NCCOS FY20 HARMFUL ALGAL BLOOM PROGRAM AWARDS

PCMHAB: Harmful Algal Bloom Community Technology Accelerator

Institutions: Southern California Coastal Ocean Observing System/University of California San Diego/Scripps Institution of Oceanography, Axiom Data Science LLC, Woods Hole Oceanographic Institution, University of California Santa Cruz, Central and Northern California Ocean Observing System

Project Period: September 2020 - August 2023

Location: California

FY20 Funding: $399,998

Total Funding: $1,193,561

Project Summary: Harmful Algal Blooms (HABs) are persistent threats to coastal resources, local economies, and human and animal health throughout U.S. waters. HABs are expected to intensify and/or expand in range as oceans change in response to anthropogenic climate change. There is an immediate need for more effective strategies to monitor and communicate the risk of algal toxins to human and ecosystem health in U.S. waters. The overarching goal of this project is to establish a California regional hub for harmful algal bloom (HAB) data, technology and knowledge transfer, and then expand or export these technological tools to other regions on a national scale. Expanding this framework will promote harmonized data feeds and management-relevant products across the community-at-large. To accomplish this, this project set objectives that scale the effort from primarily the Imaging FlowCytobot in California, to a flexible integrated system capable of supporting regional and national efforts.

PCMHAB: DinoSHIELD: A slow-release natural algicide produced by *Shewanella* sp. IRI-160 for management of red-tide

Institutions: The University of Delaware, NOAA National Centers for Coastal Ocean Science, U.S. Army Corps of Engineers/ Engineer Research and Development Center-Environmental Laboratory

Project Period: September 2020 - August 2025

Location: Delaware and Florida

FY20 Funding: $241,550

Total Funding: $2,299,855

Project Summary: Blooms of the harmful dinoflagellate Karenia brevis are known to occur regularly in the Gulf of Mexico and present a human health threat as they produce potent neurotoxins. Toxic blooms in Florida have negative effects on the economies of coastal communities, often costing millions of dollars in lost revenue, with impacts extending over hundreds of square miles. The overall goals of the project are to optimize delivery of the algicide from slow-release alginate hydrogels containing the immobilized algicidal bacteria (Shewanella sp. IRI-160) as a “mini in-situ bioreactor”; and demonstrate the utility of this technology for continuous red-tide management. Field studies will be performed initially in Delaware via in-situ mesocosm experiments and scaled-up for demonstration in small, protected embayments in Florida, already considered impaired due to blooms of Karenia spp. This work will provide managers with knowledge of applications/uses of naturally derived algicide as an environmentally neutral approach to prevent and/or mitigate dinoflagellate blooms.

PCMHAB: Rapid, portable, multiplexed detection of harmful algal toxins in the Great Lakes

Institutions: MBio Diagnostics, Bowling Green State University, State University of New York

Project Period: September 2020 - August 2023

Location: Ohio

FY20 Funding: $347,939

Total Funding: $947,647

Project Summary: Harmful algal blooms (HABs) are a significant threat to fresh waters globally. Cyanobacterial HABs (CHABs) contribute to more than $2 billion in annual economic losses and the estimated annual cost of CHABs in western Lake Erie alone exceeds $65 million. CHABs necessitate routine testing to protect humans from exposure to contaminated drinking and recreational waters and for forecasting and modeling. Since toxin profiles change spatially and temporally there is significant need for rapid tests that can provide real-time, local answers. Current technology enables portable, multiplexed detection of toxins and has been demonstrated in a commercially available duplex microcystin/cylindrospermopsins panel. This work will expand this toxin testing panel to include tests for saxitoxins and anatoxin. To date there are no commercially available portable freshwater tests for saxitoxin, and there is no 4-plex test available for freshwater cyanotoxins. This tool will be a valuable asset to water managers and community-based monitoring networks as they will have the ability to rapidly quantify the aforementioned cyanotoxins using this user-friendly platform.

PCMHAB: Validation of a triplex test for saxitoxin, domoic acid, and okadaic acid measured in shellfish tissue from New England and the Pacific Northwest

Institutions: MBio Diagnostics, Bigelow Laboratory for Ocean Sciences, NOAA National Centers for Coastal Ocean Science

Project Period: September 2020 - August 2023

Location: New England, Pacific Northwest

FY20 Funding: $164,078

Total Funding: $878,514

Project Summary: Shellfish aquaculture is a large and growing US industry due to customer demand and because shellfish are environmentally friendly, easy to seed, and immobile, making them an ideal aquaculture product. US sales exceed $260M annually, and this number is expected to rise due to the significant advantages of expanding this economic sector. However, shellfish can accumulate toxins produced by harmful algal blooms (HABs) potentially making them unsafe for human consumption. The project team will conduct a single laboratory validation study seeking the Interstate Shellfish Sanitation Conference's acceptance of MBio's triplex assay for the simultaneous detection of paralytic shellfish poisoning, amnesic shellfish poisoning, and diarrhetic shellfish poisoning toxins in mussels. A simple, low-cost detection method for concurrent determination of three toxin classes in a single sample analysis will reduce the testing burden on the aquaculture industry while maintaining the safety of the nation's food supply and contributing to NOAA's targeted enhancement of the American Blue Economy.

