. Both natural and manmade hazards were characterized in terms of their impact potential, consequence, impact scale, and impact trends. A framework was developed to conduct quantitative multi-hazard risk assessment. Preliminary criteria for quantifying the vulnerability of the ecosystems as well as estimated of effected population were developed in view of types of hazards, occurrence patterns, ecosystem characteristics, and population density. Metrics for quantification of the impacts were developed. Vulnerability of the coastline was evaluated using segmentation approach in view of risk factors, elements at risk, intensities of events, and historical damage characteristics.

11:00 AM - 11:30 AM

Applying Ecological Systems Theory to Disaster Resilience and Recovery

C. F. Bright[1], R. Hanks[2], E. Sayre[1], M. Martin[3], E. Fontenot[1]
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The researchers use Ecological Systems Theory (EST) to assess the environmental systems interacting in resilience to and recovery from disasters. The researchers use survey and interview data from individuals impacted by the BP Deepwater Horizon Oil Spill to compare the respondents' views of impact at the individual, microsystem, mesosystem, exosystem, and macrosystem and how this model looks different for sub-populations within the impacted MS and AL coastal communities. The BPOS impact is also compared to that of the Mississippi River flooding and the Tuscaloosa tornados to better explain the unique impact of oil spills. EST is used to compare models of the three disasters to understand how they each impact individuals and communities. Data collected from individuals affected by the disasters will be used to assess the behaviors and relationships with recovery that occur at each of the five levels of EST and how the extent to which the each level is impacted by the disaster is associated with one's impact and/or recovery. Disaster research demonstrates that resilience and recovery occur on many different individual and community levels and preliminary analysis of the survey data demonstrates differences in impact and recovery for different disasters, as well between sub-populations in each of the disaster communities. This research applies the EST framework to the many level of disaster resilience and recovery to refine the focus on human impact from disaster.

11:00 AM - 11:30 AM

Disseminating Oil Spill Knowledge through an Exhibit at the Estuarium

D. A. Ladner[1], Y. Tu[1], M. Salehi[2], M. Steele[1], N. K. Geitner[3], K. Carpenter[1], K. Bourne[1], M. Brown[1], B. Wang[4], P. Ke[5], F. Ding[4], S. Powers[6], A. Whelton[7]

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In an effort to engage and educate the public regarding oil spills, a collaborative group of academics and community organizations built educational materials for display at the Estuarium, the public aquarium at the Dauphin Island Sea Lab, Alabama. Through a series of three workshops, community group representatives participated in hands-on laboratory experiments with oil and dispersants, engaged in group discussions, and were interviewed to hear their stories about the BP oil spill and the way in which it affected their lives. Photos and videos of all the activities were recorded to create a website and an interactive touch-screen display, including a live oil-dispersion demonstration using sealed bottles behind an enclosure, for the Estuarium. Community group representatives participated in designing the web site and interactive exhibit. This type of collaboration between researchers and community members serves as a model for future engagements to tailor educational materials to fit the audience. Some examples of research questions that were posed by community group representatives and subsequently pursued by academics will also be discussed.

11:30 AM - 11:45 AM

Progress toward Modeling Stress-Associated Health Effects of Multiple Impacted Ecosystem Services in the Gulf of Mexico

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Our work is an exploratory effort to examine human health outcomes of major disasters like the Deep Water Horizon (DWH) oil catastrophe through the lens of impacted ecosystem services (ES) and how rapid restoration of specific ES, or exposure to healthy ES elsewhere, may help alleviate or prevent some of the stress-associated human health effects. As a first step, we are developing a conceptual model that connects impacted ES to psychological stress in an attempt to predict cumulative effects from divergent sources and in different sub-populations in the Gulf while identifying pathways through which stress results in human illness. We are also assessing existing data that may be useful in validating the conceptual model and its potential to identify likely stress effects of future extreme events. This includes efforts to elucidate potential mechanisms by which exposure to natural and biodiverse coastal habitats may reduce event-associated stress. We anticipate that the project will lead to improvements in resilience and recovery planning, a clearer understanding of likely health effects of future extreme events, identification of data collection needs for future event response, including pre-event baseline data needs, and enhanced ability to quickly respond to, ameliorate, or prevent some negative health outcomes. Findings are expected to help improve the safety and well-being of workers exposed to acute and chronic stress during response activities and the health of residents and visitors who may experience high levels of event-associated acute and chronic stress. Results may also be useful for protecting potential stress-alleviating "green spaces" and biodiverse areas from being degraded through use as debris disposal areas or other purposes.

Extending the Use of Information from Oil Spills: Synthesis and Application of Research and Observations from Regions along the US Outer Continental Shelf II

8:30 AM - 8:45 AM

Long-Term Data Provide Perspective on Ecosystem Recovery Following the Exxon Valdez Oil Spill

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Over the nearly 27 years since the T/V Exxon Valdez ran aground and spilled oil into Prince William Sound, Alaska, research and monitoring activities have led to significant understanding of how ecosystems were damaged, as well as detailed documentation of the timeline of recovery. Those same data also offer insights into ecosystem variation resulting from factors other than the oil spill. For example, a key finding was that for some species, such as sea otters, chronic oil spill effects persisted for nearly two decades and were a larger influence on population dynamics over the long-term than immediate effects of the spill. As another example, many piscivorous seabirds also experienced direct and indirect effects of the spill. However, overall population trajectories of some piscivorous birds also were linked to long-term environmental changes independent of spill effects. Another species, killer whales, suffered population declines due to acute spill effects that have not been recovered over the quarter century since. The observed inter-specific variation in mechanisms and timelines of recovery is linked to life history and natural history traits, and thus may be useful for predicting population recovery for other species following other spills. In addition, a major lesson learned following the Exxon Valdez oil spill is the importance of baseline data, including data sets considered to be of particular value in preparation for future spills. The body of research and monitoring that originally focused on oil spill effects has evolved into the Gulf Watch Alaska long-term monitoring program, designed to characterize a broad range of factors contributing to variation in the spill-affected region.

8:45 AM - 9:15 AM

Gulf Watch Alaska: Monitoring the Pulse of the Gulf of Alaska's Changing Ecosystems 26 Years after the Exxon Valdez Oil Spill

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The Exxon Valdez oil spill occurred over 26 years ago and remains the second largest oil spill in U.S. waters. This spill has provided researchers with a unique perspective on longer term impacts to fish and wildlife populations as well as human communities from these events. Gulf Watch Alaska, the long-term ecosystem monitoring program of the Exxon Valdez Oil Spill Trustee Council, integrates efforts of 15 field monitoring projects within the northern Gulf of Alaska from Prince William Sound to Katmai National Park and Preserve. Over 40 scientists participate in the collection and distribution of data that is an intersection of physical ocean conditions, nearshore ecological conditions, and species distributions related to lingering oil exposure. The program fosters collaboration across research specialties with a focus on providing integrated physical and biological information to support management of spill-affected species. The program also uses conceptual modeling to guide synthesis efforts and identify potential data gaps and sources of variability. Several data sets within the program extend across decades and are being used to focus process studies, examine the long-term effects of the spill, and

identify potential drivers of ecosystem change in the context of a changing climate. We review recent results from several of the monitoring projects and discuss highlights from the Gulf Watch Alaska science synthesis report finalized in 2015. We also highlight program resources including publicly available data sets, visualization tools, and recent publications.

9:15 AM - 9:30 AM
Pacific Herring Research in Prince William Sound
W. S. Pegau
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Pacific herring is one of the last species that is considered unrecovered from the Exxon Valdez oil spill (EVOS). Over the last 26 years there has been intermittent research into the collapse and why they have not recovered. At this time there is a concerted effort to better understand why herring are not recovering. This presentation uses herring as a model to cover importance of existing data, planning monitoring and research after an event, and the direction of current research. A managed herring fishery at the time of EVOS meant that there were some data on the fish. The major decline in the herring stock occurred nearly three years after the EVOS, which led to controversy about the cause of the collapse that remains to this day. Herring then became part of a couple major research initiatives, but gaps in the research effort fell at critical time points. Much of the early research was individual projects that weren't integrated in a manner that allowed for natural synthesis of the information generated by that research. The approach toward research has changed and should be considered by similar efforts.

9:30 AM - 9:45 AM
Environmental Studies in Support of Offshore Energy and Mineral Resource Development by the Bureau of Ocean Energy Management
W. R. Johnson, R. E. Cluck, G. S. Boland
Bureau of Ocean Energy Management, Sterling, VA

The U.S. Department of the Interior's (DOI) offshore oil and gas leasing program derives statutory authorization from the Outer Continental Shelf (OCS) Lands Act (OCSLA) of 1953, as amended. The Bureau of Ocean Energy Management (BOEM) is the agency within DOI that manages the responsible exploration and development of offshore energy, renewable energy, and marine mineral resources on the OCS. Within BOEM, the Environmental Studies Program (ESP) provides the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. BOEM uses "Applied Science for Informed Decision Making," to address a broad spectrum of research and monitoring studies undertaken through the ESP, contributing to the BOEM mission and long-term DOI goals of focusing on environmentally sound development of our Nation's energy and mineral resources. Extensive multidisciplinary studies of deep-water habitats, socioeconomics, recreation/tourism, commercial fishing, physical science, and chemistry have been funded by BOEM and in many cases, in collaboration with other agencies. These studies have provided substantial baseline environmental databases. Gulf-wide studies in both the 1980s and again in the early 2000s provided extensive data on the Gulf of Mexico that was one of the only sources of deepwater pre-spill background information after the Deepwater Horizon blowout in 2010. Since the Deepwater Horizon blowout, much research has been performed in the Gulf of Mexico to determine the impact of the spill. Future studies by BOEM will continue making additional observations of the environmental conditions of the Gulf of Mexico. These

sources of information will be incorporated into the environmental documents prepared by BOEM to improve management decisions.

