NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

NOAA'S NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE
FY23 HARMFUL ALGAL BLOOM (HAB) AND HYPOXIA PROGRAM AWARDS

Coastal Hypoxia Research Program:
Synergistic effects of hypoxia and warming on zooplankton prey for higher trophic levels in coastal waters

Institutions: Virginia Institute of Marine Science, University of Maryland
Project Period: September 2023 - August 2026
Location: Virginia, Maryland
FY23 Funding: $212,581
Total Anticipated Funding: $692,741

Project Summary: Coastal hypoxia (i.e., low dissolved oxygen) is a rapidly expanding global issue with a wide range of ecosystem consequences. One of the main concerns is how hypoxia impacts fisheries given that most hold some combination of economical, historical, societal, and ecological importance. Hypoxia is known to directly impact fisheries species by reducing their ability to reproduce and recruit, shifting their migration patterns, and causing habitat squeeze. However, a major research gap is how indirect effects of hypoxia impact fisheries. This project focuses on how hypoxia impacts the availability of zooplankton productivity to other parts of ecosystems. Mesozooplankton, and especially copepods, serve as a key regulator in the transfer of production between primary producers (phytoplankton) and higher trophic level consumers (e.g., fishes). If hypoxia disrupts the amount of carbon being incorporated into copepod production, upper trophic levels are more likely to experience food limitation. This project will utilize laboratory and field experiments to investigate how coastal hypoxia alters copepod production, and thus food availability to higher trophic levels. Specifically, this project will quantify how coastal hypoxia impacts the transfer of primary production from phytoplankton up to and incorporation into zooplankton production. This research will improve our understanding of and ability to predict how hypoxia will affect management-relevant fisheries and ecosystems.

Coastal Hypoxia Research Program:
Biological Vulnerability to Hypoxia from Climate Warming and Eutrophication in the Northern Gulf of Mexico

Institutions: Louisiana State University, Princeton University, University of Louisiana Lafayette, U.S. Geological Survey
Project Period: September 2023 - August 2027

Location: Louisiana, Texas
FY23 Funding: $352,352
Total Anticipated Funding: $1,563,015

Project Summary: The hypoxic zone in the northern Gulf of Mexico (NGOM), triggered by eutrophication, continues to have widespread negative impacts on the marine ecosystem and species. The formation, evolution, and ecological impact of the hypoxic zone under current conditions are relatively well studied. However, the hypoxic zone under future conditions with the combined effect of climate warming, ocean deoxygenation, and eutrophication remains to be explored. Dissolved oxygen concentration of less than 2 mg/L is usually used to define environmental hypoxia but the impact of hypoxic stress on marine animals, i.e., physiological hypoxia, is controlled by both dissolved oxygen concentration and animal metabolic rate modulated by temperature. To better understand the impact of hypoxia on marine organisms of importance, this project will characterize the NGOM hypoxic zone under climate warming and eutrophication, develop and calibrate an ecophysiological framework for commercially and ecologically important species in the NGOM, and apply it to study temperature-dependent habitat shifts and contraction and body size shrink for those species in NGOM in the next three decades by mid-21st century. Finally, the project will engage coastal zone resource managers and policymakers to ensure the transition of research products to management.

Coastal Hypoxia Research Program:
Emerging hypoxia on the oligotrophic West Florida Shelf and its potential impacts on marine ecosystem: Discerning the roles of HABs, warming and extreme weather events

Institutions: University of Maryland, Mote Marine Laboratory
Project Period: September 2023 - August 2027
Location: Florida
FY23 Funding: $324,460
Total Anticipated Funding: $1,436,074

Project Summary: A recent analysis of water quality data on the West Florida Shelf (WFS) revealed that hypoxia was present in five of the 16 years examined and was likely related to large *Karenia brevis* blooms that were sustained throughout summer. The emerging hypoxia on the WFS represents a newly-identified mechanism for coastal hypoxia that is distinctly different from the well-known eutrophication- and upwelling-induced hypoxia. Climate change makes it easier for hypoxic conditions to develop by increasing stratification and reducing oxygen solubility. While much is unknown about the mechanisms driving the emerging hypoxia, there is little doubt that the combination of hypoxia, toxic *K. brevis* blooms, and warming oceans will multiply the stress and pressure on the marine species inhabiting the WFS, home to one of the Nation's most diverse and productive fisheries. The overarching goal of this project is to understand the physical and biogeochemical mechanisms driving this new type of hypoxia and determine whether climate change will facilitate hypoxia formation on nutrient-poor continental