PCMHAB: Using Microcystin Degrading Bacteria and their Enzymes for Water Treatment

Institutions: University of Toledo

Project Period: September 2020 - August 2023

Location: Ohio

FY20 Funding: $336,391

Total Funding: $1,052,383

Project Summary: Cyanobacterial harmful algal blooms (HABs) occur in eutrophic waters across the world and are characterized by large aggregations of naturally-occurring photosynthetic bacteria that release cyanotoxins. A variety of cyanobacteria, including *Microcystis* and *Planktothrix*, are known to release microcystins, which threaten human health. Municipal water treatment facilities have a number of treatment processes at their disposal to treat contaminated waters, including chlorination, powdered activated charcoal, and ozonation. However, these treatment processes are expensive and generate waste products/byproducts that require additional treatment processes to mitigate. This project will develop and test the ability for already identified toxin degrading bacteria to degrade toxins from water treatment facilities. Toxin degrading bacteria in biofilters and/or microcystin degrading enzymes could reduce water treatment costs, provide safe alternatives to conventional water treatment processes, and could provide point-of-use (i.e., small scale) water treatment methods to remove microcystins from contaminated water supplies.

HABSOCIO: Evaluation of mitigation strategies for harmful algal blooms in the West Coast Dungeness crab fishery

Institutions: Oregon State University, University of Washington, NOAA Northwest Fisheries Science Center, University of California at Davis

Project Period: September 2020 - August 2024

Location: Washington, Oregon, California

FY20 Funding: $292,826

Total Funding: $1,173,193

Project Summary: The Dungeness crab fishery is the most valuable fishery on the US West Coast. Concentrations of domoic acid in crab following harmful algal blooms (HABs) can close areas to commercial and recreational crabbing. Recently HAB events have caused lengthy delays to the start of the commercial season, generating what are believed to be large economic losses and triggering federal fishery disaster assistance. Little is known about the relative economic merits of different potential mitigation strategies. This project will analyze the potential effects of alternative mitigation strategies for HAB impacts on the West Coast Dungeness crab fishery. The primary focus is on regulatory approaches that are flexible and can increase opportunities for the industry amid HAB events while ensuring food safety for consumers. Allowing for the harvest and sale of eviscerated crab is one such mitigation policy. Since domoic acid in crab tends to be concentrated in the viscera, primarily in the hepatopancreas, eviscerating crab before they are cooked and consumed can make contaminated crab safe to eat.

HABSOCIO: Value of the SoundToxins partnership: an early warning system for HABs in Puget Sound

Institutions: Washington Sea Grant, NOAA Northwest Fisheries Science Center, Washington Department of Health

Project Period: September 2020 - August 2023

Location: Washington

FY20 Funding: $79,951

Total Funding: $279,926

Project Summary: Washington State is a national leader in farmed bivalve shellfish, with an industry that employs more than 3,200 people in family wage jobs and contributes an estimated $270 million to the economy. The SoundToxins partnership was established in 2006 as a cost-effective monitoring program to provide an early warning of harmful algal

bloom (HAB) events through weekly phytoplankton monitoring. The benefits of the SoundToxins partnership to managers include helping the Washington Department of Health prioritize analysis of shellfish samples to areas identified as having the greatest HAB risk (through HAB cell counts), preventing product recall by providing alerts to the Washington Department of Health via the 24/7 communication system, and assisting shellfish growers and managers in avoiding costs associated with HAB events by allowing selective harvest, early harvest and depuration of toxic shellfish prior to harvest. This project will estimate the net economic benefits of the HAB early warnings provided by SoundToxins and evaluate net economic benefits to recreational shellfish harvesters.

HABSOCIO: Value of the Pacific Northwest HAB Forecast

Institutions: Woods Hole Oceanographic Institution, University of Washington, Washington State Department of Fish and Wildlife, Oregon Department of Fish and Wildlife

Project Period: September 2020 - August 2023

Location: Pacific Northwest

FY20 Funding: $299,948

Total Funding: $899,896

Project Summary: Along the Washington and Oregon coasts, razor clam and Dungeness crab fisheries have been adversely impacted by marine algae that produce the toxin domoic acid. The razor clam fishery is the largest recreational bivalve shellfish fishery in the region and a major source of tourist-related income to small communities along the coast. The Pacific Northwest (PNW) Harmful Algal Blooms (HAB) Bulletin is a forecasting tool that provides information to managers to facilitate their decisions to open and close the shellfisheries, including implementing delayed openings, selective harvests at “safe” beaches, and increasing harvest limits. This project will estimate the economic benefits of the PNW HAB Bulletin, using a methodology for quantifying the value of information.