9:45 AM - 10:00 AM

Use of Modeling and Deepwater Horizon NRDA Water Column Sample Analyses for Assessment of Potential Impacts of Blowouts on Deep Water Communities

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The 2010 Deepwater Horizon (DWH) spill raised awareness of the potential risks of deep water blowouts to water column and benthic communities. As part of the Natural Resource Damage Assessment (NRDA) for the DWH, oil fate modeling and baseline densities of water column biota were used to assess injuries in deep water resulting from the oil release and subsea application of dispersants. However, long-term data collections were only available for specific life stages and species groups in waters above 200m below the surface. For example: the National Marine Fisheries Service (NMFS) Southeast Area Monitoring and Assessment Program (SEAMAP) Ichthyoplankton Survey has analyzed fish egg and larval abundances sampled over the past three decades. The invertebrates in these samples have been counted and identified to broad taxonomic categories, but not to lower taxonomic levels. Trawl samples from the decades-long SEAMAP Shrimp/Groundfish Survey on the shelf have been counted and identified. These data can be used to evaluate densities, productivity and long term trends in shelf waters. However, prior to DWH, neither planktonic nor nektonic biota in the offshore water column below 200m had been quantitatively sampled. Plankton and nekton were sampled to 1500m in 2011 as part of the NRDA. Ichthyoplankton, larval stages of decapods, and larger fish and invertebrates were identified, sized and counted, providing a wealth of new information to characterize density distributions of deep water biota and for evaluation of oil spill impacts. While it is not possible to evaluate long term effects and trends with a single year's data, analysis of existing information can be used to develop conceptual models and hypotheses, such that targeted sampling programs can be designed to improve understanding, evaluate temporal changes and inform the protection of communities and ecosystems in US outer continental shelf regions in which offshore oil and gas development occurs or may occur.

10:30 AM - 10:45 AM

A Survey of the Oil Spill Literature: Trends since 1968 and Changes since Deepwater Horizon

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We perform an in-depth survey of the oil spill literature from 1968 to 2014, examining 1155 papers (approximately 10% of the published literature), with the intent of describing changes in the field and providing reasons for those changes. We are especially interested in determining how the Deepwater Horizon (DWH) accident has altered oil spill research since 2010. We examined trends in the overall interest in oil spill research, the distribution of work among various disciplines, and the level of interdisciplinary work. The field's focus on various geographical regions, the level of interest in chemical dispersants, and trends in biological and ecological studies, including types of organisms and habitats investigated, are also studied over time. We find large spikes in research productivity corresponding to certain oil spills which garnered significant public interest. Since DWH, we find a massive shift of attention to the Gulf of Mexico region. Fewer than 3% of papers in the 2004-2008 time frame focused

on this geographical region, as compared to approximately 60% in 2014. We also find an increase in the percentage of oil spill studies examining the role of dispersants since DWH and note a long-term decline (since the early 1980s) in the proportion of studies with a field component. This knowledge provides current and future researchers and their funding agencies a better understanding of the nature of oil spill research and current trends and gaps within the field.

10:45 AM - 11:00 AM

How Drilling Impacts Inform Oil and Gas Management Worldwide: Introducing the DOSI Oil & Gas Working Group

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The oil and gas industry is one of the most active agents of the global industrialization of the deep sea. The wide array of impacts following the Deepwater Horizon oil spill highlighted the need for a systematic review of existing regulations both in US waters and internationally. Within different exclusive economic zones, there are a wide variety of regulations regarding the survey of deep-water areas prior to leasing and the acceptable set-back distances from vulnerable marine ecosystems once they are discovered. There are also varying mitigation strategies for accidental release of oil and gas, including active monitoring systems, temporary closings of oil and gas production, and marine protected areas. The majority of these regulations are based on previous studies of typical impacts from oil and gas drilling, rather than accidental releases. However, the probability of an accident from standard operations increases significantly with depth. The Oil & Gas working group of the Deep Ocean Stewardship Initiative is an international partnership of scientists, managers, non-governmental organizations, and industry professionals whose goal is to review existing regulations for the oil & gas industry and produce a best practices document to advise both developed and developing nations on their regulatory structure as energy development moves into deeper waters.

11:00 AM - 11:15 AM

A Real-World Test Bed for Oil Spill Research Offshore Louisiana

I. R. MacDonald

Florida State University, Tallahassee, FL

A recent legal settlement has cleared the way for application of a valuable asset in oil spill research: an ongoing, low-volume hydrocarbon release in Gulf Coast waters. In 2004, Hurricane Ivan caused an estimated $18 billion damages in the U.S. as the fifth costliest hurricane to impact the country. The Taylor Energy platform in the MC20 block was shut in and evacuated without injury in advance of the storm, but became a total loss when outgoing water from the storm surge generated a turbidity current that toppled the platform and destroyed seabed installations that supported 26 wells. In the aftermath, platform operators made sustained and strenuous efforts to repair damages and control hydrocarbon releases. Persistent oil slicks on the surface water, which are generally visible in calm weather, indicate that releases continue despite best efforts. Possible sources of the oil include the small number of wells that were still active when Ivan struck and hydrocarbon-saturated sediments that have blanketed the site. Release magnitudes have been disputed, but the surface slicks are typically several kilometers of rainbow and metallic sheens. These unfortunate circumstances actually create a unique opportunity for oil spill scientists to investigate the fate and effects of a low-volume oil spill under real-world conditions. Many experiments are in the planning stages. The accident also illustrates a worst-case scenario in

which an unanticipated turbidity flow might destroy a production platform without warning, creating a far more damaging and discharge that would defy technical response capabilities.

11:15 AM - 11:45 AM

Deepening the Bench of Spills for Lessons Learned and Future Action Taking; Taking Advantage of Lessons Learned (and Relearned) from Smaller Incidents

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Over the past 40 years, NOAA has responded to thousands of spills and has conducted Natural Resource Damage Assessments for hundreds of incidents, yet only a few notorious incidents dominate the public and academic discourse. While large spills such as the Exxon Valdez and Deepwater Horizon are generally well studied and well known to the public, they are rare, geographically non-representative, often politically driven events that may not be the best examples for understanding the effects of spills. Furthermore, both incidents involved crude oil, yet refined oils are also frequently spilled, and these vary widely in behavior, toxicity, and persistence. Lessons learned from spills should not be limited to the narrow lens of large and catastrophic events, the impacts of which may not scale down to smaller incidents. Even relatively small oil spills can cause major environmental and economic harm, depending on location, season, environmental sensitivity, and type of oil. This abstract would highlight the second tier spills in the US- those over 100,000 gallons but still often passed over in the synthesis of lessons learned and gaps. These smaller incidents form a more geographically and environmentally representative pool of spill incidents. NRDA and response information from these incidents provide a more robust basis for answering the three questions posed by the Session. Furthermore, the NRDA studies provide perhaps a more holistic look at a spill impacts, including ecological and socio-economic losses as well as injuries caused by the response itself.

Ecological Impacts of the Deepwater Horizon Oil Spill across Multiple Scales II

8:30 AM - 9:00 AM

Assessing the Effects of the DwH Oil Spill on Large Fishes as Functions of Habitat, Trophic Ecology and Life Histories

D. Grubbs
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The DwH oil spill presented researchers with a confounding suite of challenges to assessing its effects on marine communities. It was the largest and the deepest oil spill in history, occurring at a depth of 1,500 meters and affecting habitats along the deep continental slope, through the epipelagic zone, to the coast. Data suggest toxicological effects in fish populations varied in magnitude and remain persistent in some but may be recovering in others. The dynamics of these effects were likely functions of exposure as well as the ecology and life histories of the taxa. Physiological processes are positively correlated with temperature, sunlight and nutrients and negatively correlated with depth. The effects of oil exposure may have been acute but short-lived in pelagic fishes, transferring up food chains rapidly then dissipating, but deep demersal fishes may have suffered lower but persistent levels of exposure that require years to migrate up the food chain. In addition, generation times are often only 2-4 years for large pelagic fishes, but are 5-15 years for commercially-important reef fishes and coastal sharks and 20-40 years for many large deep-sea fishes. Whereas more than a generation has passed since DwH for pelagic fishes, many deep-sea fishes that were young-of-year during the spill are less than half-way to maturity suggesting that we may be able to assess DwH effects and recovery on some taxa, long-term monitoring is required to assess effects for others.

9:00 AM - 9:15 AM

Insight into the Response of in situ Impacted Cold-Water Corals Following the Deepwater Horizon Oil Spill

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Following the Deepwater Horizon (DWH) disaster and subsequent cleanup efforts, an unprecedented amount of oil and chemical dispersants were released in the deep waters of the Gulf of Mexico. Over the past five years, various detrimental effects have been documented on both the organismal and ecosystem levels including impacts to cold-water coral ecosystems. Quantifying these effects on a cellular level is crucial to determining long-term consequences to coral populations and the deep-sea ecosystem. RNA was extracted from unexposed and DWH spill-impacted *Paramuricea biscaya* and sequenced using Illumina technology. A de novo reference transcriptome was produced and used to explore stress-induced variations in gene expression. Current findings show overexpression of genes coding for Cytochrome p450, Tumor necrosis factor receptor-associated factors (TRAFs), Peroxidasin and additional genes involved in innate immunity and apoptotic pathways. Ribosomal proteins were also significantly underexpressed. qPCR assays utilizing probable (cold-water) coral housekeeping genes were developed to verify these transcriptomic results. Expression data from the in situ exposures resemble those from experimental oil and dispersant exposures. Together, our results provide insight into the responses of cold-water corals to toxin exposure, including the implications of using dispersants for oil spill mitigation.

