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NCOOS/CSCOR'S REGIONAL ECOSYSTEM PREDICTION AND COASTAL HYPOXIA RESEARCH COMPETITION
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"The Hydrological Switch: A Novel Mechanism Explains Eutrophication and Acidification of Estuaries"

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Budget: Total 1,387,951 for three years, no ship costs required

ABSTRACT

Humans have had a significant influence on estuaries through land use change and increased use of fertilizers, causing proliferation of algal blooms, hypoxia, and presence of harmful microbes. Now, acidification due to myriad processes has been identified as a potential threat to many estuaries. In Texas estuaries for example, short-term acidification as a result of episodic hypoxia is a well-documented phenomenon. Unfortunately, a longer-term trend toward chronic acidification (decreasing alkalinity, pH) has now been observed. The alkalinity decrease is likely caused by a reduction in riverine alkalinity export due to precipitation declines under drought

conditions and freshwater diversions for human consumption. Significant human population growth and land use change has also occurred in Texas coastal watersheds, resulting in growing symptoms of eutrophication. Thus it is conceivable that multiple stressors could be coupled spatially or temporally in these systems, including dense algal blooms, hypoxia and acidification, with potential for direct (mortality) and indirect (reduced growth/reproductive output, increased disease prevalence) effects on estuarine organisms. With projected future ocean acidification scenarios, continuing freshwater shortages due to climate change, increased water diversions, and rapidly growing human populations in coastal watersheds, these estuaries will likely face more serious acidification risks and deteriorating ecosystem health.

Based on our existing long-term data, we hypothesize that hydrology acts as a switch, where increased river flows cause hypoxia and short-term acidification due to increased loads of organic matter, whereas prolonged low flows cause long-term acidification due to reduced loads of riverine alkalinity and calcification. In urbanized, wastewater-influenced systems, we hypothesize that reduced flows out of the watershed may lead to long-term acidification and chronic hypoxia due to reduced loads of riverine alkalinity and presence of low pH, high nutrient/organic matter wastewater.

To test our hypotheses, field and modeling studies are proposed to examine the relationships between estuarine acidification and other stressors (i.e., reduced freshwater inflow, hypoxia, and nutrient loading). Analysis of changes in ecosystem health and model calibration will be conducted based on long-term data collected by PIs Montagna and Hu. Mechanistic linkages between acidification, eutrophication and flow will be quantified through a field campaign by Wetz, Hu and Byrne. Chemical markers of organic matter sources fueling hypoxia will be determined PI Liu. Future ecological states of the estuaries will be predicted using ecosystem models (PIs Kim, Montagna) that account for projected changes in aforementioned parameters and ocean conditions based on IPCC estimates.

The combination of prediction and consequence will be useful to stakeholder groups such as the Coastal Bay & Estuaries Program (a National Estuary Program), and state agencies such as the Texas Commission for Environmental Quality (manages water supply and quality), Texas Parks and Wildlife Department (manages fisheries), and the Texas Water Development Board (manages water projects). In addition, results will inform water quality and nutrient reduction priority issue teams of the Gulf of Mexico Alliance as they develop plans to help improve water quality Gulf-wide. There are several connections to NOAA programs: 1) through the Environmental Cooperative Science Center (ECSC), which the HRI is a part of, and 2) through the NOAA, National Weather Service, National Centers for Environmental Prediction Environmental Modeling Center. This project will leverage ongoing NOAA-Sea Grant funded projects to Wetz and Hu, and Montagna, as well as the NOAA ECSC funding to Montagna.