

Public Health, Stressors and Water Quality in Coastal Louisiana

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ABSTRACT

This project focuses on estuarine water quality and the changes that can result from increased nutrient loading, especially detrimental eutrophication, harmful algal blooms (HABs) and increased waterborne pathogens such as *Vibrio* sp. bacteria. The overall hypothesis is: *changing hydrologic regimes and nutrient loadings in coastal waters will impact ecosystem restoration and public health.*

Our research focus is on planktonic community structure and function, measuring POM composition, microbial respiration and algal growth rates along transects in two Louisiana estuaries, Barataria Bay and Breton Sound. These estuaries are targeted for restoration by increased inputs of Mississippi River water, and our research will help test effectiveness of the river restoration strategy. We are using diverse approaches that range from traditional analyses of water quality to real-time PCR.

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HYPOTHESES and OBJECTIVES

Hypotheses:

Inputs of Mississippi River water change both hydrologic regime and nutrient loading to the Breton Sound and Barataria Bay estuaries. We hypothesize that this bottom-up forcing changes structure and function of phytoplankton and microbial communities, creating fast-turnover dynamics under nutrient-rich, fast flow-through systems. River inputs also flush marshes during flood events and likely result in a more complex mixed system in the open waters sampled during transect work. We also hypothesize that the algal groups that will respond to eutrophication will differ between marine and fresh water portions of the estuarine systems (Table 1).

Table 1. Hypothesized effect of eutrophication and salinity on algal blooms.

Trophic Status	Fresh water	Marine	Both
Oligotrophic	mixed phytoplankton	mixed phytoplankton	low chlorophyll blooms infrequent, cover small area, short duration
Mesotrophic/ Eutrophic	diatom or Chlorophyte blooms	diatom blooms	increasing chlorophyll increasing blooms
Hypereutrophic	toxic and noxious colonial Cyanobacterial blooms	Dinoflagellate blooms and other HABs	high Chlorophyll blooms frequent, cover large area, long duration

Objectives:

The overall hypothesis of the proposed work is: *changing hydrologic regimes and nutrient loadings will impact ecosystem restoration and public health in coastal waters.*

We will test these ideas within the context of public health by focusing on aspects of planktonic community structure and function. Measurements of community biomass and turnover will provide estimates of estuarine function. Detailed work with microbial indicators, *Vibrio* and HABs will focus on community structure (Fig. 1).

The specific objectives and related approaches of this project are:

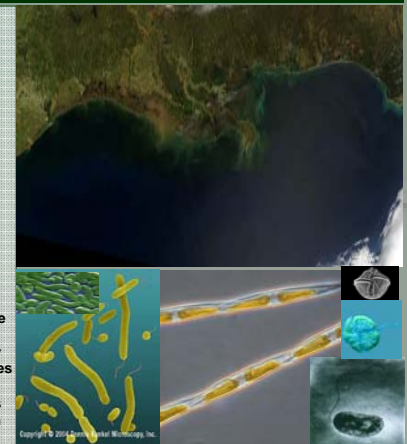
1. To quantify temporal and spatial dynamics of community biomass in the two e Louisiana estuaries, using POM samples collected from open waters during routine monthly transects;
2. To determine plankton community metrics, using fingerprint of microbial metabolites, nutrient bioassays (algae), respiratory demand (whole plankton community) and sediment records;
3. To routinely sample estuarine waters to quantify occurrence and abundance of harmful algal species, and also begin to quantify HAB toxicity using ELISA and HPLC;
4. To develop qPCR protocols to detect and quantify potentially pathogenic *Vibrio* species of interest in coastal waters and study the temporal and spatial dynamics of *Vibrio vulnificus* and *Vibrio parahaemolyticus* using both culturing and molecular methods;
5. To determine the impacts of physiochemical parameters (temperature, salinity, and nutrients in particular) on the development of microbial populations.

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REGIONAL INTEREST

The long-term consequences of eutrophication in estuaries may include reduced biodiversity, increased dominance of opportunistic species, and changes in material and energy flows. It has become increasingly apparent that these symptoms of eutrophication are not minor and localized, but have large-scale implications and are spreading. The estuaries and coastal waters of the northern Gulf of Mexico (GOM) are classic examples of these phenomena. Concerns for the Barataria and Breton Sound Estuaries targeted for "restoration" by increased inputs of Mississippi river water thus include possible eutrophication and hypoxia, probably in localized areas.

Eutrophication can also stimulate HABs and HAB toxin production. Phytoplankton toxins have been the subject of regional interest for many decades in the Gulf of Mexico. Clearly, large rivers like the Mississippi can have a significant impact on biological processes in the coastal zone and shifts in nutrients within estuaries may promote growth of potentially toxic algal species. Besides HABs, pathogenic *Vibrio* bacteria can also pose health risks in coastal systems. Infection by *Vibrio vulnificus* is one of the leading causes of seafood-related illnesses in the United States.



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JUSTIFICATION

Coastal ecosystems are highly dynamic systems, whose trophic conditions change in response to fresh water discharge, hydrologic forcing, seasonal changes in temperature and solar radiation, or pollution. On decadal and longer time scales, however, processes such as changes in sedimentation, land use in the watersheds, or climate, become increasingly important. Those long-term processes must also be taken into account if management strategies are to be effective in the decades to come. It is, therefore, unlikely that successful environmental management of estuarine systems will be accomplished using only simple, all-purpose indicators or analysis of single stressors. By developing integrative and model-based indicators of estuarine health and habitat sustainability, we can provide valuable research and management tools that could be used to tackle complex management questions.

Our group has a particular emphasis on water quality changes resulting from increased nutrient and sewerage loading.

Eutrophication is a prominent stressor in coastal systems, and is the manifestation of nutrient-enhanced aquatic primary productivity, and indicated by the presence of noxious phytoplankton blooms, bottom water hypoxia, pathogen accumulation, and wetland plant stress, and has been reported from a variety of estuarine and coastal environments (Rosenberg 1985; Andersson & Rydberg 1988).

The estuaries and coastal waters of the northern Gulf of Mexico (GOM) are classic examples of these eutrophication phenomena (USEPA 1999). The NOAA estuarine eutrophication survey (Bricker et al. 1999) reported periodic hypoxia (< 2 mg O₂ l⁻¹) in 31 of 37 GOM estuaries, and anoxia in 21 estuaries.

Concerns for the Barataria and Breton Sound Estuaries targeted for "restoration" by increased inputs of Mississippi river water thus include possible eutrophication and hypoxia in localized areas, as well as possible increased occurrence of HABs and toxigenic *Vibrio* spp.

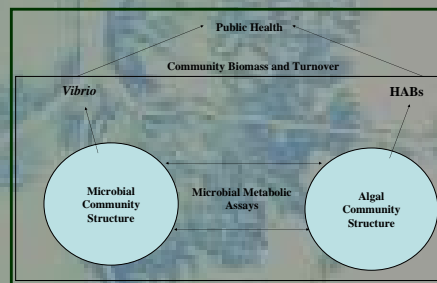


Figure 1: Conceptual diagram of structural and functional elements of water-column planktonic communities in the Delta environment, as related to public health.

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