FLORIDA'S HARMFUL ALGAL BLOOM TASK FORCE: PART OF A FRAMEWORK TO ADDRESS ALGAL BLOOMS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Florida faces a large and growing number of challenges arising from recurring and novel harmful algal blooms (HABs). Key challenges include predicting, tracking, managing, and mitigating harmful blooms. An initial response was the creation of a Florida Harmful Algal Bloom Task Force (HABTF) in 1997, which was charged under Florida Statute in 1999 to "determine research and monitoring priorities and control and mitigation strategies and make recommendations" to the Florida Fish and Wildlife Conservation Commission (FWC). In response to the severe 2017-2019 Karenia brevis bloom, the HABTF was reconvened. Additional components of a statewide framework were added, including the FWC Center for Red Tide Research (CRTR), a Red Tide Mitigation and Technology Development Initiative funded by a new statute, and a Blue-Green Algae Task Force. Concurrent and often interactive efforts have led to >25 projects developed from HABTF recommendations and funded through HABTF grants and the CRTR; workshops and HABTF meetings that initiated a Florida HAB observing network and brought together HAB experts as outlined by state statute; and formation of working groups targeting communication, public health, and response by managers. Products from the current HABTF include consensus documents that provide recommendations and summarize progress (2020, 2021, and in preparation), an updated Resource Guide for Public Health Response to HABs in Florida, plans for inter-agency responses to blooms, enhanced field observations and models, and numerous public-facing communication and risk tools guided by social science research and co-created with end-users. The HABTF continues to evaluate existing approaches and knowledge, pinpoint gaps in our efforts and understanding, and build a prioritized portfolio of strategies and actions to fill those gaps by assessing their benefits and feasibility.

SPEAKER: **Meghan Abbott, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute | Gwyneth.Abbott@MyFWC.com**

SPEAKER BIO: Meghan Abbott is an Associate Research Scientist with the Florida Fish and Wildlife Conservation Commission (FWC), Fish and Wildlife Research Institute's Harmful Algal Bloom (HAB) Research Group. She has a Bachelor in Biological and Mathematical Sciences, a Master of Public Health with special focus in Environmental Sciences and HABs, and a Master of Library and Information Science. Meghan coordinated the Florida Harmful Algal Bloom Task Force's Public Health Technical Panel (2006-2009) and currently coordinates the Florida Harmful Algal Bloom Task Force since its reactivation in 2019. She has led the development of various collaborative initiatives to realize priority recommendations for the Task Force. Through the FWC Center for Red Tide Research this includes elements of statewide cooperative programs for Karenia brevis red tide monitoring and research, education and outreach, and management and public health response.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

NEUROLOGICAL EFFECTS OF AEROSOLIZED RED TIDE NEUROTOXINS

SESSION: PUBLIC HEALTH

ABSTRACT: Harmful algal blooms (HAB) negatively impact aquatic ecosystems and the health of coastal communities. Among HAB, the Florida red tide bloom organism, Karenia (K.) brevis, releases brevetoxins (a neurotoxin), which cause respiratory irritations and negatively affect human pulmonary health. Human consumption of brevetoxin is shown to cause Neurotoxic Shellfish Poisoning (NSP), which includes a wide range of neurological symptoms. However, whether exposure to aerosolized brevetoxin can cause NSP-like (NSPL) symptoms remains unknown. We, therefore, investigated possible associations between the presence of K. brevis in coastal waters and the reporting of upper respiratory tract (URT) and NSPL symptoms by southwest Florida residents. A surrogate brevetoxin exposure (SBE) index was generated for estimating exposure to aerosolized brevetoxin based on the established relationship between K. brevis cell count in the coastal waters and subsequent aerosolization of brevetoxin. Data from self-reporting of past medical history (PMH) and medical symptoms were collected from participants (n = 258) between June 2019 to August 2021. A dose-response relationship was observed for SBE with URT and NSPL symptoms and headaches. Reporting of NSPL symptoms was higher among participants who reported PMH of migraines and chronic fatigue syndrome. Blood samples from this cohort showed the presence of antibodies against brevetoxins, and their levels were associated with NSPL symptoms and influenced by the SBE dose. These findings suggest further investigations into identifying thresholds of aerosolized brevetoxin dose required to elicit NSPL symptoms to address public health safety concerns, particularly among vulnerable individuals with preexisting neurological conditions.

SPEAKER: **Laila Abdullah, Roskamp Institute | labdullah@roskampinstitute.org**

SPEAKER BIO: I am a senior research Scientist in Neuroscience at the Roskamp Institute. The goal of my research is to study the health impact of environmental toxins, including Brevetoxin, the major toxin found in Red Tides along the Florida Coast. I evaluate and understand the significant neurological health risks to East Coast communities experiencing Red Tide outbreaks.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

NUTRIENT DISTURBANCES AND HARMFUL ALGAL BLOOMS IN THE NORTH AMERICAN GREAT LAKES – LAKE SUPERIOR, LAKE MICHIGAN, AND LAKE ERIE

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: An increase in anthropogenic nutrient loading is considered one of the drivers of frequent toxic cyanobacterial algal blooms (CHABs) that impact certain areas of the Laurentian Great Lakes. This two-year-long research investigates the interaction of nutrients (nitrate, ammonia, urea, and phosphorus) and elevated temperature in promoting CHABs and production of cyanotoxins in the three different Great Lakes bodies - Mawikwe Bay in Lake Superior, Sandusky Bay in Lake Erie, and Green Bay in Lake Michigan. Incubated bioassays of water samples from the lakes were spiked with nitrogen species and/or phosphate. Samples were analyzed for changes in algal biomass using a Fluoroprobe and toxins using Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS). The dominant toxins detected across all three lakes were the Microcystin (MC) congeners, cyanopeptolins, and anabaenopeptins (Apt) congeners. The samples spiked with the N-rich nutrients at an elevated temperature showed higher concentrations of cyanotoxins than samples spiked with P-rich nutrients in Green Bay bioassays. The quantitated cyanotoxins were MC (0.3-5.55 µg/L), cyanopeptolins (0-16.28 µg/L), and Apt (0–3.5 µg/L). For Sandusky Bay, the response of the toxins altered from a higher concentration at a P-rich spike to a higher concentration at N-rich spikes in the two years of sampling. The two abundant cyanotoxins detected in Sandusky Bay bioassays were MC (0-0.43 µg /L) and Apt (0-27.05 µg/L). There was also a detection of cyanotoxins in the bioassay of Lake Superior in 2023, 0.09 µg/L MC-LW and 0.068 µg/L Apt-A. This study points to the variability of the lake in cyanotoxin production in response to the same nutrient depending on the year and season of the blooms. The impact of nutrients in CHABs and cyanotoxin concludes that the nutrients and increasing temperature impact algal growth and cyanotoxin production in the Great Lakes region, even in the pristine freshwater bodies – Lake Superior.

SPEAKER: **Anjana Adhikari, University of Wisconsin-Milwaukee | adhikar8@uwm.edu**

SPEAKER BIO: I am currently in the second year of my doctoral studies in the Environmental Health Sciences, and I am particularly interested in aquatic toxin chemistry related to algal blooms in the freshwater water system and the factors promoting their frequent occurrences of freshwater harmful algal blooms (HABs). My current research involves studying and analyzing toxins using tandem mass spectrometry of the Great Lakes -Lake Erie, Lake Michigan, and Lake Superior. I am also involved in a similar study with a rural community in Tenmile Lakes in Oregon.

CO-AUTHORS:
Todd R Miller

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ASSESSING THE EFFECT OF GLOBAL WARMING AT A FISH CAGE CULTURE IN EPE LAGOON NIGERIA.