shelves. Specific objectives include measurements to determine oxygen consumption due to decaying harmful algal blooms (HABs), development of models for hypoxia prediction, and development of habitat models that can assess the impacts of hypoxia and other related stressors on important fish species. Field experiments will be conducted to determine the relationships between the rate of dissolved oxygen change in the water column and particulate organic matter and bacterial and phytoplankton bloom concentration. The validated model will be used to conduct hindcast simulations to understand hypoxia formation during certain years and examine its connections to HABs, physical processes regulating stratification development, and other processes such as hurricanes and tropical storms. It will also be used to conduct scenario model runs to investigate how climate change might tip the WFS and other similar shelves from episodic hypoxia to persistent summer hypoxia. A habitat model will be developed to investigate how multi-stressors (especially, hypoxia, HABs, and warming) affect key fish species, particularly in important fishery habitat areas and marine protected areas.

Prevention, Control, and Mitigation of HABs:
Developing harmonized approaches to quantify and monitor DSP toxins in shellfish tissue

Institutions: Bigelow Laboratory for Ocean Sciences, U.S. Food and Drug Administration, Washington State Department of Health Public Health Laboratory, Maine Department of Marine Resources
Project Period: September 2023 - August 2025
Location: Maine, Maryland, Washington and California
FY23 Funding: $223,390
Total Anticipated Funding: $396,595

Project Summary: Diarrhetic shellfish poisoning (DSP) toxins produced by the dinoflagellate *Dinophysis* can cause severe gastrointestinal illness in humans. The threat of *Dinophysis* blooms and associated DSP toxins in shellfish tissue may be increasing around the North American coast. Past *Dinophysis* blooms have caused the closure of shellfish beds and temporary pauses on harvesting to ensure shellfish safety, resulting in substantial economic losses. Routine, accurate quantification of DSP toxins in shellfish tissue, integrated into a comprehensive state monitoring and fishery management framework under the National Shellfish Sanitation Program (NSSP), is essential for public safety. However, adoption of the current NSSP-approved methodology has been limited due to challenges related to method implementation and transferability – approaches often need adjustment to accommodate different instrument manufacturers and their configurations. The overarching aim of the project is to increase the number of laboratories nationwide that are able to provide accurate analytical quantification of DSP toxins to regulatory decision makers at the state and federal level using NSSP-approved methodology. The primary objective is to generate a harmonized standard operating protocol for the quantification of DSP toxins in shellfish that allows a broader range of instrument configurations and analytical procedures than the current method, while maintaining sufficiently high quality control criteria to be adopted into the NSSP for broad regulatory use.

Prevention, Control, and Mitigation of HABs:
Validation of rapid lab-based brevetoxin aptamer assay prototypes

Institutions: Mote Marine Laboratory
Project Period: September 2023 - August 2025
Location: Florida
FY23 Funding: $244,426
Total Anticipated Funding: $454,926

Project Summary: Florida's red tide, a harmful algal bloom caused by the dinoflagellate *Karenia brevis,* produces neurotoxins that can accumulate in shellfish and lead to neurotoxic shellfish poisoning (NSP) in humans. The increasing frequency and duration of Gulf of Mexico shellfish farm closures due to toxic red tides have severely damaged southwest Florida's shellfish industry and reduced the availability of shellfish for consumers. In order to thrive, the industry needs innovative technology for NSP toxin detection that would correlate with existing seafood safety regulatory protocols. Rapid, cost-effective biotoxin detection methods can mitigate the severe consequences of HABs on the shellfish industry and reduce the financial and administrative burdens of managing shellfish harvesting and distribution during red tide blooms. This project aims to advance new methods for NSP toxin measurement in seafood. There are currently two National Shellfish Sanitation Program (NSSP) methods for NSP toxin detection in shellfish – the mouse bioassay (MBA), and an enzyme-linked immunosorbent assay (ELISA) – which are slow and labor-intensive, and limited in their application, respectively. This project will evaluate two recently developed prototypes – a fluorescence aptamer assay (FAA), and an enzyme-linked aptasorbent assay (ELASA) – to determine their viability as alternatives for detecting NSP toxins in shellfish.

