

Environmental Studies Program: Ongoing Study

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: A Comparative Analysis of an Oil Spill on the Biota Inhabiting Several Gulf of Mexico Shipwrecks: Microbial Analysis (NSL #GM-13-03c)

BOEM Information Need(s) to be Addressed: This study will support EIS development and decision-making by providing documentation and analysis of a major oil spill's prospective lasting effects on shipwrecks, which have been demonstrated in previous BOEM studies to serve as deepwater artificial reefs for various biota. Section 106 of the National Historic Preservation Act requires Federal agencies to consider the potential effects of their permitted activities on cultural resources before issuing such permits but impacts to shipwrecks from oil spills such as the *Deepwater Horizon (DWH)* spill of 2010 are unknown. Archaeological investigations conducted after the Exxon *Valdez* oil spill in Alaska focused on terrestrial sites even though post-spill surveys identified submerged cultural resources within the affected area. Additionally, damages to cultural resources were not addressed by the Natural Resource Damage Assessment process for the *DWH* spill, and no other studies are currently analyzing these potential impacts. General questions to be addressed in the study include whether and how oil, dispersed oil, and chemical dispersants used to manage the oil spill interact with and are integrated within the shipwreck remains, resident biota, and surrounding seafloor. This study will also analyze each selected vessel's current state of preservation, its site formation processes over time, the degradation of its hull structure (iron, steel, or wood), and associated material remains. Microbial action and resident biota at each test site will also be systematically analyzed to determine if exposure to hydrocarbons and chemical dispersants caused any long term impacts. Baseline data collected at selected sites before the 2010 *DWH* spill will be used for comparative purposes.

Total BOEM Cost: \$1,428,124

Period of Performance: FY 2013–2017

Conducting Organization(s): George Mason University (M13AC00015)

Principal Investigator(s): Dr. Leila Hamdan (Leila.Hamdan@usm.edu)

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Description:

Background: As amply demonstrated in previous studies, historic shipwrecks serve as an ideal sample because they are located at random throughout the Gulf of Mexico and provide habitat for a diverse array of marine life from microbial communities to macrofauna. Most of these sites have not been revisited since prior to the spill. Considering the overall lack of archaeological survey and environmental data among the Gulf of Mexico's shipwreck sites, the site formation processes and possible negative impacts associated with a large-scale oil spill over time are unknown.

George Mason University's (GMU) Microbiome Analysis Center is participating in overall project management, microbial ecological analyses, and laboratory analyses. GMU is providing a comparative analysis of sediment, biofilm, and coral microbiomes from shipwrecks in analogous physicochemical settings but with different degrees of anticipated spill impacts. The work employs biogeochemical analyses and next generation sequencing tools to examine biodiversity, metabolic function, and the nature and extent of microbiological response to spill contaminants in environmental samples and *in situ* and *ex situ* experiments. The outcome of this work aims to provide fundamental information on the microbiomes of shipwrecks in the deepwater environment. This work is being conducted in conjunction with sedimentary analyses and corrosion studies performed by the U.S. Naval Research Laboratory, another study partner.

Objectives: This follow-up study will complete a multi-scalar, comparative analysis of data collected prior to the spill to assess the current, post-spill physical and environmental condition of each selected site and determine if the site was exposed to oil. In addition, a comprehensive assessment of biota associated with each site will evaluate microscale temporal changes over time as well as any changes related to the oil spill which occurred in the vicinity of some of the selected shipwreck sites. The study will additionally conduct a detailed analysis of the environmental, macro and microbiological, and archaeological conditions of select wooden shipwreck sites that have been previously investigated to determine if the sites were exposed to oil and if such exposure has affected their state of preservation. The totality of data from the proposed study will inform BOEM about the rate of changes occurring at these sites (microscale to macroscale). They will also address questions related to the preservation of archeological sites in the GOM, and identify if the release of hydrocarbons and chemical dispersants have impacted shipwrecks.

Methods: The study investigates intact microbial populations, select environmentally relevant groups, and their metabolic potential in shipwreck degradation. Microbial ecological analyses allow for monitoring community diversity and biogeochemical function and their sensitivity to environmental disturbances. Laboratory experiments using field-deployed corrosion platforms simulate the shipwrecks' exposure to the *DWH* spill. For comparative purposes, assessments will be made of select wooden and steel shipwreck sites outside the area impacted by the oil spill.

Current Status: The cooperative agreement between BOEM and GMU was awarded in September 2013 and will end May 2017. Project partners completed field cruises in 2014 and 2015 to collect water, sediment, wood debris, metal fragments/rusticles, and coral samples from a total of seven shipwreck sites. Short-term and long-term microbiological experiments were deployed near the wrecks in March 2014 to recruit microbial biofilms and study localized wood degradation and metal corrosion processes. After a 4-month period, one experiment was retrieved from each shipwreck site for subsequent laboratory experiments to simulate exposure to oil and chemical dispersants. Laboratory experiments and analyses were completed in 2016. The draft

report is currently being compiled by the study partners and the final is anticipated in Summer 2017.

Final Report Due: August 2017

Publications Completed:

Various articles intended for peer-reviewed publications are currently in preparation for the following journals: The ISME Journal, Proceedings of the National Academy of Science.

An article was published in an archaeology conference proceedings:

Melanie Damour, Robert Church, Daniel Warren, Christopher Horrell, and Leila J. Hamdan. "Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, and Archaeology (GOM-SCHEMA) Project: Studying the Effects of a Major Oil Spill on Submerged Cultural Resources." In Marco Meniketti (ed.) ACUA Underwater Archaeology Proceedings of the 2015 Annual Meeting of the Society for Historical Archaeology, Seattle, WA, pgs. 51–61.

Information about this study has been presented at the following science conferences since January 2014:

- Gulf of Mexico Oil Spill & Ecosystem Science Conference (2014, 2015, 2016)
- American Geophysical Union (AGU) Fall Meeting (2014)
- Association for the Sciences of Limnology and Oceanography (ASLO) (2017)
- AGU/ASLO Ocean Sciences Meeting (2016)
- Federation of European Microbiological Societies (FEMS) (2015)
- American Society for Microbiology (ASM) (2015, 2016)
- Coastal and Estuarine Research Federation (CERF) (2015)
- National Association of Corrosion Engineers (NACE) (2016)
- Society for Historical Archaeology (SHA) (2014, 2015, 2017)
- Society for American Archaeology (SAA) (2015, 2016)
- Fields of Conflict conference (2016)
- International Biodeterioration Biodegradation Society (2017)

Affiliated WWW Sites: <https://marinecadastre.gov/epis/#/search/study/100043>

Project webpages can be found at: <https://hamdanlab.com/gom-schema/> and <https://www.boem.gov/GOM-SCHEMA/>

Revised Date: June 14, 2017