SESSION: Poster Session, Wednesday

ABSTRACT: Globally and nationally, the effect of the global warming trends and the current 2023-24 El Nino event is causing increasing cases of heat waves and heat strokes leading to warnings and lockdowns in different regions of the world. This phenomenon have become a global environmental concern with detrimental consequences to human health and the ecosystems at large. The culture of fish in lagoons has assisted in skills acquisition, empowerment, and food security. The physicochemical nature of water at each time is essential and determines the type and survival of farmed fishes. The incidences of fish mortalities from within fish cages installed in the Epe lagoon were reported. A mixed research method was adopted through the collection of water and plankton samples as well as comments from residents and observational realities from six locations, especially from an aquatic and integrated environmental management point of view. The results revealed a freshwater ecosystem with very low brackish water influence from the adjoining Lagos lagoon and estimates largely confirming previous studies in the area. Notably, the water and air temperatures deviated from the norm and increased sharply during the day. This was also confirmed by residents of the area as well as the excessive mats of water hyacinth that further acted as a blanket for the trapped heat that remarkably exacerbated the heat stress situation. Additionally, based on the tidal cycle for the region, dredging activities are further exonerated, as they are always downstream for more than half of every day. The excessive heat could have led to the fish mortalities. There is a need to develop home-grown adaptive strategies for the implications of climate change-related events in aquaculture concerns in coastal areas and lagoons. These will assist largely as the issues that caused the fish mortalities are still very present in the region.

SPEAKER: **Raimot Akanmu, Lagos State University, Ojo Lagos Nigeria | titipopoola@gmail.com**

SPEAKER BIO: Dr. Raimot Titilade AKANMU holds a Bachelor degree in Fisheries, a Master's degree in Marine Pollution and Management and a doctorate in Marine Biology with a Specialization in Marine ecology and conservation, Sustainability of environmental resources and management; and Climate change impact on the marine resource. Her doctoral thesis centred on nutrient and elemental characterization of phytoplankton biodiversity in the Atlantic Ocean, Lagos. She is currently a Research Fellow at the Centre for Environmental Studies and Sustainable Development, Lagos State University.
Her articles are published in both Environmental and Biological science related Journals. Her current research is centred on assessing environmental variables in coastal waters of Nigeria for decision-making on climate change and sea level rise. She is a member of the Nigerian Environmental Society, Fisheries Society of Nigeria and Phycological Society of Nigeria.

https://scholar.google.com/citations?user=3vPnYtQAAAAJ

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

USE OF BAYESIAN NETWORKS FOR SHORT-TERM CHABS PREDICTION

SESSION: PREDICTIVE MODELING - FRESHWATER

ABSTRACT: Available indicators of cyanobacteria harmful algal bloom (cHAB) potential and status vary in spatial and temporal scope as well as ease and cost of application. A Bayesian Network modeling approach has been applied to make short-term predictions of HABs status in a southwestern Ohio. The study site, William H. Harsha Reservior, (aka Lake Harsha) is a reservoir used for flood control, recreation and as a source of drinking water, and has a history of cyanobacteria HAB events. The modeling effort used data collected from 2015 through 2019. Several predictor variables were investigated including discretely sampled nutrient species, phytoplankton taxonomy, and chlorophyll, as well as metrics sampled at a higher temporal frequency, including dissolved oxygen, temperature, pH, specific conductivity, chlorophyll and phycocyanin fluorescence, turbidity, oxidation-reduction potential, meteorological variables, and hydrology measures. The Bayesian model under investigation is a discrete model to predict, three days into the future, cHAB status based on the exceedance of a threshold value of phycocyanin fluorescence. The model was generated by comparing water quality parameters to the one-day time shifted phycocyanin fluorescence, resulting in a one-day ahead prediction. To achieve the effective three-day prediction, submodels were used to estimate future water quality variable states two days into the future, which then were used to update the main model. To validate the forecast model, a year-by-year holdout strategy was used, in which model training used four of the five years of data with validation testing on the withheld year for all yearly combinations. The models have shown to correctly predict the next-day HAB status with > 90% accuracy and estimated trend three-day HAB status with 83-90% accuracy. A description and assessment of these results will be provided.

SPEAKER: **Joel Allen, US EPA | allen.joel@epa.gov**

SPEAKER BIO: M.S. and Ph.D. in Environmental Science: The University of North Texas
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

DISCERNING THE THERMAL TRAITS OF MARINE HARMFUL ALGAL SPECIES FROM BLOOM EVENTS

SESSION: BLOOM DYNAMICS & DRIVERS III

ABSTRACT: Marine harmful algal blooms (HABs) pose a significant economic burden and public health concern for U.S. coastal regions. To aid state agencies with HAB monitoring and mitigation, HAB forecasting models, which often incorporate species traits, are implemented to predict bloom occurrence. However, HAB species are diverse, each characterized by unique life cycles and physiologies which make them difficult to predict. For HAB species of principal concern in U.S. coastal waters (n=31), we performed a meta-analysis of 565 HAB events in North America, totaling >3,000 weeks, and correlated each event with temperature at time of occurrence to discern whether HAB events followed distinct trends. Our results suggest thermal preferences can be discerned from the natural environment, with temperature preferences characterized for 24 HAB species (14 previously uncharacterized). For some species, HAB event occurrences were closely related to experimental estimates of the species' thermal optima (Topt), the temperature that produces maximal growth, yet for other species, HAB events occurred at temperatures well below the Topt, suggesting analyses of HAB events could better constrain critical temperature thresholds in HAB forecasting models. Additionally, we find that the probability of a HAB event occurring in any region is substantially higher as temperatures approach these thermal preferences, which may allow state agencies to better target their monitoring efforts. With these data, we aim to construct a trait database characterizing bloom dynamics for several HAB species, increasing our collective ability to predict future HAB events.

SPEAKER: **Stephanie Anderson, US EPA | anderson.stephanie@epa.gov**

SPEAKER BIO: Stephanie Anderson is a biologist at the U.S. Environmental Protection Agency where her research focuses on marine phytoplankton, including harmful algal bloom (HAB) species. She employs trait-based approaches to better understand phytoplankton community responses to environmental stressors.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ARE WE MISSING THE AIRBORNE TOXIC FRACTION OF COASTAL DINOFLAGELLATE BLOOMS IN CALIFORNIA?

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The earliest documented cases of intoxication through inhalation during marine microalgal blooms date back to the early 2000s during Karenia brevis outbreaks in Florida. The respiratory distress observed during those blooms has been naturally attributed to airborne brevetoxins that can travel over several kilometers in the air. However, recent toxicological work suggests that at environmental concentrations, the bioavailability of airborne phycotoxins may be alleviated by the complexity of the sea spray aerosol matrix. To investigate the role of airborne yessotoxin analogs in triggering the inflammation of human respiratory tracts during red tide blooms of Lingulodinium polyedra, human macrophage cells were exposed to environmental chemical extracts obtained from an unprecedented bloom in Southern California in 2020 that resulted in a mass mortality event of fish and invertebrates. Dinoflagellate chemical diversity was further investigated to gain insights into the complexities revealed by the results of the macrophage assay. Over the course of the bloom, the dinoflagellate metabolism switched from an upregulation of sulfated zwiterrionic metabolites to nitrogen ones, enabling us to propose a suite of processes during Lingulodinium polyedra blooms that may present a risk to both human and wildlife health.

SPEAKER: **Clarissa Anderson, Scripps Institution of Oceanography | clrander@ucsd.edu**

SPEAKER BIO: Clarissa Anderson is a biological oceanographer with expertise in ecological forecasting and remote sensing. Her research has focused on the prediction of harmful algal blooms and toxins in estuarine and coastal ecosystems as well as the fate and transport of harmful toxins to deeper waters and sediments. Clarissa is now at Scripps Institution of Oceanography serving as the Executive Director of the Southern California Coastal Ocean Observing System (SCCOOS) and the Director of the NOAA Cooperative Institute for Marine, Earth, and Atmospheric Systems (CIMEAS). She continues to conduct research on phytoplankton ecology in coastal California. She is Chair of the IOC-SCOR GlobalHAB Scientific Steering Committee, Co-Chair of the National HAB Committee, Co-Chair of the National HAB Observing Network Community of Practice, and a member of the UN Decade Programme on Observing Air-Sea Interactions Strategy (OASIS), U.S. CLIVAR Working Group on Coastal Climate Solutions, and the Science Advisory Team for the CA Ocean Protection Council (OPC).

