

ENVIRONMENTAL STUDIES PROGRAM: Ongoing Studies

Region: Gulf of Mexico Region

Planning Area(s): Central

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

BOEM Cost: \$1,428,124

Period of Performance: FY 2013-2016

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

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Description:

Background: As amply demonstrated in BOEM's award-winning 2004 study entitled *Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico* (Church et al., 2007), such archaeological sites serve as an ideal sample because they are located at random throughout the study area and have a diverse array of organisms, both macro and micro that inhabit each of these sites. The 2004 study collected baseline data providing information on the environment at each site, a determination of the physical and biological modification of sediments in the immediate area of each site, limited sampling of the fauna attached to hard substrate for taxonomic studies, and an analysis of hundreds of hours of video imagery and sample collection to address spatial heterogeneity of the fouling community and motile fish and invertebrate association with the wrecks. In addition, archaeological assessments and site plans were created for each of the study shipwrecks along with an analysis of the structural integrity and current state of preservation to understand the individual formation processes occurring at each site. Limited, bio-chemical analyses were conducted to identify microbial metabolic potential at each site and to determine if decay (rust formation) was accelerating at any or all of the mid-20th century shipwrecks assessed. This critical analysis was key to understanding the decay processes occurring at each site and for determining if any of these sites' hulls would eventually become compromised and potentially release contaminants and/or hazardous materials contained within the vessels at the time of their sinking. Most of these sites have not been revisited since the conclusion of this pilot study in 2004, and this study did not include wooden shipwreck sites or sites on the continental shelf. 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.

Post-spill investigations of several deepwater coral colonies in 2010 have, to date, identified one colony to the southwest of the Macondo well that exhibited stress from possible exposure to oil (White et al., 2012). Using gas chromatography and other analyses, researchers concluded that the corals had indeed been exposed to oil, likely from the DWH spill. However, these investigations have not collected wood or metal

samples from shipwrecks to determine whether the hulls were exposed to oil and, if so, how exposure to hydrocarbons may affect site formation processes, state of preservation, and rates of degradation. If exposure to oil/dispersant accelerates the degradation of metal and/or wooden-hulled vessels, the long-term survival of resident coral communities as well as the availability of suitable hard structure (shipwrecks) for future coral colonization may be negatively impacted.

George Mason University's (GMU) Microbiome Analysis Center is participating in overall project management 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 and corrosion studies performed by the U.S. Naval Research Laboratory, another study partner.

Objectives: This follow-up study will complete a detailed comparative analysis of data collected during the 2004 study and other pre-spill shipwreck investigations to assess the current 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 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 during complementary efforts and are located in the area of the oil spill to determine if the sites were exposed to oil and if such exposure has affected their state of preservation. The techniques employed will be complementary to the previous 2004 work, but will incorporate sophisticated investigation of intact microbial populations, select environmentally relevant groups, and their metabolic potential in shipwreck degradation. The totality of data from the proposed study will inform BOEM about the rate of changes occurring at these sites. 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. For comparative purposes, assessments will be made of select wooden and iron/steel shipwreck sites outside the area impacted by the oil spill.

Importance to BOEM: 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* 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 are not addressed by the Natural Resource Damage Assessment process, 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 chosen 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 dispersant-based chemicals cause any long term impacts. Baseline data collected at selected sites before the 2010 DWH spill will be used for comparative purposes.

Current Status: The cooperative agreement between BOEM and GMU was awarded on September 17, 2013. Project partners completed two field cruises in March and July 2014 on board the Louisiana Universities Marine Consortium (LUMCON) Research Vessel *Pelican*. The team collected water, sediment, wood, metal/rusticle, and coral samples from a total of seven shipwreck sites. Short-term and long-term microbiological experiments were deployed near the wreck sites to study wood and metal degradation. Laboratory analyses are nearly complete. The draft report is currently being compiled by the study partners and is anticipated in March 2015.

Final Report Due: March 2016

Publications: Various articles intended for peer-reviewed publications are currently being drafted.

Information about this study has been presented at:

- 2014 Gulf of Mexico Oil Spill & Ecosystem Science Conference (poster),
- 2014 Society for Historical Archaeology conference (1 paper), and
- 2014 American Geophysical Union Fall Meeting (poster).

Conference presentations in 2015 will include:

- 2015 Gulf of Mexico Oil Spill & Ecosystem Science Conference (1 paper),
- 2015 Society for Historical Archaeology conference (1 session consisting of 10 papers, 1 poster),
- 2015 Society for American Archaeology conference (1 paper), and
- 2015 Federation of European Microbiological Societies' (FEMS) 6th Congress of European Microbiologists.

Press releases: **7/21/2014** – Gulf of Mexico Shipwreck Study Launches Second Expedition on the Research Vessel *Pelican*. <http://www.boem.gov/press07212014/>

Affiliated Web Sites: http://mbac.gmu.edu/mbac_wp/gulf_wrecks/ and <http://www.boem.gov/GOM-SCHEMA/>

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ESPIS: Environmental Studies Program Information System

All completed ESP studies can be found here:

http://www.data.boem.gov/homepg/data_center/other/espis/espisfront.asp