9:15 AM - 9:30 AM

Vulnerability, Resilience and Potential Recovery: Mesophotic Reef Fish Community Response to Major Disturbance from the Deepwater Horizon Event

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Following the Deepwater Horizon (DWH) event, reef fish abundance declined 1-3 orders of magnitude versus historical 1997-2003 baseline in ROV quantitative video transects on mesophotic reefs off Mississippi and Alabama (Sulak *et al*. 2015). Trophic guild representation in the shelf-edge fish community was also fundamentally altered from baseline. Faunal depletion and community structure alteration persisted through September 2011. The numerically-dominant small planktivorous Anthiinae seabasses (typically >85% of total fishes and the food base for higher trophic level predators) experienced greatest decline. Mean abundance dropped as much as 99.7%. Anthiines on Alabama Alps Reef (58 km from DWH) declined from a mean baseline representation of 88.8% of all fishes, to 43.5% in 2010, to 4.6% in 2011. A suite of hydrocarbons with a signature consistent with Macondo well crude oil was detected using Semi-Permeable Membrane Devices moored in the water column 1 m above the 70-75 m deep AAR reeftop in July 2010 (Bargar and Sulak 2011). Fish community disturbance was graded with distance, greatest nearest DWH. Follow-up ROV video transecting in 2014 documented recruitment of abundant juvenile fishes to the disturbed reefs, suggesting initiation of population recovery. Whether recovery will succeed remains in question. Survival of recruits to adulthood may be impacted by loss of 3-D live cover habitat due to damage to and loss of tall soft corals (Etnoyer *et al*. 2015).

9:30 AM - 9:45 AM

Natural Resource Damage Assessment Overview for the Deepwater Horizon Oil Spill

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In the immediate aftermath of the DWH oil release, the Natural Resource Trustees initiated activities under OPA to assess injuries resulting from the incident. This injury assessment serves as the basis for a restoration-based damages claim for the Natural Resource Damage Assessment. Scientific studies were initiated to document the exposure and adverse effects to the habitats and resources resulting from the incident, including toxicity and adverse effects from oil, dispersants, other related contaminants and injuries associated with response activities. To achieve a task of this spatial and temporal magnitude, the exposure and injury assessment was necessarily divided into overall resource areas including deep water benthic and water column, the wide ranging habitats and resources of the nearshore ecosystem, sea turtles, marine mammals, and birds. While assessed separately, these injuries affected a broad array of resources and services that are linked together as part of the larger interconnected northern Gulf of Mexico ecosystem. A broad overview and some key findings of the Trustees' 5+ years of comprehensive assessment work will be presented and discussed.

9:45 AM - 10:00 AM

Loss of Oysters as a Result of the Deepwater Horizon Oil Spill Degrades Nearshore Ecosystems and Disrupts Facilitation

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Nearshore marine ecosystems are among the most productive and threatened areas in the world. The input of terrestrial and freshwater derived nutrients into shallow-water environments where marine fauna and flora flourish results in extraordinarily high biological productivity; however, these ecosystems also serve as receiving areas for pollutants released into oceanic and riverine waters. The Deepwater Horizon explosion and well blowout in 2010 resulted in oiling of hundreds of kilometers of shoreline in the northcentral Gulf of Mexico. Large quantities of oil flowed into estuaries and coated coastal wetlands and beaches. In response, onsite environmental cleanup activities occurred in many of these areas. Both oiling and onsite response activities are associated with degradation of nearshore habitats. As part of the Deepwater Horizon Oil Spill Natural Resource Damage Assessment (NRDA), we examined the impact of shoreline oiling on oysters (*Crassostrea virginica*) that occur near marsh edge at 187 sites in Louisiana and Mississippi Sound in 2013. Marshes that were heavily and persistently oiled had 77% less oyster habitat than areas where oil was not observed, which translates to an estimated 320 m2 of oyster habitat lost at each heavily, persistently oiled site. Oyster habitat near marshes characterized by more modest levels of oiling was 33% less than areas where no oil was observed. Similarly, the number of sites without any oyster habitat was higher in heavily and persistently oiled areas compared to areas where no oil was observed (56% vs. 24%). The consequences of this loss are substantial and include loss of essential fish habitat, reduced nutrient cycling and decreased erosion buffering. For a subset of the sites where erosion rate was also measured between 2010 and 2013 (n = 74), shoreline loss was more than twice as high (2.9 vs. 1.3 m yr-1) in areas lacking oyster cover. The loss of nearshore oyster habitat can disrupt strong facilitation between oysters and marsh vegetation and demonstrates a previously unreported ecosystem level consequence of oil spills.

10:30 AM - 10:45 AM

Persistent Impacts to the Deep Soft-Bottom Benthos Four Years after the Deepwater Horizon Event

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In September-October 2010, three to four months after the Deepwater Horizon blowout was capped, a zone of moderate and severe impacts to deep-sea soft-bottom benthos was identified that extended over an area of 172 km^2. The impact was a loss of -53.7% of macrofauna family diversity and -38.3% of meiofauna major taxa diversity in the most severely impacted zone. The area was resampled in May-June 2011 and May-June 2014 to determine if the identified effects were persisting. The sampling design compared 19 stations in the impact zone to 13 stations in the reference zone that were sampled in all years. While there are some signs of recovery in 2011 and 2014 in terms of abundance, there is evidence of persistent, statistically significant impacts to both macrobenthic and meiobenthic diversity because the relative losses of biodiversity are largely the same as in 2010. A loss in diversity has been shown to correlate with a loss of deep-sea ecosystem services because these fauna serve vital functional roles in the deep-sea (including: biomass production, sediment bioturbation and stabilization, organic matter

decomposition and nutrient regeneration, and secondary production and energy flow to higher trophic levels). The persistence of significant biodiversity losses four years after the wellhead was capped indicates that full recovery of ecosystem services has yet to occur.

10:45 AM - 11:00 AM

Estimating the Fractional Mortality of Early Life Stage Fish from the Deepwater Horizon Spill

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The 2010 Deepwater Horizon (DWH) oil spill created an oil slick on the Gulf of Mexico that persisted for more than 100 days. Water samples collected from areas proximal to and beneath oil slicks contained concentrations of polycyclic aromatic hydrocarbons (PAHs) that are toxic to early life stages of Gulf of Mexico fish species. For the DWH Natural Resource Damage Assessment, we estimated the fraction of fish eggs in the upper water column that were lost because of exposure to oil by combining the following empirical data from the Gulf of Mexico: 1) concentrations of PAHs beneath surface slicks; 2) ultraviolet (UV) light intensity and attenuation in the water column; 3) laboratory toxicity testing results for ichthyoplankton, both with and without UV exposure; 4) buoyancy and diameter data for eggs present in the Gulf of Mexico; and 5) estimates of surface wind speeds that generated turbulence and mixing in the upper water column. Assuming that these available data represented random samples of what might have been present over the course of the spill, we estimated the probability of mortality for any particular organism using a repeated random sampling (Monte Carlo) approach. This approach allowed us to estimate the fractional mortality for fish eggs in the upper water column beneath the surface slick. When combined with fisheries data on the density of organisms in the Gulf of Mexico, these estimates provided an initial estimate for total loss of early life stage fish.

11:00 AM - 11:15 AM

Reconciling Organismal Versus Population Responses of Estuarine Fishes to the Macondo Oil Spill - a Five-Year Update

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Syntheses of research spanning diverse taxa, ecosystems, timescales, and hierarchies are crucial for understanding the cumulative impacts of the Macondo oil spill in the Gulf of Mexico. Now more than five years post spill, responses of estuarine fishes to oil pollution have been studied at organismal through population levels, and (following from an earlier synthesis paper, now updated to include papers published in the last 18 months) there continues to be a mismatch between consistent negative impacts detected among individual organisms, and absence of measurable negative impacts among populations. To reconcile this apparent contradiction, we draw on lessons learned from this and previous spills to consider two classes of mechanisms: factors obscuring negative population impacts despite known organismal responses (e.g., high spatio-temporal variability, offsetting food-web cascades, fishery closures, temporal lags); and factors dampening population-level costs despite known organismal responses (e.g., behavioral avoidance, multiple compensatory pathways). Thus, we highlight critical knowledge gaps that should form the basis of current and future research priorities to assess ecosystem responses to basin-scale disturbance.

11:15 AM - 11:30 AM

The Ecological Effects of the Deepwater-Horizon Oil Spill: A Meta-analysis

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Five years after the Deepwater-Horizon (DWH) oil spill, a number of studies have assessed its consequences on biological communities, marine and terrestrial, at levels of organization ranging from molecules to populations. Remarkably, there is little agreement regarding the impact of the disaster on many taxa. Similarly, a surprising lack of clarity exists on whether and how sub-lethal effects translate into population dynamics in the affected species. To clarify these issues, we conducted a meta-analysis of published results, including field studies as well as lab experiments. We identified more than 200 effects from 26 published papers. These papers examined a wide variety of taxa, across ecosystems ranging from deep waters to pelagic and coastal waters, to salt marshes. Preliminary analyses indicated the existence of large variation among taxa in their sensitivity to the toxicity of oil and oil/dispersant mixtures. Large variation also exists across the different categories of biomarker used, whether developmental, physiological or morphological. The results of the present meta-analysis contribute to clarifying the extent of the aftermath of the DWH oil spill in the affected ecosystems. They also have implications for the identification of sensitive bioindicators of effect for the DWH oil spill as well as for future oil spills.

