**Nutrient Dynamics and Primary Productivity at the Caernarvon River Diversion**

We propose to measure the water chemistry and phytoplankton productivity along transects in the Breton Sound estuary, which receives Mississippi River water from the Caernarvon freshwater diversion. This area has been impacted by the Gulf oil spill and may be impacted further if the amount of diverted water decreases and summer southerly winds become more predominant. This study aims to answer the following question: Did the Macondo 252 Oil Spill result in large scale perturbation of the northern Gulf of Mexico ecosystem structure or function, especially in the Breton Sound estuary. This study has three objectives: 1) determine spatial and temporal patterns of nutrient, sediments, and aquatic primary production, 2) determine the impact of different oil concentrations on aquatic primary productivity in the Breton Sound based on measured concentrations in the Breton Sound estuary and other areas along the Louisiana coast, and 3) use a linked hydrodynamic-biological 2-dimensional landscape model to describe changes in nutrient cycling and phytoplankton productivity in response to riverine freshwater and nutrient inflows and oil concentrations**.** This work builds on an extensive series of studies summarized in Day et al. (2009). This work builds on an initial NGI project for August to December, 2010.

To measure water chemistry and related hydrographic parameters, flow through transects will be carried out monthly from January-December 2011. A flow-through system will be used to map suspended sediment, chlorophyll *a*, salinity, and temperature in the major bayous and water bodies in the estuary. Discrete water samples for nutrient and hydrocarbon analysis will be collected at 16 stations, along with measurements of the underwater light attenuation coefficient (Kd). We will measure phytoplankton production seasonally using the light, semi-shaded and dark bottle oxygen technique (Harding et al. 1982; Madden and Day 1992) in a field incubator for several locations in the estuary and extrapolate the results using data from the flow-through system, to map basin wide productivity. The impacts of petroleum hydrocarbons will be measured by adding environmentally relevant concentrations to a subset of the light-dark bottles. The field data will be used to calibrate and update a coupled hydrodynamic-water quality-phytoplankton dynamics landscape model that was developed in an earlier study. The purpose of the updated model will be to provide conceptual and mathematical frameworks for assessment of the response of the Breton Sound ecosystem to riverine input and petroleum hydrocarbons. The results of the study will be shared with managers of the Caernarvon diversion structure so that operation can be done in a way that minimizes water quality problems while still achieving coastal restoration objectives. The results will also be shared with scientists and managers dealing with impacts of the oil spill.

*Spatial and temporal patterns of nutrients, light, sediments, and aquatic primary production in the Breton Sound estuary*

We will map the distribution various ecological parameters along a transect run in upper Breton Sound estuary monthly from January-December 2011 using a flow-thorough system (12 transects, see field locations below). The flow-through system consists of a 1.5 cm diameter pipe mounted on the transom of a small boat that scoops surface water at planing speed, routes the water past several environmental sensors, and eventually flushes out where it can sub-sampled if necessary (Lorenzen 1966; Madden and Day 1992, Lane 2003). Measurements of fluorescence, turbidity, salinity and temperature will be taken using a YSI-6600 probe ([www.ysi.com](http://www.ysi.com)) modified for flow-through measurement. Readings will be taken every 5 seconds, with an average boat speed of 50 km hr-1, providing a reading about every 70 meters. Prior to each transect, the YSI probe will be calibrated using known standards. During each transect, discrete water samples will be taken at about 16 fixed locations and later analyzed for nutrients (NOx, NH4, PO4, TN, TP, and SiO4), suspended sediment, chlorophyll *a*, and salinity (replicate values will be used to calibrate and check the flow-through system performance). Position along the transect will be continuously recorded using a global positioning system (GPS). Samples will also be taken for the measurement of petroleum hydrocarbons. We will work with Dr. Edward Overton to implement appropriate sampling methods and samples will be analyzed in Dr. Overton’s lab.

The flow-through system will also have an in-line photosynthetic active radiation (PAR) sensor to measure light transmittance. Incident PAR will be measured continuously on the boat with a Li-Cor LI-1400 quantum radiometer; and a sensor submerged in the flow through system will continuously measure underwater PAR. Depth profiles of PAR will be made at the same locations water samples are taken using a Li-Cor LI-1400 recording quantum radiometer with an underwater PAR sensor to calibrate the continuous measurements. From this we will generate maps of underwater light attenuation coefficient (Kd) along the transects.