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ADVANCING A NATIONAL FRAMEWORK FOR HARMFUL ALGAL BLOOM MONITORING AND FORECASTING

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Amidst the growing concern over Harmful Algal Blooms (HABs), the necessity for a robust national forecasting and monitoring system is becoming increasingly evident. Currently, as part of the NOAA National Centers for Coastal Ocean Science HAB efforts we provide displays of satellite imagery and model forecasts for several regions. While this provides useful information to stakeholders, the current system lacks the adaptability or flexibility required to fulfill our goal of providing nationwide data. Thus, our approach aims to develop a more informative and interactive map that provides data rapidly and effectively. By leveraging the Esri ArcGIS Maps SDK for JavaScript, this project seeks to enhance the accessibility of real-time HAB monitoring and forecasting, ultimately unifying these efforts alongside other data sources into a centralized platform. This effort not only bridges the gap between scientific information and stakeholder engagement, it fosters greater collaboration and knowledge sharing among stakeholders. Demonstrated through the Lake Erie satellite product, this system represents a significant stride in our capacity to promote transparency and information, empowering stakeholders to make informed decisions to proactively address the ecological and socioeconomic impacts of HABs.

SPEAKER: **Kristin Anderson, NOAA NCCOS | kristin.anderson@noaa.gov**

SPEAKER BIO: Kristin is a dedicated environmental scientist specializing in the development of geospatial products for the NOAA National Centers for Coastal Ocean Science (NCCOS). Her current focus is on creating innovative tools and applications for harmful algal bloom (HAB) monitoring and forecasting. Her work involves the integration of satellite and field data into user-friendly, dynamic mapping applications that support decision-making processes in ecosystem management.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE HARMFUL ALGAL BLOOM DATA ASSEMBLY CENTER: A NATIONAL CYBERINFRASTRUCTURE FRAMEWORK FOR PLANKTON IMAGERY

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES II

ABSTRACT: In the last decade, several novel sensors and methods for monitoring and predicting a diversity of harmful algal bloom (HAB) events have emerged for real-time detection. These include the Imaging FlowCytobot (IFCB), a robotic microscope that delivers high-resolution phytoplankton imagery every hour. A National HAB Data Assembly Center (HABDAC) was developed to build national capacity to accelerate research to operations for HAB technologies and monitoring efforts so they can be better integrated into management tools, monitoring, and predictive frameworks, while also providing standardization of data collection, processing, interpretation, and archive. Specifically, the HABDAC provides a centralized location for existing HAB data products, provides cyberinfrastructure for processing near real-time imagery and sampling feeds, hosts a common code repository for machine learning models and training data sets, and provides data science and data management support to research teams producing information products. Given the long-running HABMAP, the California Harmful Algae Risk Mapping (C-HARM) predictive system, and 12 operational IFCBs in the integrated HAB early warning system, the prototype region is California with recent build out to the Northeast Shelf and the Salish Sea. Daily alerts are now being issued to CA State managers from the HABDAC. Ultimately, the cyberinfrastructure developed to support imagery data processing and product development will form the backbone for advanced ecological forecasting and HAB data management.

SPEAKER: **Clarissa Anderson, Scripps Institution of Oceanography | clrander@ucsd.edu**

SPEAKER BIO: Clarissa Anderson is a biological oceanographer with expertise in ecological forecasting and remote sensing. Her research has focused on the prediction of harmful algal blooms and toxins in estuarine and coastal ecosystems as well as the fate and transport of harmful toxins to deeper waters and sediments. Clarissa is now at Scripps Institution of Oceanography serving as the Executive Director of the Southern California Coastal Ocean Observing System (SCCOOS) and the Director of the NOAA Cooperative Institute for Marine, Earth, and Atmospheric Systems (CIMEAS). She continues to conduct research on phytoplankton ecology in coastal California. She is Chair of the IOC-SCOR GlobalHAB Scientific Steering Committee, Co-Chair of the National HAB Committee, Co-Chair of the National HAB Observing Network Community of Practice, and a member of the UN Decade Programme on Observing Air-Sea Interactions Strategy (OASIS), U.S. CLIVAR Working Group on Coastal Climate Solutions, and the Science Advisory Team for the CA Ocean Protection Council (OPC).

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IN SITU IMPACTS OF MODIFIED CLAY ON KARENIA BREVIS CELL CONCENTRATIONS, WATER QUALITY, AND MICROBIAL COMMUNITIES

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: In Florida, blooms of the toxic marine algae Karenia brevis are a common disturbance with widespread ecological impacts. To address this problem, mitigation techniques are being developed to reduce cells and toxins in order to minimize the effects of an ongoing bloom. Clay-based compounds are one of the most widely studied mitigation techniques and have been applied on a large scale in natural waters in China and Korea, and are now being investigated for use in the United States. In this study, a PAC-modified clay was investigated within large scale in situ mesocosms (limnocorrals) in Sarasota Bay, an area frequently impacted by K. brevis blooms. This study looked at the effects of clay treatment on the physical and chemical properties of ambient waters and the microbial community during a naturally occurring K. brevis bloom. Water samples for cell counts, eDNA metabarcoding of the microbial community, physico-chemical parameters (pH, salinity, temperature, dissolved oxygen, chlorophyll a), and nutrients (dissolved, particulate, and carbonate chemistry) were collected at sampling periods of 0, 4, 24, and 48 hours following clay application.Cell concentrations ranged from 37,000 - 60,000 cells/L in control limnocorrals for the duration of the study. In treated limnocorrals , cell concentrations were reduced by 60% after 4 hours and 100% for succeeding sampling periods. pH values were significantly lower in limnocorrals with clay ($p=0.0000000006944$). Dissolved oxygen decreased over time in all limnocorrals, and was significantly lower in limnocorrals with clay ($p=0.000209$). Alkalinity and inorganic carbon decreased immediately after application and were significantly lower 4 hours after clay application ($p=0.021$ and $p=0.043$ respectively), but returned to ambient levels after 24 hours and onwards. Data for eDNA metabarcoding will be presented in the conference.

SPEAKER: **John Kristoffer Andres, University of Central Florida | johnkristoffer.andres@ucf.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

WHAT NUCLEIC ACID MOLECULES DOES A SANDWICH HYBRIDIZATION ASSAY MEASURE IN CYANOBACTERIAL CELL HOMOGENATES?

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: Freshwater harmful algal blooms (fHABs) are largely caused by overgrowths of photosynthetic cyanobacteria. Several cyanobacterial genera produce toxic compounds that deteriorate water quality and threaten human health. Rapid detection and accurate abundance estimation of cyanobacteria are critical because they provide essential information and strategic guidance for site-specific fHAB mitigating. As a molecular tool, the sandwich hybridization assay (SHA) is used to identify and quantify fHABs-associated cyanobacteria. In a typical SHA, a biotinylated capture DNA probe (immobilized to a streptavidin-coated solid support surface) hybridizes with target nucleic acids. A signal probe then hybridizes to this nucleic acid-capture probe hybrid to produce a quantifiable signal proportional to the amount of captured target nucleic acids. However, when we applied the SHA to RNA isolated from cyanobacterial cells, we failed to detect reproducible signals even after extensive protocol modifications, including the use of microplates or magnetic beads as the solid support, RNA defragmentation, and colorimetric or fluorescent methods for signal detection. Then we used denatured genomic DNA, cDNA reverse-transcribed from cyanobacterial RNA, and 16S rRNA gene amplicons (from cDNA) as the template and performed the SHA reaction with both antisense and sense genus-specific capture/signal probes designed to target the cyanobacterial 16S rRNA gene. Both colorimetric and fluorescent assay results indicate that (1) RNA did not hybridize with either antisense or sense probes, (2) denatured genomic DNA hybridized with antisense probes only, and (3) cDNA and 16S amplicon hybridized with sense probes only. These lines of evidence led us to conclude that DNA probes in the SHA assay cannot hybridize with RNA, and the signal detected with cell homogenates or lysates were derived from hybridization with denatured genomic DNA released from lysed cells. Our findings underscore the importance of understanding what nucleic acid targets the SHA detects to ensure accurate interpretation of assay results.

SPEAKER: **Anna Antrim, US ACE ERDC | Anna.K.Antrim@erdc.dren.mil**

SPEAKER BIO: Anna Kathryn Antrim is a Research Biologist at US Army Engineer Research and Development Center located in Vicksburg, Mississippi. She received her B.S. in Research Biology from Mississippi College in Clinton, Mississippi. Her current research interests focus on rapid monitoring and mitigation of harmful algal blooms in freshwater using molecular techniques.

