Gulf of Mexico Alliance – Water Quality Team

A NETWORK OF AUTONOMOUS, IN-WATER SENSORS FOR WATER QUALITY BIOMONITORING IN THE GULF OF MEXICO

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PROJECT SUMMARY: The primary aim of this project is to establish a demonstration network of three Environmental Sample Processor (ESP) instruments located at strategic sites along the Florida Gulf Coast. A fourth core ESP (i.e., not deployable) will be used to continue developing tests to detect emerging targets of concern to Gulf water quality. Deployment sites have been selected to achieve the highest and most immediate impact on management decisions benefitting from early warning of biological threats to shellfish harvesting/consumption, recreational use of coastal waters, and other local tourist activities. These installations will serve as a foundation for the future build out of a wider ESP biomonitoring network to include other locations in the state of Florida and throughout the Gulf of Mexico and be integrated within the existing and planned infrastructure of the Gulf of Mexico Coastal Ocean Observing System (GCOOS). The ESPs will be coupled with (either physically or deployed in close proximity to) existing contextual sensors that currently monitor and report physical and chemical water quality characteristics as part of the GCOOS network, thereby effectively leveraging instrument assets and data streams contributed by a number of Gulf-based institutions.

NEED / STATEMENT OF WATER QUALITY ISSUES TO BE ADDRESSED: Gulf of Mexico water quality is threatened by many natural and human-induced biological phenomena with the potential to worsen under increasing pressures of coastal development for shelter, food, recreation, and commerce. Climate change impacts are also rapidly emerging concerns due to their effects on species' growth and geographic distribution. As an example of biological threats to water quality, blooms of the Florida Red Tide organism *Karenia brevis* can have catastrophic economic impacts on tourism and seafood industries resulting in millions of dollars in lost revenue. Pulmonary effects of these blooms on the sensitive (e.g., asthmatic) human population can cause acute suffering and medical costs. Another example is the widespread contamination of shellfish by bacterial pathogens (*Vibrio*), which can also result in human illness and economically devastating harvest closures. In addition, contamination of coastal waters by coliform bacteria (enterococci) frequently limits their recreational use due to public health concerns. Timely, accurate detection of microbial threats such as those identified above is critical to inform decisions made by coastal managers and regulatory officials to protect public health and to mitigate impacts on local/regional economies. Moreover, advanced detection capabilities are needed to improve our understanding of factors that regulate these biological phenomena, leading to better forecast methods used to support these important decisions.

BACKGROUND: The ESP is a robotic, electro-mechanical platform capable of autonomous, in-water detection of microbes and their metabolites via onboard sensors specific for such targets. The ESP can be deployed sub-surface or on a pier, and results of tests conducted remotely on the instrument are

available in real-time over the internet for further processing, evaluation, and incorporation into decision making processes. The ESP is a commercially available instrument sold by McLane Research Laboratories, Inc. (MRL; East Falmouth, MA), our primary corporate partner in this effort.

The ESP has been deployed successfully numerous times in California coastal waters and in the Gulf of Maine, and on pier-based stations in the Pacific Northwest. The main focus of these deployments has been detection of harmful algal bloom species and toxins, similar (but not identical) to the Florida Red Tide organism, *K. brevis* and its toxins. Bacterial pathogens and microbial water quality indicators have also been targeted successfully by the ESP. A patent for detection of enterococci for marine water quality monitoring was submitted recently by co-PI Paul. The biggest difference from previous deployments is the elevated ambient water temperature in the Gulf of Mexico, and therefore thermal stability of assay reagents will need to be validated – although some of the ESP sensors operate normally at temperatures well above expected water temperatures. There is thus a high level of confidence in the ESP's ability to perform as intended and generate the data streams required to support and inform critical management decisions.

PROJECT IMPLEMENTATION: Total project duration is four years. The ESP instrument is a mature technology, commercially available as a 'built-to-order' item from MRL. It is anticipated that fabrication of the three ESPs identified in this proposal will require 9 to 12 months for completion and delivery. During this time, team members will focus on 'bench testing' various components of the system, given that co-PI Doucette has a core ESP instrument on loan to his laboratory. This testing will include evaluating thermal stability of reagents, validating performance of the assay to detect *K. brevis* and it toxins (i.e., brevetoxins), and confirming accuracy/sensitivity of molecular methods to detect bacterial pathogens and microbial water quality indicators on the ESP.

Sites selected for location of the three fully-deployable ESPs, based on their high degree of relevance for our specific biological targets, include: Charlotte Harbor, an area of active shellfish harvesting in close proximity to waters with recurring *K. brevis* blooms; Cedar Key, a leading site for clam aquaculture and oyster harvesting subject to bacterial pathogen contamination; Panama City, a popular tourist destination included in the FL Healthy Beaches water quality monitoring program.

The initial capital investment to purchase the ESP instrumentation/mooring hardware/etc. and implement data acquisition/reduction/management is being absorbed by this project's budget. The primary costs associated with sustaining operation of this ESP biomonitoring network will be associated with the purchase of assay reagents and with the deployment/recovery/maintenance of instruments as required. It is anticipated that the Florida Dept. of Health and/or the Florida Dept. of Aquaculture and Consumer Services (FDACS) will operate and maintain these units beyond the project lifespan, based on successful implementation of the ESP network for generating real-time, actionable water quality monitoring data.

BENEFITS: Establishing this ESP-based biomonitoring network, as integrated within the existing and planned GCOOS infrastructure, has a number of clear community benefits for industries dependent on and influenced by coastal water quality and its effects on natural resources. The Florida Fish and Wildlife Conservation Commission (FWC; K. Hubbard, co-PI, contact) monitors *K. brevis* in Florida coastal waters and provides data to other state agencies to direct shellfish harvest closures and protect public health. The Shellfish Environmental Assessment Section (SEAS; J. Seagle, contact) under FDACS classifies and manages shellfish harvesting areas impacted by both red tides and bacterial pathogens. Florida Dept. of Health established the Healthy Beaches Program to monitor and report levels of the US EPA-recommended microbial water quality indicator, enterococci. Real-time, ESP-generated data streams for

K. brevis/ brevetoxin, bacterial pathogen, and enterococci levels represent a new and powerful tool to inform timely decision-making by these state regulatory agencies.

DELIVERABLES: The output will be real-time reporting of biological, physical, and chemical data for critical locations on Florida's Gulf Coast that supports the targeted RESTORE outcomes of restoring, improving, and protecting water resources, as well as improving science-based decision-making processes.

ESTIMATED PROJECT BUDGET:
Year 1
(cost of three, fully-deployable ESP units (with mooring hardware) = 3 x $393,800/unit =
(cost of one core ESP unit) = 1 x $238,000/unit) =
Non-ESP Operations costs = $785,000
Total for Year 1 = $ 1,419,400;

Year 2:
Operation costs = $785,000;

Year 3:
Operation costs = $785,000;

Year 4:
Operation costs = $785,000;

Total Project Cost: $4,559,400