Volume 33 • No. 1 • Winter 2019

Introduction to the GoMRI Special Issue on Research Resulting from the 2010 Deepwater Horizon Oil Spill

On April 20, 2010, the Deepwater Horizon oil rig exploded in the Gulf of Mexico, releasing 210 million gallons (780,000 cubic meters or m^3) of oil and gas into the surrounding ecosystem; the flow persisted for 87 days before the well was capped. Sadly, 11 workers died. As responders began efforts to stop the flow and collect spilled oil, officials worked to minimize threats to human health and economies, and environmental scientists jumped into action to learn as much as possible about the spill and its effect on the Gulf of Mexico.

High school teachers process plankton samples aboard the R/V *Point Sur* in the Gulf of Mexico during Consortium for Oil Spill Exposure Pathways in Coastal-River-Dominated Ecosystems (CONCORDE's) AUV Jubilee Workshop Cruise in July 2015. Courtesy of Jessie Kastler

Researchers quickly realized that the lack of baseline data on the Gulf of Mexico ecosystems would make it difficult to know how the Gulf and the organisms living there would be impacted. Furthermore, the complex interactions and linkages between the ecosystems in the Gulf required scientists with a wide variety of backgrounds to work together to answer challenging questions. Where would the oil end up? How would it impact the animals living in the Gulf? How would the spill affect the local communities? Fish ecologists needed toxicologists, field scientists needed modelers, and geochemists needed physicists to assemble a complete understanding of the effect of the spilled oil and dispersant.

One month into the spill, BP made a commitment to provide $500 million for 10 years to fund a research program on the impact of the spill and to prepare for future spills. BP worked with the Gulf State governors through the Gulf of Mexico Alliance to create a program that would publish scientific results totally independent of BP. That program, the Gulf of Mexico Research Initiative (GoMRI), which is governed by a Master Research Agreement with BP, has provided an unprecedented opportunity to bring together over 2,500 scientists with the common goal of understanding the impacts of oil spills and improving response and mitigation capabilities for the future. GoMRI-funded researchers are comprehensively studying the Gulf ecosystem, and research is funded under five major research themes: physical distribution of petroleum and dispersants in the ocean; chemical and biological evolution and degradation of petroleum and dispersants; environmental effects of petroleum and dispersants throughout the water column and the surrounding ecosystem; technology developments; and public health impacts. A full listing of the GoMRI Research Themes is available here: http://research.gulfresearchinitiative.org/research-about/.

Research sponsored by GoMRI is selected through a peer-review process modeled after National Science Board standards, and results are published in peer-reviewed journals. GoMRI requires that data generated through these research efforts be made publicly available through the

Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC). Nine years into the 10-year program, GoMRI-funded research has produced more than 1,000 peer-reviewed journal publications and over 2,100 publicly available datasets. The program is also training the next generation of young researchers who are professionally at home in the Gulf of Mexico and, in many cases, contributing to the development of baseline data Gulf-wide. From this single event, and through the GoMRI program, a huge body of scientific knowledge has grown. Strong scientific collaborations have unfolded that have enabled researchers to address complicated questions across disciplinary boundaries about the impacts of the Deepwater Horizon and other oil spills.

Since its inception, GoMRI valued and prioritized efforts to communicate and share GoMRI-funded research with the public. The GoMRI program itself generates and disseminates information through website stories, newsletters, webinars, and social media. GoMRI provides funding for research consortia to carry out public outreach efforts in ways that are relevant to each consortium's research activities and local communities. GoMRI has also established partnerships with Smithsonian Ocean Portal, the Gulf of Mexico Sea Grant Oil Spill Science Outreach Program, and Screenscope Films. The Ocean Portal publishes articles and blog posts featuring GoMRI-funded researchers and their science. The Gulf of Mexico Sea Grant Oil Spill Science Outreach team delivers oil-spill related products and services to specific target audiences in the Gulf region and the nation, including accessible publications of use to educators. GoMRI's partnership with Screenscope Films has resulted in the *Dispatches from the Gulf* series, which includes two documentary films and 75 short videos sharing stories about GoMRI science and the GoMRI community. More information about the GoMRI-funded consortia and these partner-produced products is included in this issue and can be found online at http://gulfresearchinitiative.org/.

Through this special issue, we hope to convey elements of the process of science by exploring how GoMRI researchers have addressed the GoMRI research themes. Starting with a single event in 2010, successive observations and results have quickly grown into a body of knowledge that is building our understanding of oil spill and dispersant impacts on the Gulf of Mexico. This asking and answering of questions is how science moves forward.