Discrete samples will be taken in acid-washed polyethylene bottles, stored on ice, and taken to the laboratory for processing. Within 24 hours the water will be subsampled into acid washed bottles for TN and TP analysis. Also, 60 ml from each water sample will be filtered through pre-rinsed 25 mm 0.45 um Whatman GF/F glass fiber filters into acid washed bottles. The total and filtered samples and filters will be frozen for nutrient and chlorophyll *a* analysis, respectively. Within one week of sample collection, total suspended sediment (TSS) will be determined by filtering 100-200 mL of water through pre-rinsed, dried and weighed 47 mm 0.45 um Whatman GF/F glass fiber filters. Filters will be dried for 1 hr at 105°C, weighed, dried for another 15 minutes, and reweighed for quality assurance (Greenberg et al., 1985). Salinity will be determined using a handheld YSI-85 sensor. Within one month of sample collection, filtered samples will be analyzed for chlorophyll *a*. NO3-N and NO2-N will be determined separately using the automated cadmium reduction method (Greenberg et al., 1985). NH4-N will be determined by the automated phenate method, and PO4-P by the automated ascorbic acid reduction method (Greenberg et al., 1985). Total nitrogen and phosphorus will be determined by methods described by Valderrama (1981). Chlorophyll *a* will be determined by a modified version of the technique of Strickland and Parsons (1972). Chlorophyll pigments will be extracted with a 40:60 ratio of dimethyl sulfoxide (DMSO): 90% acetone as described by Burnison (1980). The extract will be measured fluorometrically with a Turner Designs model 10-AU fluorometer (Greenberg et al., 1985).

*Hydrodynamic Biogeochemical and Primary Production Model*

For the proposed study, we will use a 2-D, finite-element, TABS-MD model. The TABS-MD (Multi-Dimensional) Numerical Modeling System (<http://chl.wes.army.mil/software/tabs/>), developed by the U.S. Army Corps of Engineers (USACE), is a collection of generalized computer programs and utility codes, designed for studying multi-dimensional hydrodynamics in rivers, reservoirs, bays, and estuaries. These models can be used to study project impacts on flows, sedimentation, constituent transport, and salinity. The model has been found well suited to perform hydrodynamic, salinity and sediment transport simulations for the river diversions in Louisiana, including the Breton Sound Estuary. We will integrate TABS-MD model with a simple nutrient-phytoplankton-zooplankton (N-P-Z) model that was developed within the framework of the PULSES project (Day et al. 2009). Within this proposed project, we will expand the PULSES model to include the include DIP and Si as potentially limiting factors. This will allow us to examine the implications of altered nutrient ratios on algal productivity.

Budget

1.tiff

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NGI-BP/GRI Phase I Project Summary

Title: Nutrient Dynamics and Primary Productivity in the Breton Sound Estuary as Impacted by the Gulf of Mexico Oil Spill.

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We have been carrying out a study of the water chemistry and phytoplankton response of the Breton Sound estuary, which receives Mississippi River water from the Caernarvon freshwater diversion. Monthly water quality transects have been conducted as part of a larger effort since August 2007, and as part of this study since August 2010. A flow-through system was used to map suspended sediments, chlorophyll a, salinity, and temperature in the major bayous and water bodies in the estuary. During each transect, discrete water samples were taken at about 16 fixed locations and later analyzed for nutrients (NOx, NH4, PO4, TN, TP), suspended sediment, chlorophyll a, and salinity.

In addition to monthly transects, two additional flow-through transects are planned for October and December 2010 that will collect discrete water samples for nutrient and hydrocarbon analysis along with measurements of the underwater light attenuation coefficient (Kd). We will measure phytoplankton production using the light, semi-shaded and dark bottle oxygen technique in a field incubator at several locations in the estuary, and extrapolate the results using data from the flow-through system to map basin wide productivity. We will use a linked hydrodynamic-biological 2-dimensional model to describe changes in nutrient cycling and phytoplankton productivity in response to riverine freshwater and nutrient inflows. Additional funding will be used to continue these water quality surveys and modeling analysis through 2011.