Prevention, Control, and Mitigation of HABs:
Advancing the use of the receptor binding assay to multispecies monitoring for paralytic shellfish poisoning

Institutions: Washington State Department of Health Public Health Laboratory, Sitka Tribe of Alaska, NOAA National Centers for Coastal Ocean Science
Project Period: September 2023 - August 2025
Location: Washington, Alaska
FY23 Funding: $191,024
Total Anticipated Funding: $392,075

Project Summary: Paralytic shellfish toxins (PSTs) are potent neurotoxins that cause paralytic shellfish poisoning (PSP) in fish, birds and mammals including humans. Commercial shellfish are routinely tested for PSTs using National Shellfish Sanitation Program (NSSP)-approved

regulatory methods. The receptor binding assay (RBA) is a rapid, cost-effective test that is approved as an alternative method to the mouse bioassay for PSTs in mussels. Currently, the RBA is used by the Sitka Tribe of Alaska Environmental Research Laboratory (STAERL) for testing non-commercial shellfish. To extend the potential use of the RBA for shellfish regulatory applications, RBA method validation studies must be conducted for other shellfish species. The goal of this proposal is to expand the species of shellfish approved under this method. The Washington State Department of Health Public Health Laboratory and the National Centers for Coastal Ocean Science will partner with STAERL to conduct a series of shellfish matrix extension studies, and findings will be submitted to the Interstate Shellfish Sanitation Conference (ISSC) for evaluation.

Monitoring and Event Response for HABs: *Developing an operational Sargassum HAB monitoring and forecasting system for the US southeastern and Caribbean waters*

Institutions: University of South Florida, Florida Atlantic University, Caribbean Coastal Ocean Observing System, US Virgin Islands Department of Planning and Natural Resources, NOAA Atlantic Oceanographic and Meteorological Laboratory
Project Period: September 2023 - August 2028
Location: Florida, Puerto Rico, US Virgin Islands
FY23 Funding: $648,636
Total Anticipated Funding: $3,224,393

Project Summary: Coastal communities in the southeastern US and Caribbean have been plagued by increasingly severe inundations of floating macroalgae (*Sargassum* sp.). These inundation or beaching events are considered harmful algal blooms and can have devastating impacts on coastal ecosystems and economies. This project will improve existing *Sargassum* detection and forecasting technologies; facilitate a better understanding of biochemical impacts associated with inundation or beaching; and foster the autonomous delivery of timely delivery of accurate forecasts and warning. The project team will produce delineated, daily *Sargassum* distribution maps at coarse-to-fine spatial scales. Forecast trajectories will be computed for each *Sargassum* patch identified and estimates of biochemical impacts will be determined when inundation is predicted or observed. Improved forecast and warnings will be autonomously integrated across several distribution platforms, allowing users free access to these data passively (e.g., web distribution) or actively through customized alerts. The project directly involves managers and engages an advisory group to help guide the research product development. Improved alerts will give communities in Florida, Puerto Rico, the US Virgin Islands and the wider Caribbean more time to mobilize responses and minimize the harm caused by *Sargassum* inundation events.

Monitoring and Event Response for HABs:
Early warning for amnesic shellfish poisoning in the Gulf of Maine through real time in situ characterization of upstream phytoplankton blooms

Institutions: Woods Hole Oceanographic Institution, Florida Fish and Wildlife Commission, Bigelow Laboratory for Ocean Sciences, and Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS)
Project Period: September 2023 - August 2028
Location: Maine
FY23 Funding: $550,125
Total Anticipated Funding: $2,999,457