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U.S. National Office for Harmful Algal Blooms

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US HAB-CTI - A NATIONAL PROGRAM TO ACCELERATE THE DEVELOPMENT AND APPLICATION OF HAB CONTROL TECHNOLOGIES

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: State and federal agencies along with stakeholder partners are actively engaged in addressing the factors that cause Harmful Algal Blooms (HABs). However, those prevention efforts may take decades before intended outcomes are achieved. We need strategies to control HABs immediately when they form, to reduce health and socio-economic impacts. The United States Harmful Algal Bloom Control Technology Incubator (US HAB-CTI) is a partnership between National Oceanic and Atmospheric Administration, University of Maryland Center for Environmental Science - Institute of Marine and Environmental Technology and the Mote Marine Laboratory, to streamline the vetting process of novel HAB control ideas. The US HAB-CTI is a source of funding, research equipment, and regulatory guidance to accelerate the development and application of control technologies. The incubator funds small, short term projects of freshwater and marine HAB control technologies still in the initial stages of research. This allows more control tools to be tested for their potential to be 1. effective, 2. scalable, 3. feasible, and 4. economical. Additionally, US HAB-CTI is developing a clearinghouse website to provide guidance to end users and stakeholders on navigating the relevant licensing and permitting processes, and environmental compliance requirements that apply to both potential and existing technologies.

SPEAKER: **Taylor Armstrong, University of Maryland Center for Environmental Science - Institute of Marine and Environmental Technology | tarmstrong@umces.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

IMPACT OF HARMFUL ALGAL TOXINS YESSOTOXINS, PECTENOTOXINS, AND AZASPIRACIDS ON LARVAL BIVALVES: EFFECTS ON MORTALITY, GROWTH, AND METAMORPHOSIS RATES

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: Bivalve populations along the East and West coasts of the United States have experienced substantial declines in both harvest and abundance over recent decades. While these declines have been attributed to various environmental stressors, emerging marine harmful algal blooms (HABs) and their associated toxins now present new threats to recreational, subsistence, and commercial shellfisheries. In this study, 8-day-old Crassostrea virginica pediveliger larvae were subjected to environmentally relevant concentrations of purified toxins, including yessotoxin (YTX), pectenotoxin-2 (PTX2), and azaspiracids (AZA1). The exposure experiments were conducted in 1-liter glass jars containing 500 mL of filtered seawater, with a larval density of 10 larvae/mL. Larvae were provided with a non-toxic diet of Pavlova pinguis. Mortality was assessed through microscopy after 48 hours of toxin exposure. Significant mortalities were observed in larvae exposed to AZA1 (95 ± 7%) and PTX2 (34 ± 4%) at the highest concentration (1 nM), compared to the control treatment (17 ± 2%), while no significant mortalities were observed at lower concentrations (0.01 and 0.1 nM). Furthermore, exposure to YTX did not result in significant mortalities (20-24%) at any of the tested concentrations. Given the occurrence of AZAs (i.e. 1, 2, and 59), YTXs and PTXs in coastal regions during late spring and summer—coinciding with natural spawning and early developmental stages—these toxins pose additional threat to the survival and restoration efforts of these bivalve species. Future experimental steps aim to evaluate individual and combined toxin exposures on additional bivalve species (C. gigas, Mytilus edulis, and Mercenaria mercenaria) during later larval stages, assessing impacts on survival, growth, clearance, and metamorphosis rates to settled juveniles. Furthermore, examining lower concentrations of AZA1 and exploring the toxicity of alternative AZA analogs (2 and 59) will help determine toxicity thresholds for these bivalve organisms.

SPEAKER: **Nour Ayache, Virginia Institute of Marine Science (VIMS) | nayache@vims.edu**

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CO2 DEPRIVATION DELAYED THE PRODUCTION OF CYANOPHAGES AND LYSIS OF INFECTED CYANOBACTERIA

SESSION: ECOPHYSIOLOGY & BIOGEOCHEMISTRY

ABSTRACT: The phototrophic organisms fix carbon dioxide to build sugar in the Calvin-Benson-Bassham (CBB) cycle. It has been proposed that cyanophages block the CBB cycle of the host cyanobacteria to fulfill their requirements for nucleotides and other metabolic necessities. During this process, the ATP and NADPH produced in the light reaction are redirected for the nucleotide biosynthesis of the cyanophages. Several studies have shown that an intrinsically disordered small protein, CP12, is produced in higher plants, algae, and also expressed by cyanophages to block the CBB cycle. CP12 binds to phosphoribulokinase and glyceraldehyde 3-phosphate dehydrogenase, key enzymes in the CBB cycle, thereby inhibiting CO2 fixation. Despite previous reports on the potential role of CP12, its impact on phage production still remains elusive.

To elucidate the impact of CBB cycle inhibition on cyanophage production and ultimate host cell lysis, we inhibited phosphoribulokinase using glycolaldehyde. It was observed that the inhibition delayed the maturation of cyanophages and host cell lysis. Cyanophages independently control host cell metabolic processes for the production of new cyanophage particles, indicating that a healthy host cyanobacterial cell is crucial for successful cyanophage infection and replication. Under CO2 starvation of the host cell, cyanophages delay the lytic cycle until the full maturation of their particles, with the extent of this delay depending on the degree of CO2 starvation. Our findings indicate that while CP12 is not required for cyanophage biosynthesis, an unblocked CBB cycle is necessary for proper metabolite availability for both host cyanobacteria and cyanophages. This study is the first to demonstrate that continuous supply of all nutrients and their utilization in host cell metabolic pathways are vital for biosynthesis of cyanophage particles.

SPEAKER: **Syed Lal Badshah, Indiana University | sbadshah@iu.edu**

SPEAKER BIO: Postdoc researcher working on cyanoHABs.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

HARMFUL ALGAL BLOOMS AS A BIG DATA PROBLEM

SESSION: BLOOM DYNAMICS & DRIVERS I

ABSTRACT: Harmful algal blooms (HABs) pose several types of emergent threats to ecosystems and economies. They are mostly known for causing unsightly and foul smelling biofilms in lakes, rivers and oceans. In many cases, toxins are released, killing pets and making freshwater unfit to drink. Several efforts have been made around the world, to track physical, chemical and biological parameters in environmental quality assessments. The results of these studies suggest that climate change and anthropogenic factors such as pollution have a large role in shaping the dynamics and toxicity of blooms. With the advent of next generation sequencing, biomolecular characterization has become more common and allows for a deeper understanding of the complex physiology of aquatic communities associated with HABs. The holistic analysis of physical and chemical data in the context of this deepened physiological knowledge presents an interesting big data problem.
We argue that this big data problem has been crystallized at the right time, given remarkable advances in computing power and artificial intelligence (AI). In order to maximize the impact of high computing power and AI, it is important to formulate the right problem. We present a meta-analysis of existing digital data on HABs spanning 4 geological scales of spatial scale and and temporal resolution, highlighting where knowledge gaps exist. We also suggest ways to improve future data collection, that can significantly better leverage the power of artificial intelligence and more effectively mitigate HABs.

SPEAKER: **Shounak Banerjee, Los Alamos National Laboratory | baners4@lanl.gov**

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DEVELOPMENT OF A QUANTITATIVE PCR ASSAY FOR THE DETECTION OF AMOEBOPHYRA PARASITES IN ALEXANDRIUM CATENELLA RESTING CYSTS

SESSION: BENTHIC HABS

ABSTRACT: Dinoflagellate endoparasitoids in the genus Amoebophyra infect a broad range of free-living marine dinoflagellates and can play an important role in harmful algal bloom dynamics. In the Nauset Marsh, species commonly infect annually recurrent blooms of Alexandrium catenella, a HAB species that can cause paralytic shell-fish poisoning (PSP). Infection prevalence in this host can reach as high as ~80% during bloom termination and new cyst production. Apparent host specificity suggests that the Amoebophyra are highly dependent on A. catenella for their persistence in the system. Further, the timing of infection spread suggests that they use a co-encystment strategy for survival during long periods when A. catenella are absent from the water column.