Researchers and graduate students associated with The Center for the Integrated Modeling and Analysis of the Gulf Ecosystem (C-IMAGE) work with teenage girls to process fish samples during the summer Oceanography Camp for Girls' research cruise aboard the R/V *Weatherbird II* in the Gulf. Courtesy of Teresa Greely

GoMRI-funded oil spill research offers a unique opportunity to teach students the three dimensions of the *Next Generation Science Standards* (NGSS, https://www.nextgenscience.org/): disciplinary core ideas (content), scientific and engineering practices, and cross-cutting concepts. Specifically, this research captures how we practice science and engineering, and demonstrates their application in the real world. To assist in sharing this content, each article is accompanied by a selection of resources that can be incorporated into classroom teaching. Additionally, each article begins with a few bullets which highlight the main points of the article, summarize how it addresses a key research question and relates to the scientific process, and provides a brief description of the associated activity, if applicable.

There are five articles in this issue. Three address some of the overarching questions about the Deepwater Horizon oil spill and how GoMRI science is working to answer them. *The Story of Oil in the Gulf of Mexico* asks, "Where did the oil go?" From a physical oceanography standpoint, how do we know where the oil went in the Gulf of Mexico, and what new science has emerged to help scientists answer this question? *Deepwater Horizon Oil Spill Impacts on Organisms and Habitats* asks, "What happened to the ecosystem as a result of the oil?" From an ecological perspective, what impacts did the oil have on the wildlife and ecosystems in the Gulf? *Technological Advances in Ocean Sciences Resulting from the Deepwater Horizon Oil Spill* discusses new technologies that have been developed to better understand impacts from the oil spill and some citizen science projects that have resulted.

Two additional features introduce the curious phenomenon of marine oil snow (MOS) and GoMRI's data sharing policies. In *An Underwater Blizzard of Marine Oil Snow*, research into the formation and sedimentation of MOS illustrates how scientists with diverse research interests uncovered a process with unexpected significance in moving released oil to the floor of the ocean. The final article, *The Gulf of Mexico Research Initiative Information and Data Cooperative: Data Transparency and Data Sharing* describes GoMRI's requirement to make all data produced through GoMRI funding publicly available for sharing with the broader scientific community, and highlights the importance of data transparency.

These articles represent only a snapshot of the vast amount of research being produced by GoMRI-funded scientists. The GoMRI program will conclude in 2020. An effort is now underway to synthesize the knowledge accrued through 10 years of dedicated research effort, to make the scientific advancements available to the research, response, and user communities in responding to future spills. Of course, the state of the knowledge is always changing; it is GoMRI's hope that the legacy of the program will serve to inform new scientific discoveries in oil spill science for many years to come. Links to additional resources, websites, and information are provided throughout the issue. We also invite you to utilize GoMRI's Special Issue of *Oceanography*, "GoMRI: Deepwater Horizon Oil Spill and Ecosystem Science": tos.org/oceanography/issue/volume-29-issue-03. We hope you enjoy this special issue and find it to be a useful resource in your classroom.

CO-EDITORS: JESSIE KASTLER, KATIE FILLINGHAM, SARA BERESFORD, AND TERESA GREELY

JESSIE KASTLER is the Outreach Coordinator of the Consortium for Oil Spill Exposure Pathways in Coastal River-Dominated Ecosystems (CONCORDE), and the Coordinator of Program Development for the Marine Education Center of the University of Southern Mississippi, Gulf Coast Research Laboratory in Ocean Springs, Mississippi.

KATIE FILLINGHAM is a Program Specialist with the Gulf of Mexico Research Initiative (GoMRI) at the Consortium for Ocean Leadership in Washington, District of Columbia.

SARA BERESFORD is the Communications and Outreach Lead for the Ecosystem Impacts of Oil and Gas Inputs to the Gulf (ECOGIG) research consortium at the University of Georgia Department of Marine Sciences in Athens, Georgia.

TERESA GREELY co-leads the Center for the Integrated Modeling and Analysis of the Gulf Ecosystem (C-IMAGE) Outreach Team, and serves as the Director of Education and Outreach and a teaching faculty at the University of South Florida's College of Marine Science in St. Petersburg, Florida.

This special issue of Current *was sponsored by the Gulf of Mexico Research Initiative (GoMRI). The editors thank the GoMRI outreach coordinators for contributions and appreciate reviews by Debi Benoit, Steve Sempier, Chuck Wilson, and two anonymous peer reviewers whose comments greatly improved the manuscripts.*