Project Summary: Highly productive shellfisheries in the northeast US continue to be challenged by toxic blooms of certain species of the marine diatom *Pseudo-nitzschia* (PN) which first emerged as a management concern in 2012. Certain PN species can produce domoic acid, a potent neurotoxin. Domoic acid can accumulate in shellfish that feed on PN, and can lead to amnesic shellfish poisoning (ASP) in people who eat tainted shellfish. Regional shellfish agencies have adopted monitoring protocols to maintain seafood safety but a lack of advanced warning can lead to costly, precautionary closures of large harvest areas. This project will identify the underlying drivers of ASP emergence on the Maine coast. The project will track toxic PN blooms as they develop offshore and track bloom progress as they move across US-Canada maritime boundary and toward Maine coastal shellfish beds. The team will track blooms with Imaging FlowCytobot\autonomous surface vessel (IFCB\ASV) mobile platforms. Data from IFCB-ASV systems will be telemetered to shore by satellite and made publicly accessible alongside remote sensing products and numerical model simulations of bloom transport. Detection of significant blooms entering the Gulf of Maine will trigger charter vessel-based, event driven intensive sampling cruises to determine toxicity and species composition. The project will also establish co-deployments of IFCB and Environmental Sample Processor (ESP) sensors at three stations along the Maine coast to expand an existing HAB observation network for New England (HABON-NE), including two in Downeast Maine and one in Western Maine. These shore stations will track the evolution and toxicity of PN as blooms are transported west into New Hampshire and Massachusetts waters. All sources of HAB monitoring information will be made available in real-time through an open-source, interactive data access and visualization portal called HABhub. All HABhub data layers, including new remote sensing and numerical model visualizations, will be built to ingest standard data formats, facilitating adoption of HABhub data sharing by other US regions.

Monitoring and Event Response for HABs:
Employing a novel molecular toolbox for rapid sensitive detection of toxic Pseudo-nitzschia species

Institutions: Gloucester Marine Genomics Institute, Florida Fish and Wildlife Research Institute, Bigelow Laboratory for Ocean Sciences
Project Period: September 2023 - August 2026
Location: Maine, Florida
FY23 Funding: $239,384
Total Anticipated Funding: $815,297

Project Summary: Toxin production can vary across strains of the same algal species. For example, more than species of the marine diatom *Pseudo-nitzschia* have been identified, but only certain species of *Pseudo-nitzschia* produce domoic acid, a potent neurotoxin. Having cost effective and accurate methods to determine if toxin-producing *Pseudo-nitzschia* species are present is a critical need for agencies working to mitigate bloom impacts. Domoic acid can accumulate in shellfish prompting human health and marine ecosystem concerns for fishery managers in the Gulf of Maine and Florida. This targeted project will enhance existing *Pseudo-nitzschia* monitoring efforts with molecular, genetic-based assays. The team will evaluate existing diagnostic tests including a Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-based (SHERLOCK) assay and qPCR-based assays to identify optimal methods for accurate, rapid, cost-effective, sensitive, and portable molecular detection of toxigenic species and in-field estimates of HAB risks by managers and community scientists. Collaborations with Maine Department of Marine Resources, the New Hampshire Department of Environmental Services, the Massachusetts Division of Marine Fisheries, and Florida's Department of Agriculture and Consumer Services and Fish and Wildlife Conservation Commission will allow the team to test new methods with field samples, tailor methods to fit end-user needs, and speed integration of improved approaches into state HAB monitoring and response programs. The project will create and maintain a field sample database and a curated online sample library. It will also tie-in to existing Maine Environmental DNA (eDNA) project and IFCB user networks to promote data sharing, develop protocols and create a communications toolkit in partnership with NERACOOS.

Monitoring and Event Response for HABs:
New technologies and a coordination framework for an Integrated HAB detection and monitoring system across the San Francisco estuary

Institutions: San Francisco Estuary Institute, U.S. Geological Survey California Water Science Center, California Department of Water Resources, University of California Santa Cruz, Central Valley Regional Water Quality Control Board, San Francisco Regional Water Quality Control Board, Bend Genetics, LLC
Project Period: September 2023 - August 2029

Location: California
FY23 Funding: $789,390
Total Anticipated Funding: $3,005,377

Project Summary: The goal of this project is to improve monitoring and response to harmful blooms (of both marine and freshwater species) and a suite of algal toxins they produce which have been documented throughout the San Francisco Estuary (SFE), spanning from the upper estuary to the San Francisco Bay. The project team will develop a cost-effective robust system-wide HAB monitoring program, identify optimal sites for routine monitoring and foster improved coordination among SFE management entities. This project will advance remote sensing applications for HAB detection and response, molecular DNA-based toxin detection, and broaden community HAB monitoring efforts. An Estuary HAB dashboard will integrate all existing and new data facilitating improved understanding and better decision-making. Key knowledge gaps about the transport of freshwater and marine HAB cells (multiple taxa) and toxins (microcystin, saxitoxin, domoic acid) will be addressed by the team using dock and boat-based water grabs, passive in water sampling devices, shellfish and molecular tools. An advisory group with representatives from the San Francisco Water Board, Bay Area Clean Water Association, Baykeeper, State Water Board, CA Dept. of Fish and Wildlife, NOAA Fisheries, Central Valley Water Board, CA Dept. of Water Resources, Delta Stewardship Council, and Restore the Delta will help facilitate transition of research findings to application and build sustainable support for the piloted system-wide HAB monitoring program.