In this study, the presence of Amoebophyra DNA in Alexandrium resting cysts was confirmed using a TaqMan-based PCR assay. Primers capable of distinguishing dinoflagellate host from parasite DNA amplified a ~ 160 bp region of the 18S rDNA gene. To better understand, the average load of parasite in infected Alexandrium cysts, the assay was applied to a series of sediment dilutions to estimate infection prevalence more precisely by most probable number (MPN). Comparison of MPN results against a plasmid standard curve was then used to determine that the parasite rDNA copies per host cyst was generally fewer than 5 copies. This result was then used to examine variability in infection prevalence among A. catenella cysts collected from sites throughout Nauset and neighboring Pleasant Bay. Results suggest substantial variability in these populations relative risk (or susceptibility) to Amoebophyra.

SPEAKER: **David Beaudoin, Woods Hole Oceanographic Institution | dbeaudoin@whoi.edu**

SPEAKER BIO: David Beaudoin is a Research Associate in the Biology Department at the Woods Hole Oceanographic Institution in Woods Hole, MA. He is broadly interested in marine microbial ecology topics, including microbial adaptaion to micro-oxic conditions, symbiosis, and harmful algal blooms. David also manages the Enivronmental Sample Processor (ESP) lab at WHOI which is currently focused on monitoring seasonal occurences of the neurotoxin domoic acid in the Gulf of Maine. He received a B.S. degree in Zoology from the University of Rhode Island and an M.S. degree in Microbiology from the University of Maine.

CO-AUTHORS:
Nate Spada, Mike Brosnahan

SECRETS HIDDEN IN FISH SLIME: EVIDENCE OF MICROBIAL RESPONSE TO ALGAL BLOOMS IN FISH MUCUS

SESSION: MICROBIAL INTERACTIONS

ABSTRACT: In the Great Lakes, nuisance algal blooms are predominantly caused by cyanobacteria, which can stress freshwater organisms through the release of toxins and alteration of water quality and habitat. Previous studies have linked environmental disturbance to shifts in microbial communities in fish mucus. The mucus coat on the surface of fish is a microbe-rich, protective barrier between the fish and their environment, making this surface a potential indicator of environmental stress and fish health. To investigate this relationship further, we hypothesized that sites with recent histories of cyanobacterial blooms would exhibit differences in the relative abundances of microbial taxa within the fish mucus. We tested this hypothesis by characterizing the surface mucosal microbiome of Yellow Perch at six sites within the St. Louis River Estuary, three with recurrent cyanobacterial blooms and three without. At each site, five individual perch (~100mm in length) were collected by electrofishing and swabbed for DNA-based identification of the skin mucosal microbiome. For comparison, water samples were collected to characterize the surrounding microbial community. Each site was sampled twice, once in August and once in September, after multiple observations of local cyanobacterial blooms. We found that water and Yellow Perch microbial communities differed in the proportional abundances of dominant taxa. Following cyanobacterial blooms, both water and fish mucus samples showed shifts in microbial communities, including elevated abundance of taxa known to break down cyanobacterial polysaccharides. The results of this preliminary study are a key first step in understanding the relationship between algal blooms and the fish mucosal microbiome. In the future, assessments of microbial communities could be an effective non-lethal method of evaluating environmental disturbance.

SPEAKER: **Kasey Benesh, US EPA ORISE Fellow | Benesh.Kasey@epa.gov**

SPEAKER BIO: In May of 2019, I obtained an MS degree in biology with a concentration in conservation from Central Michigan University where I used molecular techniques to study rare aquatic species, from the elusive White Shark to newly invading Grass Carp. After graduate school, I was a researcher at Florida Atlantic University where I studied the neuroanatomy of the blind Mexican cavefish. I am currently an Oak Ridge Institute for Science and Education master's fellow at the U.S. Environmental Protection Agency in Duluth, MN. My research centers around harmful algal blooms in the Great Lakes and their potential impact on the microbial community in the water as well as in the mucus of fish. www.linkedin.com/in/kasey-benesh-566a30203

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INCORPORATING HARMFUL CYANOBACTERIA BLOOMS (HCBS) AND CYANOTOXINS INTO CLEAN WATER ACT PROGRAMS: A NATIONAL REVIEW OF CRITERIA AND ASSESSMENT METHODS

SESSION: AGENCY PROGRAM APPLICATIONS

ABSTRACT: Under the U.S. Clean Water Act (CWA), states (and authorized Tribes) are required to adopt water quality goals for waterbodies (designated uses) and identify pollutant thresholds (criteria) that will achieve those goals. Every two years, states must assess water quality data against these goals and thresholds, and waterbodies not currently meeting are listed as impaired. No Tribes currently have CWA authority for listing waters as impaired. States then develop pollutant loading plans for impaired waters to improve water quality and meet goals. Here, we review the status of CWA criteria and impairment assessment methods related to cyanobacteria and cyanotoxins across the United States for recreation, drinking water, and aquatic life uses. We found that few jurisdictions have incorporated cyanobacteria or cyanotoxin criteria directly into state administrative code as criteria (<10 for recreation, <10 for drinking water, <5 for aquatic life at the time of writing). Furthermore, in the absence of numeric criteria, few jurisdictions currently use cyanobacteria or cyanotoxin data to assess waterbody impairment (<15 for recreation, <10 for drinking water, <5 for aquatic life). A larger collection of states has numeric criteria or assessment thresholds related to broader algal impacts (e.g., chlorophyll a), which could address some, but likely not all, impacts from HCBs. Although states and Tribes, as well as federal and local agencies, are increasingly concerned about HCBs, this review illustrates a gap in linking HCB science to CWA functions but also highlights opportunities for improving these linkages.

SPEAKER: **Micah Bennett, US EPA | bennett.micah@epa.gov**

SPEAKER BIO: Micah Bennett is a freshwater ecologist and Nutrient Coordinator in the Water Division at the U.S. EPA's Region 5 office in Chicago. He joined EPA as a Postdoctoral Researcher in 2015 in the Office of Research and Development where he refined and implemented science synthesis methods for ecological assessment. In 2019, Micah joined EPA Region 5 where he focuses on nutrients, Harmful Algal Blooms, biological criteria, and water quality monitoring issues. Micah received a Ph.D. in Zoology from Southern Illinois University Carbondale, a M.S. in Biology from Saint Louis University, and a B.S. in Biological Science from the University of Alabama (Roll Tide).

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ECOLOGICAL AND SPATIAL INFLUENCES ON CARIBBEAN CIGUATOXIN DISTRIBUTION IN FISH FROM ST. THOMAS, U.S. VIRGIN ISLANDS

SESSION: BENTHIC HABS

ABSTRACT: Ciguatera poisoning (CP) is primarily caused by carnivorous reef fish. Gambierdiscus is the main producer of ciguatoxins (CTXs), but the organisms transferring CTXs from dinoflagellates to carnivores are not well defined. Evaluating accumulation and distribution patterns of CTXs within prey fishes is an important step to identifying in advance the CP risk posed by predatory species destined for human consumption. Damselfishes (Pomacentridae) represent a large pool of potential demersal prey, which generally are strongly attached to small areas, and may be a major CTX-laden food source for predators. Given these qualities, damselfishes may be useful in CP monitoring as sentinels, or biological samplers, for detecting CTX bioaccumulation and transfer. We investigated whether damselfishes were an important link for CTXs and other algal metabolites to carnivores in St. Thomas, U.S. Virgin Islands. In doing so, our primary objectives were to screen damselfishes and a potential predator, Cephalopholis cruentata, for neurotoxic bioactivity displayed by CTXs and other microalgal metabolites using mouse neuroblastoma assay (N2a), survey fish toxicity across a coastal gradient where toxigenic Gambierdiscus occur, search for known and novel CTX metabolites by LC-MS/MS, and investigate the influence of trophic patterns on toxin presence in multiple species. We found damselfish (n = 140) muscle extracts were more highly toxic to N2a cells than C. cruentata (n = 76) by both sodium channel and non-specific pathways, suggesting presence of CTX-like metabolites. Furthermore, locations where G. silvae, a CTX super producer, had been previously detected held the most toxic fish. Also, certain species were consistently less toxic by N2a, which supports a possible influence of trophic partitioning in CTX distribution. Further results presented will include LC-MS/MS profiles, statistical models, and bulk stable isotope and molecular analysis to evaluate trophic partitioning with the objective to enhance CP monitoring strategies.