11:30 AM - 11:45 AM

Acute and Chronic Impacts of the Deepwater Horizon Oil Spill on Red Snapper in the Northern Gulf of Mexico

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Red snapper, *Lutjanus campechanus*, is perhaps the most economically and ecologically important reef fish in the northern Gulf of Mexico (nGOM). Given that distinction, as well as its contentious fisheries management, there are more pre-Deepwater Horizon Oil Spill (DWH) data to examine spill effects for this species than any other fish in the nGOM. Remotely operated vehicle survey data demonstrate declines in adult as well as juvenile red snapper abundance following the DWH, and stock assessment results clearly indicate declining recruitment in the eastern but not western GOM. Projections of those recruitment declines into the future predict declining yields for the Gulf-wide fishery at a time when the western GOM population is projected to continue its recovery, thus further complicating red snapper management. We are aware of no evidence that directly links the DWH to declining red snapper recruitment. However, we will present a range of evidence that demonstrates acute and chronic effects of the DWH on red snapper, including exposure of red snapper to PAHs in the years following the DWH, changes in fish density and size composition on natural and artificial reefs, shifts in diet and muscle stable isotope ratios that indicate food web effects of the spill, and declines in red snapper size at age that have implications for spawning stock biomass and future egg production. Implications for these post-DWH changes will be placed in the context of red snapper fisheries management, including population structure assumptions for both assessment and management of this iconic species.

11:45 AM - 12:00 PM

Atlantis Modeling of Ecosystem Impacts and Recovery in the Gulf of Mexico after the Deepwater Horizon Blowout

L. Dornberger, C. Ainsworth
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An important step in modeling the ecosystem-level impacts of oil spills on resident species is developing an accurate representation of the functional response of life rates to use in model simulations. The creation of subroutines in the Atlantis modeling software now allows for the alteration of a functional group's growth, recruitment, and mortality across space and time. These new subroutines were implemented in Atlantis simulations of the Gulf of Mexico Deepwater Horizon blowout. To understand how growth and mortality might have changed, a literature analysis of health and growth impacts of polycyclic aromatic hydrocarbons on fishes was conducted and dose response models parameterized. Recruitment impacts were implemented using species level larval overlap with surface oil. The functional response toxic impacts were implemented in both the water column and benthic community. Other impacts included in simulations were oxygen limitation at the benthos, resuspension by storms, and fisheries closures after the spill. I will present Atlantis simulation results including recovery time and ecosystem changes.

The Evolution of the Deepwater Horizon Oil Spill: Updates on Fate and Transport of the Oil II

8:30 AM - 8:45 AM

Deposition and Redistribution of Petroleum Hydrocarbons following the Deepwater Horizon Oil Spill: Where Is It Going and How Long Will It Remain?

I. C. Romero[1], G. Toro-Farmer[1], A. Diercks[2], F. Muller-Karger[1], G. Brooks[3], R. Larson[3], P. Schwing[1], S. Murawski[1], D. Hollander[1]

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The Deepwater Horizon blowout (DWH) in 2010 released ~4.9 million barrels of oil, a discharge over seven times larger than the average annual input of oil into the Gulf of Mexico (GoM). Between 2010 and 2011, 688 sediment cores were collected at depths ranging from 79 to 2400 m to evaluate the sedimentary footprint of DWH. Sediment core collection and geochemical analysis conducted by the University of South Florida, the U.S. Government (ERMA Deepwater Gulf Response), and British Petroleum (Gulf Science data) were integrated to reconstruct a temporal record of hydrocarbon distribution and composition in the GoM. The sedimentary occurrence of natural and petroleum derived hydrocarbon compounds (n-alkanes and isoprenoids, polycyclic aromatic hydrocarbons, and biomarkers) over an extensive geographic area (25,000 km2) documents a 3-5-fold increase in the concentration of hydrocarbon compounds that were deposited in 2010-2011 relative to previous years. Basin-scale analysis indicates hydrocarbons were deposited on the seafloor from distinct transport mechanisms including sinking of oil marine aggregates and impingement of deep-water oil plumes on the seafloor. Spatial patterns also indicate that there is an ongoing redistribution of these deposited hydrocarbons on the seafloor. The environmental factors that control the spatial redistribution will be discussed relative to the long-term fate of the petroleum hydrocarbons deposited in the GoM after the DWH.

8:45 AM - 9:00 AM

Identifying the Most Effective Strategies in Tracking the DWH Deepwater Plume from a Natural Resource Damage Assessment (NRDA) Perspective

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Due to the unprecedented depths and scale of the Deepwater Horizon (DWH) blowout, it was necessary to develop a number of adaptive sampling strategies to document the oil's fate and transport in the deep ocean over three dimensions and time. As we sampled and later forensically examined analytical chemistry results for 5,300 offshore water-column samples collected during the Natural Resource Damage Assessment (NRDA), we identified several practices regarding workplans, sampling designs, field detection and sampling methods, shipboard sample processing, handling and logistics, lab analytical methods, data management, and forensic assessment techniques that ensured the most complete and useful data. From the NRDA perspective, we summarize the final DWH oil fate and transport in the deepwater plume. Optimal sampling approaches included: Collecting filtered, phase-separated water samples to aid in parsing out dissolved versus particulate signatures in unfiltered samples; combining multiple real-time sensors (DO, fluorometry, CTD, particle-size-analyzers, and video) with ROV and rosette-based sampling systems to detect and collect oil at depth; and using ROVs for sampling near-bottom water and identifying and collecting floc samples, burn residues, and sediments without disturbing the ephemeral oil layer at the sediment-water interface.

9:00 AM - 9:15 AM

Overview of 14C-Depleted Petrocarbon in Coastal Sediments, on Seafloor and in the Water Column

B. E. Rosenheim[1], M. A. Pendergraft[2], B. D. Walker[3], E. Druffel[3], M. M. Evans[4], Z. Liu[4], J. P. Chanton[5], D. Hollander[1], K. Yeager[6], P. Adhikari[7], K. Maiti[7], J. Kolasinski[8]

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We have employed ^{14}C as an "inverse isotopic tracer" of oil contamination in multiple environments following the 2010 Deepwater Horizon (DWH) blowout. Due to their considerable age, most petroleum deposits, including those of the northern Gulf of Mexico are devoid of radiocarbon (^{14}C). Thus, depletion of radiocarbon in sedimentary organic matter on the seafloor and dissolved and particulate organic matter in the water column can represent contamination by petroleum. The power of using an isotope tracer lies in its ability to fingerprint intermediate degradation and assimilation products as well as primary, extractable petroleum compounds in a quantitative manner - we refer to this as petrocarbon. Here we present a summary of an array of advanced ^{14}C measurements (including bulk and Ramped PyrOx ^{14}C, particulate and dissolved organic ^{14}C) from oil deposited in coastal settings (beaches and marshes), the seafloor, and from the water column. Even after four years, DWH-related petrocarbon continues to be a major constituent of organic matter (>80% in most cases) in marsh and beach sediments and in the water column (10-20% of the DOC at depths related to subsurface hydrocarbon plumes). In seafloor sediments, sparse geographic sampling yields an incomplete spatial perspective with only spotty oil contamination occurring near the wellhead. In all cases, we have been able to use complementary knowledge, including development of thermal slicing Py-GC-MS and comparison to wet chemical methods such as polycyclic aromatic hydrocarbon (PAH) signatures, about the chemical fates of oil to ascertain in which forms this petrocarbon is present.

9:15 AM - 9:30 AM

Cluster Analysis and Principal Component Analysis of Biomarkers and Polyaromatic Hydrocarbons in Deep Gulf of Mexico Sediments following the Deep Water Horizon Event

N. L. Guinasso, T. L. Wade, S. T. Sweet, A. H. Knap, G. Gold-Bouchot

Texas A&M University, College Station, TX

Surface sediment data from the freely-available BP Sediment Chemistry database was analyzed focusing on Polycyclic Aromatic Hydrocarbons and Biomarkers. This database contains PAH and Biomarker data (mostly complete) for 713 core samples collected from depth intervals of 0 to 1 cm. Total PAH for these samples has a slightly skewed (towards higher concentrations) log normal distribution with a mean concentration of 1201 ng/g. Total PAH concentrations reported for the Gulf of Mexico prior to the DWH had concentrations ranging from not detected to 1033 ng/g (Wade et al, 2008). More than 50% of the 713 samples fall within this range. In close proximity to offshore production platforms PAH concentrations ranged from 7.8 to 6,359 ng/g (Kennicutt *et al*. 1996). More than 88% of the 713 samples fall within this range. A weathering index (sum of C1-, C2- and Naphthalene / C-30Hopane) indicated that a majority of the samples are highly weathered. The samples with the lowest PAH concentration were less weathering indicate the possibility of small amount of fresh oil. A hierarchal cluster analysis of the 56 individual or groups of PAH chemical species showed most samples grouped together with about 7% of the samples grouped in 6 additional groups. These 6 additional groups all were collected on cruises that targeted natural seeps. PCA analysis of the 57 biomarker species including DWH standard oil clearly separated the samples into groups consistent with the PAH cluster analysis. The outlying samples

from the PAH cluster analysis were clearly separated from the majority of the samples on both the PCA analysis and weather index. Total PAH plots. Biomarker ratio plots show a complex picture indicating that many of the samples represent many different oils and or mixtures of oils.

9:30 AM - 9:45 AM

Forensics Methodology for Accurate and Consistent Fingerprinting of Weathered MC 252 Macondo Spill Oil

J. S. Brown[1], B. Patterson[2], S. Lu[3]
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Significant weathering of the oil released from the Macondo well during the 2010 Deepwater Horizon accident has altered its geochemistry. Macondo oil is a member of the South Louisiana Sweet Crude (SLSC) family of oils which are generated from the same Jurassic age source rock. Differentiating weathered Macondo oil from weathered SLSC oils originating from other sources such as active natural seeps or other leaking facilities (e.g., Mississippi Canyon - 20) can be difficult. This presentation provides a tested methodology for the accurate and consistent fingerprinting of weathered oil samples collected on GOM shorelines and marshes after the Deep Water Horizon accident. The methodology involves investigation of all evidence and collective integration of the sample's location, physical state and geochemical attributes derived from accepted analytical techniques performed by chemistry laboratories (e.g., GC/FID, stable carbon isotopes, GC/MS). Quantitative measurement of diagnostic analytes and ratios of analytes provide weathering-resilient data for statistical correlation with Macondo oil. Application of this methodology resulted in consistent identifications of unknown shoreline tar ball and marsh samples collected during a four-year time frame (2011 to 2015) and independently analyzed by three laboratories.