Monitoring and Event Response for HABs:
HABs in the Kodiak Archipelago: HAB Monitoring and toxin testing to support community subsistence harvesting and forecast model development

Institutions: University of Alaska Fairbanks, Kodiak Area Native Association, NCCOS HAB Forecasting – Beaufort Laboratory, SeaTox Research, Inc.
Project Period: September 2023 - August 2029
Location: Alaska
FY23 Funding: $254,484
Total Anticipated Funding: $1,524,109

Project Summary: Subsistence harvesting of seafood is a major focus of food resources and cultural practices among the Native villages in Alaska's Kodiak Archipelago, but food security is threatened by recurrent blooms of toxic *Alexandrium* and *Pseudo-nitzschia* species. Similarly, these blooms are a major obstacle to the developing Kodiak mariculture industry. This targeted project will develop increased capacity for monitoring harmful algal blooms and their toxins in Kodiak coastal waters. Monitoring locations will be established at traditional harvesting sites along the Kodiak Road system and data will be shared to help mitigate HAB impacts on rural and Native communities in the City of Kodiak and greater Chiniak Bay area including those of the Sun'aq Tribe of Kodiak, the Native Village of Afognak and the Tangirnaq Native Village, and

a significant number of Filipino-Americans. Coordination and information sharing between communities will be strengthened by building on established Alaska Sea Grant (ASG) and the Kodiak Area Native Association (KANA) efforts and with local education and training opportunities. The project will establish a laboratory in Kodiak providing capacity to test shellfish and seawater samples for algal toxins. It will also advance the development of lab-based quantitative molecular methods such as quantitative polymerase chain reaction (qPCR) testing for more rapid, accurate detection of *Alexandrium* cells and cysts. Capabilities for running lab-based enzyme-linked immunosorbent assay (ELISA) tests will enable better detection of saxitoxins. The team will continue efforts to map *Alexandrium* cyst distributions in local waters to identify where future blooms may occur and support efforts to develop and validate an *Alexandrium* HAB forecast model for Kodiak, Alaska. The team will leverage partnerships with the Knik Tribe of Alaska and with a private company developing improved algal toxin tests.

Monitoring and Event Response for HABs: *Developing a monitoring and forecast system for Margalefidinium polykrikoides and Alexandrium monilatum in the lower Chesapeake Bay*

Institutions: Old Dominion University, Virginia Institute of Marine Science, Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS)
Project Period: September 2023 - August 2028
Location: Virginia
FY23 Funding: $593,107
Total Anticipated Funding: $2,997,251

Project Summary: In the lower Chesapeake Bay region, annual blooms of two harmful algal species, *Margalefidinium polykrikoides* and *Alexandrium monilatum,* have been linked to shellfish and fish kills, eutrophication and regional oxygen depletion (hypoxia/anoxia). These blooms disrupt oyster aquaculture and bay restoration, degrade coastal ecosystem quality, and can impact local tourism and recreation. This project will pilot a regional monitoring and response network that incorporates a diverse suite of measurements to expand our understanding of the geographic and temporal distribution of HAB species in the region. This information will help inform predictive models that will enable the delivery of HAB forecasts to inform decisions by shellfish growers, state and regional managers, and other stakeholders. Engagement and training of scientists, growers and citizens on the use of PlanktoScope, a high-resolution digital microscope designed for professional and citizen scientists, will add new phytoplankton image data to existing HAB monitoring efforts. Improved spatial and temporal monitoring data will enable the team to validate remote sensing and in situ sensor observations and support efforts to develop and refine HAB now-cast and forecasts for the region. Data and forecasts will be accessible via the Chesapeake Bay Environmental Forecasting System (CBEFS) and Mid-Atlantic Regional Association Coastal Ocean Observing System portals. This effort will also help advance NCCOS operational HAB forecasting and observing goals for the region.