SPEAKER: **Clayton Bennett, University of South Alabama | cbennett@disl.org**

SPEAKER BIO: Clayton Bennett is a doctoral student in the Stokes School of Marine and Environmental Sciences Marine Sciences at the University of South Alabama and Dauphin Island Sea Lab. He has experience in fisheries monitoring through the Alabama Department of Conservation and Natural Resources and as a contracted Fisheries Observer through the Gulf of Mexico Shrimp and Reef Fish NOAA Observer Program. Bennett's dissertation research is focused on understanding the bioaccumulation, distribution, and elimination of algal toxins in Caribbean fish to aid in prediction of risk in fish destined for human consumption.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

RAPID DETECTION AND ENUMERATION OF CYANOBACTERIAL BLOOMS IN DIVERSE FRESHWATER SYSTEMS USING DIGITAL HOLOGRAPHY

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Harmful algal blooms (HABs) caused by the colonial cyanobacteria, Microcystis aeruginosa, pose significant threats to aquatic life, human health, and the economy. While in situ imaging can facilitate rapid detection and enumeration of Microcystis abundance, the main challenges associated with this approach are: (i) intake blockage of flowthrough imaging systems by large Microcystis colonies; (ii) fragmentation of colonies during sampling, leading to bias in size estimates and (iii) obtaining individual cell counts from imaged colonies. Rapid, non-invasive (freestream) volumetric imaging of Microcystis colonies using digital holography can overcome these limitations and enable better quantification of Microcystis cells and understanding colony dynamics. Holography encodes depth to high-resolution images by illuminating a sample volume with a laser beam and recording resulting diffraction patterns as holograms, which can be numerically reconstructed to obtain focused 2D planes at various depths, offering detailed insights into particle spatial distributions.

Here, we present an extensive set of lab measurements using digital holographic imaging to establish an empirical relationship between Microcystis colony size and cell counts. Microcystis colonies were isolated and cultured from two diverse freshwater ecosystems, Lake Okeechobee (Florida) and Lake Erie (Michigan), representing different strains and aggregate structures, thus accounting for a large variability in colony size and morphology. Each experiment involved the following steps: (i) imaging individual Microcystis colonies using holography; (ii) sonication to break up colonies into individual cells; and (iii) counting cells using flow cytometry and holography. Dozens of replicates across different colony sizes and shapes are analyzed to develop an empirical relationship between colony size and cell counts. Additionally, data from in situ deployments of a custom-built holographic imaging system to characterize Microcystis abundance and distribution in both Lake Erie and Lake Okeechobee will also be presented, to indicate the potential value of holography towards HAB research.

SPEAKER: **Madison Bennett, Florida Atlantic University | mbennett2019@fau.edu**

SPEAKER BIO: As an undergraduate research assistant at Florida Atlantic University Harbor Branch, I'm involved in several exciting projects led by Dr. Aditya Nayak's Ocean Engineering lab in Fort Pierce, Florida. My responsibilities include conducting holography experiments, contributing to machine learning databases, collecting zooplankton samples, and maintaining algae cultures. My interest in research was ignited by previous experiences in public policy and outreach, where I witnessed the importance of bridging scientific advancements with tangible societal benefits. I'm excited to use tools like holography to study a wide range of aquatic ecosystems. This work encourages my passion for exploring the complexities of aquatic environments and using technology to address pressing environmental challenges.

CO-AUTHORS:
Madison Bennett, Olivia Ruchti, Karuna Agarwal, Aditya R. Nayak

A 20-YEAR PERSPECTIVE OF LAKE OKEECHOBEE (FLORIDA, USA) USING COMBINED SATELLITE AND HISTORICAL DATA TO IDENTIFY CRITICAL FACTORS OF CYANOHABS

SESSION: REMOTE SENSING

ABSTRACT: Lake Okeechobee, a large and shallow lake in Florida, is often plagued with cyanobacterial harmful blooms (cyanoHABs) that substantially impact South Florida ecosystems and local economies. Real-time monitoring and forecasting are essential to better comprehend and predict blooms on this lake, as there are currently no practical HAB forecasting models for Lake Okeechobee. A fundamental aspect of monitoring cyanoHABs involves applying satellite imagery to physical and environmental drivers to form coherent models. To provide inputs for a cyanoHAB forecasting model for Lake Okeechobee, DBHydro data from 2002-2022 were assembled, validated, and analyzed with the goal of discerning factors that may be predictive of bloom formation. A continuous chlorophyll-a time series for the same timeframe was derived from Envisat-MERIS, Sentinel-3 OLCI, and Terra-MODIS observations. An intercalibration of measurement methods used in the database as well as daily matchups between satellite and chlorophyll-a concentrations (the current reference for cyanoHAB occurrence), was undertaken to ensure the data was comparable across spatial and temporal landscapes. Environmental variables including chlorophyll-a, calculated water depth, and nutrients including nitrogen and phosphorus were gathered from stations within a 300-1000m off the satellite-derived lake shoreline, dictated by sensor resolution. From our analyses, the intensity and duration of cyanoHABs were distinct across five functionally unique ecoregions determined from spatiotemporal chlorophyll-a trends. Our results indicate that the combination of ecoregion partitioning and water chemistry, especially depth, and temperature anomalies, are key factors in modulating blooms across Lake Okeechobee.

SPEAKER: **David Berthold, University of Florida | dberthold@ufl.edu**

SPEAKER BIO: Biological Scientist IV dedicated to uncovering marine cyanobacteria diversity, chemical and compound production potential through classical culturing and contemporary methods.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

DIVERSITY AND TOXICITY OF BENTHIC MARINE CYANOBACTERIA FROM FLORIDA (USA) AND THE CARIBBEAN

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Benthic cyanobacterial mats (BCMs), or benthic cyanoHABs, in marine environments are on the rise, partly driven by nutrient loading and climate change. Reports of BCMs occurring across the Florida coast and Caribbean countries including Curaçao and Bonaire have increased, from mangroves to seagrass beds and corals, demonstrating a need to understand the diversity and physiology of this threat. In line with continued monitoring efforts of this environmental health hazard, benthic proliferations were sampled between 2021 and 2023 to investigate their diversity and physiology. Cyanobacterial mats were collected, eDNA was extracted, and the 16S rRNA of cyanobacteria were amplified as well as the 18S rRNA of accompanying eukaryotes. In addition to amplicon sequencing, there was isolation, characterization, and genome sequencing of select strains as well as toxin analysis of environmental samples through LC-MS/MS. Results indicated that benthic mats are primarily composed of the large cyanobacteria Dapis, Okeania, and Sirenicapillaria while acting as a reservoir for several known bloom-forming dinoflagellates including Amphidinium and Alexandrium. Toxin analyses revealed the presence of anatoxin-a, dihydroanatoxin-a, and cylindrospermopsins. Results from this study indicate a need to further assess the diversity and physiology of these blooms by not only investigating their cyanobacterial and eukaryotic community structure and the production of toxins, but as well as the driving factors.

SPEAKER: **David Berthold, University of Florida | dberthold@ufl.edu**

SPEAKER BIO: Biological Scientist IV dedicated to uncovering marine, terrestrial, and freshwater cyanobacteria diversity, chemical, and chemical compound production potential through classical culturing and contemporary methods.

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THE CHEMICAL BIOLOGY AND BIOSYNTHESIS OF HIGHLY POTENT MICROCYSTINS CONTAINING HOMOLOGATED AMINO ACID RESIDUES

SESSION: EMERGING TOXINS & SPECIES

ABSTRACT: Cyanobacterial harmful algal blooms (cyanoHABs) and the toxic compounds produced during these events have become a persistent problem in freshwater systems and have affected local populations by contaminating drinking water and placing a significant burden on local economies due to diminished recreational activity. This was perhaps best exemplified by the Toledo Water Crisis of 2014. Microcystins, generally the dominant class of toxins in cyanoHABs, primarily affect the liver (hepatotoxin), but have been described to also affect the kidney, the reproductive system, and the brain. Cyanobacteria in these bloom events are known to produce a suite of hepatotoxins in addition to the microcystins such as the cylindrospermopsins, and alkaloid neurotoxins such as saxitoxin and anatoxin. Our group has shown that exquisitely potent cytotoxins exist in environmental collections of cyanobacterial biomass harvested from inland lakes and water bodies. A suite of these emerging compounds (steroidal lactones) departs significantly from the types of toxic compounds typically associated with these bloom events (peptidic and alkaloidal toxins). These newly discovered compounds are significantly more potent than microcystin-LR and have never been previously described from cyanoHAB events. Furthermore, preliminary results indicate that there are new microcystins in cyanoHABs that are significantly more cytotoxic than any of the >300 known microcystin congeners. In our current investigations we want to understand both the chemical ecology of these toxins (e.g., the dynamics of cyanobacterial populations and toxin production) and the chemical biology of these toxins (e.g., the biochemistry that creates them and the transportation and cellular mechanisms they affect). This research will develop an understanding of the mechanistic toxicity of these novel emerging metabolites to potential liver injury, which can be an early mediator of systemic disease.