9:45 AM - 10:00 AM

Chemometric Analysis of Coastal Marsh Sediments Collected from 2010-2015

B. M. Meyer, E. B. Overton
Louisiana State University, Baton Rouge, LA

The sheer magnitude of the Deepwater Horizon oil spill has provided an opportunity for applying quantitative oil source-fingerprinting techniques in unique Gulf of Mexico coastal environments, and for studying the long-term effects of these environments on compounds commonly used in oil source-fingerprinting, the oil biomarkers. Oil biomarkers are compounds that typically suffer little interference from weathering and biodegradation effects because of their high molecular weights; however, the composition of crude oil in the environment is continually altered by a variety of different biological, chemical and physical processes. The culmination of these processes over many years could logically affect the resilience of oil biomarkers. Chemometric analysis, a quantitative oil source-fingerprinting approach that uses principle component analysis (PCA) and hierarchical cluster analysis (HCA), will be applied to near-surface sediments collected from Louisiana coastal marshes from 2010-2015 to determine distinct oil families present from year to year, and may provide an indication as to whether or not oil biomarkers are affected by weathering in these types of environments as reflected by changes in oil family clusterings.

10:30 AM - 10:45 AM

Microbial Community Structure in Oiled Sediments Undergoing Natural Attenuation in Coastal Louisiana

V. Elango, J. Pardue

Louisiana State University, Baton Rouge, LA

Washover events such as tropical storms, hurricanes and tidal events mobilized MC252 oil from the beach and deposited oil into the back marshes and shallow mudflat areas. Submerged oil mats (SOM) on the beach were also exposed to the surface during washover events. The mobilization of oil has the potential to impact oil persistence by moving oil into beach regions. Oil contaminated sand and sediments were collected from Fourchon Beach following washover events from 2011 to 2014. The objective of this study is to evaluate the effect of oil contamination on microbial community structure observed in contaminated beach sand, shallow mudflats and back marsh sediments. Seventy samples from Fourchon Beach were evaluated for microbial community structure using next-generation sequencing. The samples were in the form of surface residue balls (SRBs), SOM that were deposited on the beach by washover events, and soil cores from contaminated and uncontaminated back marsh areas. Soil cores were also collected from impacted marshes adjacent to Bay Jimmy, LA which is not protected by a headland beach barrier. 16S rRNA from genomic DNA was amplified using universal bacterial primers and sequenced by MiSeq Illumina platform to characterize microbial community structure. Substantial difference in microbial community structure was observed between oil contaminated and uncontaminated marsh sediments. Phylotypes belonging to Gammaproteobacteria were dominant in oil contaminated sediments, followed by phylotypes under Alphaproteobacteria, Deltaproteobacteria, Bacilli, Firmicutes, *Flavobacteria*, Spirochaetes, and Sphingobacteria. In uncontaminated marsh sediment, *Sulfurovum* was the dominant phylotypes and was not observed in the oiled location. The abundance of shared richness in oil contaminated sites ranged from 73 to 78%. Only less than 5% of richness observed in oil contaminated marsh sediments were observed in uncontaminated sediments. Phylotypes responsible for shared richness between contaminated and uncontaminated marsh sediments accounted for less than 1% of total abundance in contaminated marsh sediments. Data analysis of SRBs and SOM are in progress. Based on the marsh sediment analysis, oil contamination influences the microbial community characteristics at Fourchon Beach and Bay Jimmy, LA.

10:45 AM - 11:00 AM

Evaluation of Chemical Weathering following the Deepwater Horizon Oil Spill in Louisiana Salt Marshes using Ramped Pyrolysis - Gas Chromatography - Mass Spectrometry

M. Evans[1], J. Liu[1], B. E. Rosenheim[2], Z. Liu[1]

[1]The University of Texas Austin, Marine Science Institute, Port Aransas, TX, [2]The University of South Florida, Tampa, FL

In the summer of 2010, hundreds of miles of coastline in the Gulf of Mexico were polluted by the Deepwater Horizon oil spill. Crude oil pollution, however, is not static; weathering processes will alter the chemical composition (i.e. toxicity) over time and space. As such, a major challenge of oil spill response is to understand and be able to predict these chemical changes. In this study, we address this challenge by evaluating the fate of DWH petroleum hydrocarbons on Grand Isle, Louisiana from 2010-2012. Oil, tar and sediment were analyzed for n-alkane, polycyclic aromatic hydrocarbon (PAH) and alkylated PAH content via solvent extraction, silica gel fractionation and mass spectrometry. We found that n-alkane depletion was initially slower than PAH and alkylated PAH depletion, but within two years, over 99.0% of n-alkanes were removed from all samples. Conversely, over 95.0% of PAHs and alkylated PAHs were removed within eighty-eight days. After this, PAH and alkylated PAH content remained

relatively constant. Several PAHs (i.e. benzo[k]flouranthene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene and benzo[ghi]perylene) showed no depletion at all. We confirmed these PAH and n-alkane concentrations by uniquely employing ramped pyrolysis - gas chromatography - mass spectrometry (Py-GC-MS) with cold-trap, thermal slicing. This technique has many advantages: no sample preparation, minimal sample requirement, high time efficiency, application to 14C terminal oil pollution budget studies, and potential ability to quantify oxygenated hydrocarbon content. (Py-GC-MS analysis is in progress; up-to-date results will be reported.) This advanced, analytical method and the results presented here, detailing petroleum hydrocarbon weathering in a coastal salt marsh and beach deposits over time, can be used to improve future oil spill response strategies.

11:00 AM - 11:15 AM

Weathering Patterns of Forensic Biomarker Compounds and PAHs in Coastal Marsh Sediment Samples since the 2010 Deepwater Horizon Oil Spill

E. B. Overton, B. Meyer, S. Mles, G. Olson, P. Adikari
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It has been well established that the composition of oil, when spilled into the marine environment, undergoes substantial changes caused by weathering. The general sequence of this compositional change begins with straight chain alkanes (the fastest to degrade), followed by low molecular weight branched and cyclic alkanes and, finally the aromatics. Most resistant to weathering are the so called “forensic biomarker compounds” consisting of higher molecular weight multi-ring saturate compounds (the hopanes and steranes) and tri-aromatic ringed steroids. The composition of these biomarker compounds is particularly resistant to change because they are not affected by evaporative weathering, are not water soluble, and are not readily degraded by microbial and/or photo-oxidation. However, after extensive time in the environment, being subjected to numerous weathering factors, biomarker compositional patterns are beginning to exhibit significant changes. This presentation will describe the general weathering patterns of petroleum residues in sediment samples collected from marsh areas of coastal Louisiana over a five year period. Particular attention will focus on compositional changes that have been observed in the steranes and diasteranes compounds that traditionally have been considered the most resistant to compositional changes due to weathering.

11:15 AM - 11:30 AM

Evaluation of the Vertical and Horizontal Distribution of Oil Residues in Louisiana Coastal Marshes Impacted by the Deepwater Horizon Oil Spill

P. Adhikari
Louisiana State University, Baton Rouge, LA

The 2010 explosion and fire aboard the Deepwater Horizon oil rig, approximately 50 miles off the coast of Louisiana, resulted in the largest marine oil spill in U.S. history. While much of the oil remained offshore and was degraded by normal weathering processes, a significant amount came ashore stretching from as far west as Vermilion Bay to near Apalachicola in the east. Significant coastal marsh oiling of Barataria Bay occurred in the summer of 2010; and, in addition to the initial oiling, several tropical weather events have since crossed this area resulting in a redistribution of DWH oil residues. In an effort to understand the effect of tropical storm events on the redistribution of DWH residues, samples from the northeast area of Barataria Bay were collected and the vertical and horizontal distribution of oil residues were subsequently examined. A UV-fluorescence probe (Vertex FFD) was deployed to detect the subsurface presence of petroleum hydrocarbons and simultaneous sediment core samples were collected. The Vertek FFD probe was manually inserted into various sampling

locations while measuring its UV-F output with depth. The sediment cores were taken simultaneously with the probe sampling and were analyzed using GC/MS for target saturate, aromatic and biomarker petroleum hydrocarbons. The results of this study and the implications associated with the patchy vertical and horizontal distribution of oil residues in coastal march samples will be discussed.

11:30 AM - 11:45 AM

Spatial Biodegradation of MC252 Crude Oil across a Coastal Headland Beach Profile

Z. Romaine, L. Fitch, V. Elango, **J. Pardue**
Louisiana State University, Baton Rouge, LA

Beach response efforts involving hard structures were conducted to deter oil migration into sensitive marsh areas behind Fourchon Beach, LA. These hard structures created conditions for accumulation and burial of oil across an 8 foot deep beach profile. Buried oil persists in these areas due to the anaerobic conditions of groundwater on these beaches. The objectives of this field study are to compare the rate and extent of biodegradation of 3-ring PAHs in crude oil deposits from the surface and subsurface, and to investigate the effects on beach groundwater after the introduction of O2. Field samples were removed from 2011-2015 from the area including oil samples from depth with a Geoprobe, oil-sand aggregates distributed over the surface of the beach, free oil floating on the groundwater surface and oil recovered during excavations used as part of response in 2013 and 2015. Weathering of PAHs was estimated based on ratios of alkylated phenanthrenes and dibenzothiophenes to poorly biodegradable chrysenes. Terminal electron acceptors and nutrients were evaluated based on repetitive (pre and post oxygen introduction) groundwater analysis of O2, nitrate, nitrite, ferrous and ferric iron, sulfate, sulfide, ammonium, orthophosphate, pH and alkalinity. The ratio of total phenanthrenes and dibenzothiophenes to chrysenes ranged from 0.37 to 0.93 and 0.18 to 0.71 respectively, with lowest values were observed in SRBs from the surface where O2 limitations are absent. In the samples removed from depth, weathering ratios were significantly higher coincident with submergence in anaerobic groundwater. O2 addition is being conducted in a field trial of in situ biostimulation. In groundwater samples collected prior to oxygen introduction, high levels of sulfate (400 to 1500 mg/L) and sulfide (0.1 to 4 mg/L) were measured coupled with non-detectable dissolved oxygen (less than 0.02 mg/L). Groundwater pH is close to neutral, alkalinity ranged from 750 to 1400 mg/L, with ammonia and phosphate levels greater than 1.0 mg/L, suggests nutrient conditions favorable for biodegradation in the subsurface. Salinities are generally hypersaline, routinely exceeding 50 ppt. Data from post-oxygen introduction is ongoing and introduction of oxygen can change the conditions for enhanced biodegradation in the subsurface.