HABSOCIO: Assessing Societal Impacts of Harmful Macroalgae Blooms in the Caribbean

Institutions: University of Rhode Island and Woods Hole Oceanographic Institution

Project Period: September 2020 - August 2023

Location: U.S. Virgin Islands, Puerto Rico

FY20 Funding: $318,292

Total Funding: $838,137

Project Summary: In recent years, the number, distribution, and magnitude of macroalgal blooms have increased globally, with consequent impacts on coastal system resilience that have led many to consider them a new type of natural disaster. This is particularly true in the Caribbean and Gulf of Mexico regions, where blooms of free-floating *Sargassum spp.* are resulting in pelagic, nearshore, and onshore accumulations that have become an increasingly persistent and severe nuisance since first appearing in 2011. Management responses to these HAB events vary considerably from place to place. Response techniques can include the erection of floating interception barriers, development of removal technologies in nearshore waters, varying intensities of manual and mechanical removal of beached macroalgae, and transport and disposal of removed biomass, often to unlined landfills or illegal dump sites. This study will use a mixed methods approach to examine how *Sargassum* events and their mitigation in the Caribbean affect multiple dimensions of social resilience, including economic impacts, human wellbeing, local ecological knowledge, and individual attitudes, values, and behaviors.

MERHAB: Implementing *Karenia brevis* Respiratory Risk Forecast System in the Gulf of Mexico

Institutions: Gulf Coast Ocean Observing System, NOAA NCCOS, FL Fish and Wildlife Research Institute, Texas A&M University

Project Period: September 2020 - August 2023

Location: Florida and Gulf of Mexico

FY20 Funding: $99,100

Total Funding: $653,960

Project Summary: The nearly annual blooms of *Karenia brevis* in the Gulf of Mexico adversely impact human and animal health and cause significant economic losses. *K. brevis* blooms can produce a suite of potent neurotoxins called brevetoxins. Brevetoxins can become aerosolized, resulting in a significant risk to people with chronic respiratory illnesses such as asthma, and results in substantial irritation to other people. The goal of this project is to substantially reduce the public impact of *K. brevis* blooms by providing a capability for daily monitoring and three hour forecasting of these blooms at the level of individual beaches. This project extends current work done under a NASA funded project, which developed an inexpensive microscope system, called the HABscope, which allows volunteers to collect samples and take videos from individual beaches daily. These videos are uploaded and processed within minutes to estimate cell counts, then combined with high resolution wind speed and direction to predict respiratory risk at individual beaches. This project will establish a network that incorporates state monitoring partners and citizen scientists to enhance monitoring, show the reliability of HABscope, and determine the lower limit of detection. Once refined and fully operational, GCOOS will permanently operate the respiratory forecast.

ECOHAB: Trophic Transfer and Effect of HAB Toxins in Alaskan Marine Food Webs

Institutions: NOAA Northwest Fisheries Science Center, Woods Hole Oceanographic Institution, NOAA Alaska Fisheries Science Center, NOAA National Centers for Coastal Ocean Science, Florida Fish and Wildlife Research Institute, Alaska Veterinary Pathology Services, Sitka Tribe of Alaska, Alaska Sea Grant, University of Alaska Fairbanks, North Slope Borough, United States Geological Survey

Project Period: September 2020 - August 2025

Location: Alaska

FY20 Funding: $1,460,870

Total Funding: $4,989,708

Project Summary: Harmful algal blooms (HABs) and associated toxins are present in Alaskan waters. Paralytic shellfish toxins, produced by *Alexandrium* spp., and domoic acid, produced by *Pseudo-nitzschia* spp., can cause illness or death in humans or marine wildlife when ingested. These toxins have been detected in this region in commercially valuable shellfish and finfish, and subsistence-harvested marine mammals including seals, walruses, sea lions, and whales. Detailed data on the distribution and prevalence of harmful algal blooms (HABs) in Arctic and Subarctic waters are limited. The project team will determine species composition and cell densities of *Alexandrium* and *Pseudo-nitzschia*; establish toxin transfer pathways to zooplankton, shellfish, finfish, and marine mammals, and evaluate potential risks to human health. The overall goal of the project is to develop quantitative models for trophic transfer and impacts of HAB toxins in Arctic and Subarctic food webs using empirical data on the abundance *Pseudo-nitzschia* and *Alexandrium* species, toxin levels in different species at multiple trophic levels, and health assessments and behavioral observation data for marine mammals and fish.