SPEAKER: **Matthew Bertin, Case Western Reserve University | mxb1224@case.edu**

SPEAKER BIO: https://chemistry.case.edu/bertin-lab/

BENTHIC MACROINVETEBRATE COMMUNITY COMPOSITION WITHIN AND SURROUNDING BENTHIC ANATOXIN-PRODUCING CYANOBACTERIAL (MICROCOELUS) MATS IN A NORTHERN CALIFORNIA RIVER, USA

SESSION: PLENARY

ABSTRACT: Benthic cyanobacteria that produce toxins have been increasingly detected in streams and rivers across the globe, and the risk these cyanotoxins pose to public health have been well-documented. However, the ecological effects of toxin-producing benthic cyanobacterial mats, such as anatoxin-producing Microcoleus mats, on benthic macroinvertebrate communities and the potential for bioaccumulation of cyanotoxins within macroinvertebrate tissues are unclear. To examine differences in benthic macroinvertebrate community assemblages within and surrounding Microcoleus mats, we collected 6 rocks in a paired design (3 covered by Microcoleus & 3 covered by green algae within a 1 m radius) within three separate riffles along a 1 km reach of the South Fork Eel River in northern California on two dates in August and September of 2022. To determine the anatoxin levels in the tissues of the macroinvertebrates, we collected individuals from the target taxa (Perlidae, Hydropsychidae, Psephenidae, Gastropoda) representing a range of functional feeding groups within the riffle and froze them following a period of excretion. We identified all macroinvertebrate community assemblages to a family or genus level and examined variation in community indices (e.g., richness). Preliminary data suggest that Chironomidae, known for their resilience to unfavorable environmental conditions, are much more abundant within Microcoleus mats than in mats dominated by green algae on nearby rocks. Examining the differences in benthic macroinvertebrate communities living within and outside of toxin-producing cyanobacterial mats can improve our understanding of the ecological consequences of benthic cyanobacterial mat proliferations.

SPEAKER: **Joanna Blaszczak, Department of Natural Resources & Environmental Science and the Global Water Center, University of Nevada, Reno | jblaszczak@unr.edu**

SPEAKER BIO: Lab website: https://blaszczaklab.weebly.com/

Dr. Joanna Blaszczak is an assistant professor in the Natural Resources and Environmental Science department at the University of Nevada, Reno. She received her bachelor’s degree from Cornell University in Science of Natural & Environmental Systems, her doctoral degree in Ecology from Duke University, and was a postdoc at the Flathead Lake Biological Station in Montana from 2018-2019. The Blaszczak Lab broadly focuses on the effects of land use and global change on the ecosystem ecology of rivers and streams.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

IMPACTS OF HARMFUL ALGAL BLOOMS ON MICROBIAL STRATIFICATION IN A MICRO-TIDAL ESTUARY

SESSION: MICROBIAL INTERACTIONS

ABSTRACT: The York River Estuary experiences recurrent summer harmful algal blooms caused by Margalefidinium polykrikoides and Alexandrium monilatum. However, bloom dynamics vary each year as biotic and abiotic bloom drivers differ, resulting in some years where both species bloom and others where only one or neither blooms. While several studies have explored environmental factors affecting bloom formation, the impact of blooming dinoflagellates on the co-occurring aquatic microbial community remains understudied. Investigating microbial communities and nutrient metabolism is essential to understanding HAB dynamics and their interactions with the aquatic microbiome. We conducted shotgun metagenomic and 16S rRNA amplicon sequencing analyses with water samples collected at two different depths (surface vs. 5 m) and at four time points during an extensive two-months M. polykrikoides bloom in 2022. Preliminary results indicated that Synechococcales dominate nitrogen assimilation across depths and negatively correlate with the ammonia-oxidizing archaea Thaumarchaeota; implying a suppression of nitrification by cyanobacteria, while potentially competing with M. polykrikoides due to comparable nutrient requirements. Whole microbial community nitrogen assimilation potential was higher at the surface, but a clear distinction in nitrification potential across depths was absent. Our study confirms the presence of microbial stratification within the 2022 M. polykrikoides bloom based on differing metabolic potentials and community structure. A further investigation into microbial stratification over the bloom progression of M. polykrikoides will be conducted to better understand the impact that bloom stage and density have on the aquatic microbial community that ultimately influences the York River estuarine biogeochemical cycle.

SPEAKER: **Lilly Blume, Virginia Institute of Marine Science | ltblume@vims.edu**

SPEAKER BIO: Lilly T. Blume joined the Virginia Institute of Marine Science (VIMS) as a graduate student in summer 2021, and is now a fourth-year Ph.D. candidate. She has since been working on harmful algal bloom (HAB) microbial interactions using molecular techniques. Lilly received her integrated bachelor-master degree in 2020 from Cardiff University in the UK and spent one of her undergraduate years at the University of Miami in Florida, where she was involved in cyanobacterial HAB toxicology research at the Rosenstiel School of Marine and Atmospheric Science (RSMAS). With a love for phytoplankton, Lilly has previously interned at the Alfred-Wegener-Institute (AWI) for Polar and Marine Research in Germany, her home country, where she studied Antarctic diatoms.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

A COMPARISON OF RIVERINE HARMFUL CYANOBACTERIAL ALGAL BLOOM DRIVERS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The impacts of nutrients and environmental dynamics on the growth of cyanobacterial harmful algal blooms (cyanoHABs) and cyanotoxin production in riverine ecosystems remain poorly understood. This case study presents a comparison of total microcystin concentrations (ug/L) between two Iowa river systems with similar climates and nutrient loading, the Des Moines River and the Raccoon River. By comparing river systems with similar hydrologic and environmental factors, this study provides insight into the role that watershed differences may play in cyanoHAB development and growth.

SPEAKER: **Elizabeth Bolton, Argonne National Laboratory | ebolton@anl.gov**

SPEAKER BIO: Dr. Elizabeth Bolton is an Infrastructure Risk Analyst in the Decision and Infrastructure Sciences Division of Argonne National Laboratory. She has worked on multiple technical projects and national programs to assess risk and increase resiliency of critical infrastructure, with a primary focus on water and energy infrastructure. She has a background in sociotechnical systems analysis, with expertise in complex systems analysis techniques, survey-based research, and inverse modeling approaches.

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Molly Finster

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

WHAT DOES A TYPICAL RECREATOR KNOW ABOUT HABS? IMPROVING COMMUNICATION THROUGH A PUBLIC PERCEPTION SURVEY

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Communication is a key element in protecting the public from harmful algal blooms. Monitoring efforts are only effective if the results reach potential recreators. Furthermore, a baseline awareness of how to identify HABs is key for recreators to make safe decisions at waterbodies where monitoring isn't available or conditions change rapidly. To enhance the effectivity of our communication efforts, staff with the Utah Division of Water Quality and Utah Department of Health and Human Services, conducted a two-year public perception survey. These survey results yield insights on a typical recreator's background knowledge of HABs: the majority of Utah recreators have heard about harmful algae, but don't feel confident in their ability to recognize it. Results highlight communication venues with the broadest reach: most recreators learn about HABs through news media or signage at visited waterbodies. And the survey has helped us hone in on ongoing educational efforts: the state has worked with stakeholders to develop new waterbody signage and build a partner-driven social media toolkit.