11:45 AM - 12:00 PM

A Review of Science Based Assessments of Residual Oil along Gulf Shorelines Used to Support Response Operations

W. Bryant
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As part of the Deepwater Horizon MC-252 oil spill response, the Federal On-Scene Coordinator assembled interagency teams of scientists (Operational Science Advisory Teams - OSAT) to provide situational data and analysis for use in directing the operational response activities. Two separate efforts (OSAT-2 and OSAT-3) focused on the source, transport, fate and effects of residual oil along Gulf shorelines. The OSAT-2 team evaluated the risks and benefits of leaving remnant oil in place or removing it with the goal of achieving the quickest possible recovery for the area. The OSAT-2 team concluded: (1) the potential cancer and non-cancer health effects from short and long-term exposures to remnant oil were below health-based risk and hazard levels and (2) aquatic and wildlife resources would likely

experience a greater threat from further cleanup beyond established guidelines than from the oil that remained on the beaches. Operational Science Advisory Team (OSAT-3) evaluated the recurring oiling of shorelines that prevented many locations from meeting clean-up endpoint criteria. The OSAT-3 team utilized existing data to characterize re-oiling conditions across the varied shoreline types, developed hydrodynamic models to assess the transport and deposition of residual oil and native sediment, and evaluated the potential for formation and persistence of weathered oil deposits by mapping changes in beach morphology after initial shoreline oiling. OSAT-3 conclusions included: (1) most residual oil remobilization is caused by the burial, uncovering, and/or cross-shore transport of small, diffuse material nearshore; (2) buried oil deposits formed landward of the first sand bar; and (3) the majority of shoreline and nearshore areas had undergone sufficient erosion to result in the breakup and/or redistribution of the initial sand/oil deposits.

The Chemistry of Oil Evolution and Exopolymeric Substances and their Interaction with Microbes in Oil Spills

8:30 AM - 9:00 AM

Oxidized Transformation Products from Macondo Well Oil

R. P. Rodgers[1], S. M. Rowland[2], H. Chen[1], Y. E. Corilo[1], A. M. McKenna[1], A. C. Clingenpeel[1], D. C. Podgorki[2], P. Z. Ray[1], M. A. Tarr[3]

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Biotic and abiotic transformation products of petrogenic contaminants can extensively alter their chemical functionalities that, in turn, affect toxicity, water solubility, stable emulsion formation, aggregation, and bioavailability. Molecular level, qualitative understanding of the (predominately) oxidative “weathering” is hampered by the immense complexity of the unaltered oil and multiplicative increase in complexity post-oxidation. Furthermore, a large fraction of the unaltered oil that was accessible by GC-methods is chemically transformed into species that preclude GC based analyses. Thus, a detailed inventory of petrogenic transformation products and potential to form future contaminants (benign or toxic) remain unknown. The detailed compositional analysis of oil-impacted areas along the Gulf of Mexico coast reveals tens-of-thousands of previously unidentified biotic and abiotic transformation products that have persisted years after the initial spill. GC-based analyses facilitate weathering loss estimates of highly abundant alkane, cycloalkane, and low ring-number, aromatic species. However, GC analyses are hampered by the loss of material within the GC analytical window (through oxidation that increases polarity and boiling point) and generation of the well-documented unresolved complex mixture (UCM). Here we highlight our continued efforts to understand the temporal evolution of Macondo well oil oxidized transformation products and the primary generation mechanism(s) responsible for high boiling (polar) material. Whole Macondo well oil and structurally specific chromatographic fractions are subsequently introduced into abiotic (photo-oxidation) microcosms to reveal the primary structural motifs responsible for photo-transformation products. Compositional differences between these microcosms and field samples will be discussed. Work supported by NSF Division of Materials Research through DMR-11-57490, BP/The Gulf of Mexico Research Initiative to the Deep-C Consortium, Future Fuels Institute, and the State of Florida.

9:00 AM - 9:30 AM

Marine Microgels

M. Orellana

University of Washington, Seattle, WA

Polymer gels are cross-linked networks of marine polymers that self-assemble from dissolved organic carbon (DOC) polymers. About 10-30 % of the DOC can self assemble as polymer gels, playing critical roles in biogeochemical dynamics. Understanding marine polymer networks in the context of soft matter physics is valuable in order to identify the properties and the structure of the organic matter field, as well as clarifying the mechanisms and dynamics of marine polymers. Phytoplankton and bacteria produce DOC polymers by diverse mechanisms. While, heterotrophic bacteria control their degradation, polymers can self-assemble, transforming the truly dissolved polymers into a gel phase and into a particulate organic matter size continuum. This process represents the biggest shunt of organic matter available for bacterial degradation in the dilute DOC environment. Theory and tools of polymer physics can provide valuable insights into understanding the mechanisms and the dynamics of marine

biopolymers, their emergent properties, as well as their roles in colloidal behavior, the microbial loop, carbon cycling in the biological pump, trace metal complexation, and determining cloud properties.

9:30 AM - 9:45 AM

Atmospheric Ozone Oxidation of Polycyclic Aromatic Hydrocarbons in Seawater and Effects of Oil Dispersant

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Ozone is a strong oxidant for oil hydrocarbons, and atmospheric ozone in the Gulf Coast environment is known to affect the health of the ecological systems. However, effects of atmospheric ozone on weathering of spilled oil remained unknown. Using phenanthrene, pyrene, 1-methyfluorene and 9,10-dimethylanthracene as model oil polycyclic aromatic hydrocarbons (PAHs), this work investigated ozonation rates and extents of the PAHs in seawater under simulated atmospheric ozone, and examined effects of a popular oil dispersant (Corexit EC9500A) on the ozonation process. In all cases, fairly rapid oxidation of the PAHs was observed. For instance, at an air phase ozone concentration of 86 ppb, 200 ppb of 1-methylfluorene or 40 ppb of 10-dimethylanthracene was completely degraded in 22 days. In general, the degradation kinetics followed a two-stage pseudo-first order rate profile, with a slower initial stage followed by a much faster stage. The presence of 18 and 180 mg/L of the dispersant inhibited the phenanthrene and pyrene degradation rates, but enhanced the degradation rates of the methylated PAHs. The ozonation rates decreased with increasing solution pH and temperature, but remained independent of ionic strength. The results indicate that atmospheric ozonation can play an important role in oil weathering and should be taken into account in assessing fate and environmental impacts of oil spill, and oil dispersants may have complex impacts on the ozonation rate and extent.

9:45 AM - 10:00 AM

Impact of Oil Spill and Corexit on Marine Microgel Formation

M. Chiu[1], **W. Chin**[1], P. Santschi[2], S. Doyle[3], Z. Finkel[4], G. Gold[4], P. Hatcher[5], I. Irwin[4], T. Knap[3], X. Li[3], Y. Lin[2], W. Obeid[5], U. Passow[6], A. Quigg[2], K. Schwehr[2], D. Shi[3], J. Sylvan[3], T. Wade[3], C. Xu[2], S. Zhang[2]
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Marine dissolved organic carbon (DOC), a major reservoir of reduced carbon in the ocean, plays a critical role in the marine carbon cycling. Marine microgel formation represents a critical link between more refractory DOC and POC (particulate organic carbon), an available pool of higher bioreactivity and biodegradable organic carbon accessible to the microbial community. Biopolymers (exopolymeric substances, EPS) released from marine phytoplankton or bacteria serve as important sources for the surface DOC pool that contribute to microgel formation. Here we aim to investigate the impact of oil and Corexit on this critical process for surface ocean carbon dynamics. We performed mesocosm studies with four treatments: control, water accommodated oil fraction (WAF), Corexit plus WAF, and a diluted WAF (to match oil concentration in the WAF tank). Our preliminary results based on dynamic laser scattering indicate that oil and Corexit can significantly change the assembly of microgels. Our observation will provide supporting evidence to help us understand the relationships shaping remineralization of these materials and the interactions with the microbial community. Further, the findings will help elucidate processes for the transport/mobilization of oil-derived carbon in the water column, and consequently its fate (sinking, dispersion or aggregation) in the ocean.

10:30 AM - 11:00 AM

Oil, Diatom Exudation and Marine Oil Snow

U. Passow[1], J. Sweet[1], K. Schwer[2], C. Xu[2], S. Zhang[2], Y. Lin[2], P. Santchi[2], A. Quigg[2]
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Extracellular substances released by marine phytoplankton as a response to the presence of oil serve a wide variety of purposes. Exudates, especially transparent exopolymer particles (TEP), are key for the formation of large, rapidly sinking diatom aggregates, which when they incorporate oil are considered marine oil snow (MOS). Whereas diatom species composition and primary production are known to respond to oil contamination, the impact of oil exposure on exudation and aggregate formation and the consequences for the sedimentation of MOS has remained largely unexplored. We show experimental results from select diatom species on the impact of oil exposure on the characteristics of a) exudates (composition, surface tension, stickiness) and b) aggregates (composition, sinking velocity). These findings will help us to better understand the role these materials play in the removal of oil and oil related substances from the water column after a spill event.