Monitoring and Event Response for HABs:
Expansion of our anatoxin-a monitoring methods to include new and additional congeners

Institutions: State University of New York College of Environmental Science and Forestry, National Research Council Canada
Project Period: September 2023 - August 2026
Location: New York, Michigan, and Canada
FY23 Funding: $565,447
Total Anticipated Funding: $849,878

Project Summary: Cyanobacteria naturally produce toxins. The most commonly found cyanotoxins found in the U.S. are microcystins, cylindrospermopsin, anatoxins and saxitoxins. Many states have robust monitoring programs which are strongly focused on microcystins, a potent liver toxin. While these are widespread, increasingly other species and their toxins are being reported in the Great Lakes. For example, *Anabaena* and *Aphanizomenon* are cyanobacteria known to produce anatoxins. Variants of anatoxin can cause respiratory paralysis and have been associated with dog, livestock, and wildlife fatalities. A lack of robust detection methods has resulted in a lack of monitoring programs focused on anatoxins. Currently, only one anatoxin variant is measured using the approved U.S. Environmental Protection Agency (EPA) method 545; anatoxin-a (ATX). This can lead to under-estimates of the total cyanotoxicity in a freshwater body and complicate the accurate assessment of cyanoHAB risks to humans and wildlife. This project will develop peer-validated, certified reference materials and standards for several anatoxin variants including anatoxin-a (ATX), homoanatoxin-a (HTX), and their derivatives. The team project will communicate all results to state agencies, produce a published peer-reviewed method validation helping ensure compatibility across different laboratories, and will share the new method with the EPA to encourage upgrading method 545 to include new anatoxin variants. A partnership with the National Research Council Canada will enable the team to provide standards for general distribution in Canada and abroad.

Regional Ecosystem Research Program:
Characterizing and forecasting coastal ecosystem responses to multiple stressors for management applications in South Florida

Institutions: University of Miami, NOAA's Atlantic Oceanographic and Meteorological Laboratory, Florida Fish and Wildlife Research Institute, Northern Gulf Institute, Southeast Coastal Ocean Observing Regional Association, University of South Florida, Virginia Institute of Marine Science
Project Period: September 2023 - August 2027
Location: Florida
FY23 Funding: $499,983
Total Anticipated Funding: $2,023,053

Project Summary: South Florida's coastal and marine ecosystems provide critical ecosystem services to the Nation, generating billions of dollars for the economy and tens of thousands of jobs annually. The well-being of over six million people in coastal counties depend on these ecosystems, which are beset by multiple stressors and global climate change. This project addresses these multiple interacting stressors (i.e., ocean acidification, hypoxia, harmful algal blooms, increasing water temperatures, and eutrophication) and their varying concentrations across South Florida's ecosystems from the West Florida Shelf to the Florida Keys National Marine Sanctuary. It investigates how they are impacting/will impact ecosystems under present and future climate change scenarios, and different management/restoration strategies under Mission: Iconic Reefs and the Comprehensive Everglades Restoration Plan.

Congressionally Directed Spending:
Examining the influence of discharges on coastal ecosystems health and HAB dynamics - Kimberly's Reef case study

Recipient: Florida Gulf Coast University
Requested by: Rep. Byron Donalds
Location: Florida
FY23 Funding: $440,000

Project Summary: The project will conduct an intensive study of the effects of Caloosahatchee River discharges on coastal water quality and bottom habitats, including impacts of harmful algal blooms, nutrient loading, and low salinity on local fishes, sponges, and shellfish. This study will use a new approach, with emphasis on a newly deployed artificial reef structure (i.e. Kimberly's Reef) that serves as grounds for recreational, charter, and commercial fishing. The approach will couple hydrodynamic monitoring with benthic nutrient flux estimates and water surveys that focus on both biological (fishes, shellfishes, and algae) and chemical (nutrients and algal toxins) aspects of the ecosystem. This integrated approach will better characterize the effects of river discharges on offshore resources. In turn, this will improve our understanding of how changes in salinity and nutrient loading combine to impact water column and benthic ecosystems, and will help managers better identify maximum nutrient loading targets. This project will benefit stakeholders that utilize coastal resources (e.g., fishing and diving) and will provide experiential learning opportunities for Florida Gulf Coast University students. Additionally, it will generate valuable data to assess the resiliency of coastal ecosystems to discharges from the Caloosahatchee and related harmful algal bloom impacts.