11:00 AM - 11:15 AM

Role of Microbial Exopolymers in Aggregation of Oil and Dispersants

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An estimated 60% of the oil spilled during the Deepwater Horizon (DwH) accident reached the sea surface. Of that, 5-30% settled on the sediments via marine oil snow (MOS) formation. Microbially produced exopolymeric substances (EPS) are an important component of MOS. Thus, understanding how the presence of hydrocarbons triggers production of EPS that may protect organisms, emulsify and/or remove the oil products via settling, and therefore alter its degradation pathways is important. Research on the role that EPS, micro-gels, and transparent exopolymer particles (TEP) play in the fate of oil and the dispersant Corexit, requires experiments at different levels of complexity. We report here initial results from using large (79 L) mesocosms that investigated the interactions between natural microbial communities, EPS and water accommodated oil (WAF, 4mg/L) or oil and Corexit (CWAF, 20:1). Analysis of colloidal and particulate EPS in three layers (surface, water column and bottom) indicate that CWAF facilitated formation of aggregates that either floated to the surface or sank to the bottom over time, resulting in a higher carbon removal efficiency. Colloidal EPS concentrations increased with time, especially polysaccharides. The decreasing water column carbon trend appeared to be related to the removal of sinking aggregates. Our various observations suggest that EPS was involved in facilitating aggregate formation, but the exact mechanisms are still under investigation.

11:15 AM - 11:30 AM

The Role of Environmental Factors in Controlling the Oil Weathering in the Gulf of Mexico Waters

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Environmental factors, such as sunlight, temperature, nutrients and initial bacterial community, are important in controlling the oil weathering in marine waters, yet their respective roles in the Gulf of Mexico waters have not been systematically studied despite the huge research efforts after the Deepwater Horizon (DWH) oil spill. This knowledge is critical to evaluate the fate of oil, as oil spills, such

as the DWH one, are often across large environmental gradients in marine waters. From both field work and laboratory incubations over the last several years, we have systematically examined the role of sunlight, temperature, nutrient and initial bacterial community in the oil weathering processes. For example, our data showed that strong sunlight explained not only the rapid disappearance of aromatic hydrocarbons and the corresponding formation of asphaltenes, but also the development of certain bacteria in sea surface oil mousses and slicks after the DWH oil spill. Our data also indicated that a combination of 4°C and bottom water inoculum was key for the growth of *Cycloclasticus*, while surface water inoculum and bottom water key for *Pseudoalteromanas*; both strains are important oil degraders during the DWH oil spill. Overall, this presentation will synthesize our results related to oil weathering in the Gulf of Mexico, and offer insights into the fates of oil after the DWH oil spill.

11:30 AM - 11:45 AM

Snow on the Seafloor? Carbohydrates in Deep-sea Sediments Impacted by the Deepwater Horizon Oil Spill

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A significant fraction of the oil released from the Macondo well after the Deepwater Horizon (DwH) explosion reached the seafloor, but processes responsible for its deposition are not fully resolved. Marine snow--small, composite particles composed largely of extracellular polymeric substances (EPS) exuded by algae and bacteria--has been proposed as a major driver of hydrocarbon sedimentation after the blowout (e.g., 1). Sinking snow particles, rich in carbohydrates, could have entrained oil and oil-mineral aggregates from the water column. To investigate if marine snow from the DwH event left a sedimentary record, we analyzed carbohydrates in 2 mm intervals in cores collected at four sites in 2013. A modified phenol-sulfuric acid method revealed sharp subsurface peaks in bulk carbohydrates near the Macondo well, coincident with increases in polycyclic aromatic hydrocarbons and other oil components. Distal sites showed no increase in carbohydrates above background levels, but a three-year time series indicates that carbohydrates persist near the wellhead. We used confocal microscopy and fluorescent lectin-binding assays to help understand whether carbohydrate peaks reflect marine snow or in situ production of EPS by bacteria in sediments. Particles were large, and morphologies included collapse structures suggestive of a water column origin, supporting the conclusion that bulk carbohydrate peaks represent snow deposited on the seafloor. (1) Passow, U., *et al*. Environmental Research Letters 7, 035301.

11:45 AM - 12:00 PM

Self-Assembled Surfactant Mesophases as Buoyant Gel Dispersants

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Oil spill dispersants are typically liquid solutions of surfactant such as DOSS (di-octyl sulfosuccinate, sodium salt) and Tween 80 (polyoxyethylene (20) sorbitan monooleate) in organic solvents such as propylene glycol and petroleum distillates. Liquid dispersants suffer from spray drift and gets washed off by ocean currents when in contact with weathered oils. Gel based dispersants can provide advantages including adherence to weathered oil, increased contact time with oil, minimal solvent use and high surfactant concentrations. Here, a gel-like surfactant mesophase is formulated by adding water to a micellar solution consisting of equimolar concentrations of DOSS and a zwitterionic surfactant, phosphatidylcholine (PC) in a paraffin solvent. The non-ionic surfactant, Tween 80 is successfully incorporated into the self-assembled DOSS/PC mesophase. Small Angle Neutron Scattering and Cryo-

Scanning Electron Microscopy are complementary techniques useful for characterizing the gel microstructure. The DOSS/PC/Tween 80 gel system effectively lowers the crude oil-saline water interfacial tension to the to the 10-2 mN/m range, appropriate for the oil dispersion. The interfacial tension reduction facilitates the creation of new oil-water interfacial area leading to the formation of stable emulsions with an average droplet size of about 7.81μm. The gel is buoyant on water and breaks down on contact with oil releasing surfactant components that stabilize the oil-water interface.

Fusion of Bio-physical Data and Predictive Modeling to Understand Gulf of Mexico Marine Species Resilience to Environmental Stresses and Disasters

8:30 AM - 9:00 AM
Sensitivity Analysis of Transient Population Dynamics during Oil Spill Recovery
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University of Amsterdam, Amsterdam, Netherlands

Asymptotic measures of population performance (e.g., the population growth rate, equilibrium density, etc.) characterize the long-term fate of a population. Sensitivity analyses of these quantities show how they would respond to changes in population parameters. However, long-term fate may provide only limited information about the transient, short-term dynamics that may be of major concern during response to, and recovery from, an environmental incident. These transient dynamics are described by time-varying (usually non-stationary) population projections over a specified time interval and subject to a specified scenario of changes in the vital rates. We will present the sensitivity analysis of such projections, to changes in any of the vital rates, at any or all times during the projection. Possible dependent variables include the population vector at any time in the projection, or the total population, the weighted total population, ratios of population segments, and short-term growth rates. The results will be applied to a stage-structured model for sperm whales, but the techniques are generally applicable.

9:00 AM - 9:15 AM
Accessing the Impact of Environmental Disasters on Population Dynamics Using Stochastic Matrix Models
R. Chiquet[1], A. Ackleh[1], B. Ma[2], T. Tang[1], N. Sidorovskaia[1]
[1]University of Louisiana at Lafayette, Lafayette, LA, [2]Millersville University of Pennsylvania, Millersville, PA

We develop matrix population models which account for demographic stochasticity and environmental stochasticity. We investigate how reduction in the survival rates affects the sperm whale population. We show that a reduction of as little as 1.2% in the estimated survivorship of the mature female sperm whales or a 4.5% reduction using the best case parameters will lead to an asymptotic growth rate below one, which indicates the population will be in decline. Then, we investigate the long term effect of a catastrophic event, such an oil spill, on the population of sperm whales in the Gulf of Mexico by assuming that vital rates will eventually recover to their original value and by using different functions to model such a recovery. These recovery functions will take into account the impact on the vital rates, how long an event is likely to affect the population, and the time it takes the individuals to recover back to pre-event rates. We then calculate recovery probabilities as well as the recovery time of the population. Our results show that for certain recovery functions, there is no possibility for the population to recover in 50 years and could take 100 or more years for the population to return to the same levels prior to a catastrophe, if it is possible to recover at all.

9:15 AM - 9:30 AM
Population Dynamics Modeling of an Invasive Species, *Pomacea maculata*
K. Sutton[1], L. Zhao[2], J. Carter[3]
[1]Mathematics, University of Louisiana at Lafayette, Lafayette, LA, [2]University of Louisiana at Lafayette, Lafayette, LA, [3]National Wetlands Research Center, Lafayette, LA

Pomacea maculata, or the applesnail, is a relatively new invasive species to the Gulf Coast region and poses a potential threat to local sugar and rice crops, based on past history. The processes that determine the population dynamics of *Pomacea maculata* have largely been unquantified. We discuss insights gained regarding the applesnail growth dynamics, and therefore population projections, from a closed population in a laboratory setting. The growth stages, along with other size characteristics, notably differed in a statistically significant way between males and females, which were present at an approximately 1:2 ratio in the observed population. Ongoing work includes efforts to design and carry out experiments to quantify other processes that affect the population size and dynamics of these snails both in the laboratory and in the field. We discuss also how this mathematical model can be used as a basis for simulation studies to make predictions regarding the potential spread of this species, and to make projections regarding its population size under various proposed management scenarios.

9:30 AM - 9:45 AM
Modeling Green Treefrog Population Dynamics Using Capture-Mark-Recapture Field Data
B. Ma[1], A. S. Ackleh[2], X. Li[2]
[1]Millersville University of Pennsylvania, Millersville, PA, [2]University of Louisiana at Lafayette, Lafayette, LA

An apparent global decline of amphibians has created concern, which has led to numerous research efforts. Many of these efforts focus on monitoring amphibian populations to better understand their dynamics. From 2004-2009 green Treefrogs (*Hyla cinerea*) were captured, marked, measured and released at an urban study site in Lafayette, Louisiana. A statistical method based on a generalization of the hypergeometric distribution was used to derive weekly time-series estimates of the population sizes. To describe the population dynamics, a size-structured mathematical model with distributed size-at-birth was developed and compared to the time-series obtained from the weekly population estimates using a least-squares approach. The results of the model-to-data fit are very good and suggest that this model can be used as a tool to predict the long term dynamics of this population and to understand conditions for its persistence.

9:45 AM - 10:00 AM
Development of Spatial Model to Support Oil Spill Response and Natural Resources Damage Assessment
P. J. Rubec[1], R. Kiltie[2], R. Flamm[1], L. McEachron[1]
[1]Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL, [2]Florida Fish and Wildlife Conservation Commission, Gainesville, FL

Habitat suitability models (HSM) have been developed to model catch-per-unit-effort (CPUE) data across environmental gradients. The HSM uses delta-type generalized additive models (GAMs) to separately fit splines to positive CPUEs (based on either gamma or beta distributions) and probability of occurrence data. Using R statistical software in gamlss, the model predicts numbers per unit area (no/m^2) at sampling stations within an estuary or the coastal zone. Habitat grids are created from interpolated sampling data or oceanographic modeling. Then, a predicted abundance grid is created by linking the HSM with the habitat grids using GIS. Population numbers can be estimated from the predicted CPUE grid. Polygons representing zones of low to high abundance are created. Polygons from the HSM can be imported into oil spill models such as SIMAP to predict the impacts of an oil spill on fish or shrimp

species by intersecting the species-distribution polygons with oil-spill polygons predicted from circulation modeling. The maps created can be used to support oil spill response and natural resources damage assessment (NRDA).

10:30 AM - 11:00 AM
Acoustic Assessment of Cetacean Population Responses to the Deepwater Horizon Disaster
D. K. Mellinger[1], N. Sidorovskaia[2]
[1]Oregon State University, Newport, OR, [2]University of Louisiana, Lafayette, Lafayette, LA

Cetaceans typically have large ranges (100s-1000s of kilometers) and are apex predators, and can therefore integrate the responses of an ecosystem to an event across large temporal and spatial scales. The LADC-GEMM project is studying the population responses of several groups of cetaceans -- deep-diving sperm whales, beaked whales, and dolphins -- to the Deepwater Horizon (DWH) disaster in the northern Gulf of Mexico. Beginning in 2001, acoustic recordings were made in the region of the DWH, providing a unique baseline for a comparison of cetacean populations pre- and post-disaster. Recordings were again made in summer 2015 using ocean gliders, autonomous surface vehicles, and moored autonomous hydrophones for comparison to earlier data. Data are being analyzed using (1) automated call detection and localization to find and track desired species, (2) techniques to estimate population densities in the vicinity of sensors, (3) ecosystem and population dynamics modeling to explain the spatiotemporal distribution of the species. Primary goals are to (1) understand the oil spill impact and recovery dynamics of deep diving marine mammals; (2) infer fine-scale information about stock status, including gender and age composition; and (3) correlate abundance dynamics with environmental factors such as pollutants, anthropogenic noise level, prey presence, etc. to assess the health of the deepwater ecosystem.

11:00 AM - 11:15 AM
Photo-identification Can Be Used to Assess Effects of Natural and Man-made Disasters on Dolphins
S. Kuczaj, S. McBride
USM, Hattiesburg, MS

Longitudinal records of dolphin behavior can provide valuable information about the effects of both natural and man-made disasters. For example, Hurricane Katrina decimated the Gulf Coast of Mississippi in August of 2005, and in 2007 there was a significant increase in the number of dolphin calves in the Mississippi Sound, suggesting that Katrina had impacted normal birthing patterns. It is possible that many dolphin calves were separated from their mothers during the storm, and that the many dolphin mothers that lost their calves during Hurricane Katrina became available for mating sooner than normal, the resulting pregnancies producing a significant increase in calves in 2007. But an increase in viable females would not result in an increased number of successful births unless there were adequate resources to support the pregnant females. Hurricane Katrina destroyed most of the commercial and recreational boats in the Mississippi Sound and surrounding area, which resulted in two benefits for the dolphins. First, the lack of fishing vessels meant less competition for fish, and likely made fish more readily available to the dolphins. Second, the presence of boats, especially high-speed boats, disturbs dolphin foraging and socializing. Thus, the absence of boats in general allowed dolphins to spend less time avoiding boats and more time socializing and foraging. All of these factors produced the perfect storm for dolphin well-being and reproductive success in the years immediately following Hurricane Katrina, the result being the increase in the number of dolphin calves that occurred in 2007. In addition to results such as these, dolphins can be identified using photo-identification techniques, and individual identifications over time make it possible to better assess the effects of both natural and man-made

events on dolphin habitat use and behavior. We will present photo-identification data on dolphins in the Mississippi Sound that were collected over an eight year period, and show how such data allows for meaningful comparisons before and after Hurricane Katrina and the Deep Water Horizon oil spill.

11:15 AM - 11:30 AM
A Gulf of Mexico Comparative Analysis of Numerical Model Results, Cruise-Based Observations, and Historical Data
S. deRada[1], B. Penta[1], T. Sutton[2], M. Johnston[2], A. Cook[2], K. Boswell[3], C. Lembke[4], D. English[4]
[1]Naval Research Laboratory, Stennis Space Center, MS, [2]Nova Southeastern University, Dania Beach, FL, [3]Florida International University, North Miami, FL, [4]University of South Florida, St. Petersburg, FL

The Gulf of Mexico Research Initiative DEEPEND (Deep-Pelagic Nekton Dynamics of the Gulf of Mexico) consortium's objectives include the characterization of biophysical variability in the water column. Observational and multi-model approaches are used to increase understanding of the dynamics of deep-pelagic (0-1500 m) fish assemblages at multiple temporal and spatial scales. The first two DEEPEND cruise campaigns, conducted during the summer of 2015, collected bio-physical data in the Northern Gulf of Mexico. During this time, the Northern Gulf exhibited vigorous mesoscale regimes that were dominated by a large anti-cyclonic eddy intermittently shedding off the loop current; a similar condition that occurred in 2011. A 1/25° horizontal-resolution HYCOM ocean model, running in near real time to support the DEEPEND cruise campaigns, captures these features and illustrates the eddy formation and shedding events that transpired during the summer of 2015. The structure of these eddy regimes is examined at the surface and through the water column using the model results and evaluated against cruise and other observational data from NDBC and NASA.

11:30 AM - 11:45 AM
CONCORDE: Bio-Physical Observations
S. D. Howden[1], R. Arnone[1], J. Book[2], M. K. Cambazoglu[1], B. Dzwonkowski[3], G. Jacobs[2], K. Martin[1], T. Miles[4], J. Moum[5], O. Schofield[4], A. Shiller[1], I. Soto[1], R. Vandermeulen[1], A. Weidemann[2], Rest of CONCORDE Team[1]
[1]The University of Southern Mississippi, Stennis Space Center, MS, [2]The Naval Research Laboratory at Stennis Space Center, Stennis Space Center, MS, [3]University of South Alabama, Mobile, AL, [4]Rutgers University, New Brunswick, NJ, [5]Oregon State University, Corvallis, OR

The CONsortium for oil exposure pathways in Coastal River-Dominated Ecosystems (CONCORDE) is focused on a region where development of multiple river plumes, and other forcing (e.g., internal waves and offshore eddies) set the vertical and horizontal stratification that determine plankton distributions. The physical structure affects both advective pathways and mixing, which can transport sediments, oil/dispersant and plankton and affect the growth and exposure of plankton. To address these questions requires a multi-platform, multi-disciplinary approach. The Bio-Physical Observations Group is utilizing remote sensing, near-real-time model nowcasts/forecasts, mixing moorings, gliders, shipboard biophysical and chemical measurements, small vessel estuarine pass surveys and the extant real-time monitoring infrastructure to characterize the bio-physical coupling in the study region and ascertain how a subsurface source of oil and dispersant can be exposed to the biological layers through advective processes and mixing, and how it can eventually reach the coast. An adaptive sampling strategy, informed by the remote sensing and modeling, will guide the shipboard and glider locations to ensure that a range of representative features are sampled. The approach is multi-tiered, with a focus both on understanding individual processes, and on synthesizing the results with the plankton and synthetic modeling groups in order to address the fundamental questions posed by the consortium.

11:45 AM - 12:00 PM

CONCORDE: Resolving the Role of Pulsed-River Systems in Oil Spills and Potential Exposure of Organisms to Toxicants

W. Graham[1], F. Hernandez[2], S. Howden[1], J. Wiggert[1], A. Shiller[1]

[1]The University of Southern Mississippi, Stennis Space Center, MS, [2]The University of Southern Mississippi, Ocean Springs, MS

Complex three-dimensional coastal circulation in the northern Gulf of Mexico is seasonally dominated by freshwater plumes extending well offshore, where they interact with oceanographic processes. Winds, tides, river pulses and offshore eddies drive the motions of both surface and sub-surface waters and create regions of enhanced biological activity. River discharge plumes interact with shelf waters to generate transport pathways for plankton and, presumably, surface oil. Following Deepwater Horizon, scientific effort was focused on understanding deep sub-surface modes of ODS transport and chemical change as it related to organism exposure. Ironically, little understanding of sub-surface exposure exists for the more productive nearshore and coastal environments. We established the CONsortium for oil spill exposure pathways in COastal River- Dominated Ecosystems (CONCORDE) to expressly address how complex fine-scale structure and processes in coastal waters dominated by pulsed-river plumes control the exposure, impacts and ecosystem recovery from offshore spills like the Deepwater Horizon release of 2010. CONCORDE is characterizing these complex circulations and their relevance for oil and dispersant movement using a combination of remotely-sensed and field-collected oceanographic data. These data will ultimately be assimilated into an operational ocean 3-D circulation model that informs biological sampling, eco-toxicology experiments and a synthesis model.