SPEAKER: **Hannah Bonner, Utah Division of Water Quality | hbonner@utah.gov**

SPEAKER BIO: Dr. Hannah Bonner, with the Utah Division of Water Quality, leads Utah's Recreational Water Quality Program. This program includes statewide efforts to monitor for and respond to planktonic and benthic cyanobacteria health concerns. In recent year's Hannah's work has focused on exploring qPCR for cyanotoxin gene detection, analyzing historic trends in bloom formation, developing recreational health guidance for benthic cyanobacteria, and expanding understanding of public perception of HCBs.

CO-AUTHORS:
Karen Valcarce, Carina Thiriot

A METAGENOMIC SEARCH FOR MARINE VIRUSES THAT INFLUENCE THE HARMFUL BLOOM FORMER KARENIA BREVIS

SESSION: MICROBIAL INTERACTIONS

ABSTRACT: Karenia brevis (dinoflagellate) form regular, persistent harmful blooms in the Gulf of Mexico. Yet, little is known about how microbial interactions influence K. brevis or bloom dynamics. Here, we focus on the poorly studied interactions between K. brevis and marine viruses by incubating K. brevis cultures with 2021 bloom waters that were size fractionated by passing through either a 1-µm filter to remove protists, a 0.22-µm filter to remove protists and large bacteria, or a 0.02 µm filter to remove all biological particles. Uninoculated K. brevis cultures acted as a control. Incubations with the 1-µm or 0.22-µm seawater filtrates resulted in K. brevis lysis within two weeks. Flow cytometry showed giant virus-like populations only present in the lysed K. brevis cultures. Metagenomic analyses revealed the presence of 11 unique giant virus metagenome assembled genomes (GVMAGS, 34-100% complete) that grouped into four clades. Phylogenetic analyses place these GVMAGs within the order Imitervirales, which includes algae infecting viruses. All GVMAGs contain most of the 9 conserved genes associated with this phylum, common giant virus genes involved in DNA replication, transcription, & translation, and 8-42 eukaryotic associated genes. In 2 of 11 GVAMGs a dinoflagellate-viral-nucleoprotein (DVNP) was present, these proteins are found in dinoflagellates and act similarity to histones. Additionally, half of the functionally annotated genes were associated with host metabolic reprogramming and evasion of host immune defenses. Auxiliary metabolic genes included a bacteriorhodopsin-like protein and an asparagine synthase. Bacteriorhodopsin-like proteins are common among giant viruses, enabling viral-induced light-driven energy transfer to the host. Less common asparagine synthases aid viruses in counteracting host asparagine limitation, a documented method for eukaryotic cells to hinder viral protein synthesis. Overall, this study provides evidence for direct viral infection of K. brevis by multiple viral populations who come prepared to resist host defenses.

SPEAKER: **Anne Booker, Bigelow Laboratory for Ocean Sciences | abooker@bigelow.org**

SPEAKER BIO: Hello! I am Dr. Anne Booker with a PhD in Microbiology from The Ohio State University. I am currently a postdoc at Bigelow Laboratory for Ocean Sciences where I first worked with Dr. Beth Orcutt and now work with Dr. Joaquín Martínez Martínez. As a microbiologist I have studied microbial communities in the terrestrial subsurface via hydraulically fractured wells, the oceanic subsurface via long-term observatories named CORKs (Circulation Obviation Retrofit Kit), and surface seawater associated with Karenia brevis (a harmful algae) blooms. I love studying microbiology because microbes rule the world! Microbes influence chemical processes, and therefore life, everywhere they are found. I think it is fun to learn what microbes are doing in hopes to use this knowledge to address issues on our shared planet. So far, projects I have been involved in includ laboratory based (bacterial isolations, culture maintenance, fluorescent microscopy, flow cytometry) and bioinformatic based (single cell genomic, metagenomic, and proteomic) work. Currently I am working on identifying viral genomes in metagenomic datasets and trying to connect them to the HAB K. brevis. If you have advice on linking metagenome assembled viral genomes to their host, then let's chat!
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

GENETIC COMMUNITY COMPOSITION AND CYANOTOXIN ANALYSIS IN COASTAL LAKES OF NEW JERSEY

SESSION: CELLULAR & MOLECULAR TECHNOLOGY

ABSTRACT: Coastal lakes are unique and important ecosystems that provide many benefits to migratory birds, local wildlife, and local communities. However, the health of these ecosystems is threatened and facing gradual degradation due to anthropogenic activities, stormwater runoff, and harmful algal bloom formations (HABs). Genomic approaches of microbial community composition and toxin analysis can improve our ability to monitor the health of these ecosystems and better understand HAB dynamics. Here, environmental DNA (eDNA) samples collected from three coastal lakes were analyzed by 16s meta-barcoding to characterize spatial and temporal distributions of microbial community composition. Samples were also characterized using qPCR for 16S cyanobacterial abundance and cyanotoxin genes with comparisons to ELISA toxin analyses. Non-parametric multi-dimensional scaling (NMDS) and K-means clustering were used to classify distinct communities from complex 16S metabarcoding data, resulting in a variable which can more easily be analyzed and spatially represented. The results show distinct spatial and temporal patterns of cyanobacterial community composition and toxin abundance within and between coastal lakes. This study, and subsequent ones utilizing the same analytical pipeline will contribute to the conservation and management of these critical ecosystems, providing a better understanding of the roles microbial communities play in coastal lake ecology.

SPEAKER: **Diederik Boonman Morales, Monmouth University | s1345446@monmouth.edu**

SPEAKER BIO: I am a student at Monmouth University completing a bachelor's degree in Marine and Environmental Biology and Policy. I have assisted in research for CLONet lake monitoring program, as well as eDNA and statistical analyses to understand the relationship of microbial composition and coastal lake health, and as an indicator of harmful algal blooms in coastal lakes of New Jersey. I have also had experience in conducting a population analysis of the invasive Asian Shore Crab along rocky shorelines, and assisting in research tagging sharks and striped bass with acoustic telemetry tags and deploying receivers along bays and estuaries of New Jersey.
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CYANOBACTERIA BLOOM DYNAMICS IN A SOUTH CAROLINA RESERVOIR

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Freshwater reservoirs in South Carolina (SC) often serve as primary drinking water sources and are heavily used for recreational purposes such as swimming, boating, and fishing. Maintaining good water quality in these reservoirs and understanding what causes harmful algal blooms (HABs) will better help us manage these reservoirs moving forward. The purpose of this research was to study cyanobacteria bloom dynamics in a typical SC reservoir, Goose Creek Reservoir. Goose Creek Reservoir is a 600-acre, 2.5m deep reservoir with high recreational activity, the potential to serve as a drinking water source, and is located in an increasingly urbanized watershed. Cyanobacteria blooms have been documented on Goose Creek Reservoir since at least 2018. In 2023-2024, we sampled monthly at three stations for temperature, dissolved oxygen, pH, phytoplankton biomass and community composition, nutrients, and algal toxins. We found distinct differences in phytoplankton community composition seasonally, with cyanobacteria dominance in warmer months (May, July). Nutrient bioassays showed N-limitation of growth via responses by green algae, diatoms, and cryptophytes. Two different cyanobacteria genera have been identified on the lake, Aphanizomenon sp. and Dolichospermum sp., but have been found to not produce microcystins or cylindrospermopsin. Sampling will continue through summer 2024 to document cyanobacteria abundance, speciation, nutrient limitations, and toxin production.

SPEAKER: **Emily Bores, University of South Carolina | ebores@email.sc.edu**

SPEAKER BIO: I have been working for the SC Department of Health and Environmental Control as the Harmful Algal Bloom program coordinator since 2018. I was tasked with the creation and implementation of a statewide HAB program throughout SC which includes identifying algal blooms, testing for algal toxins, and issuing recreational advisories in waterbodies of the state. More recently, I have been attending the University of South Carolina as a PhD student in the Biology Department. For my research, I have been focused on studying nutrient and seasonal impacts on phytoplankton dynamics in a typical SC reservoir.

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

IDENTIFICATION OF TOXIGENIC BENTHIC CYANOBACTERIA IN THE CALIFORNIA SIERRA NEVADA MOUNTAINS

SESSION: BENTHIC HABs

ABSTRACT: Maintaining high water quality is a management priority in Yosemite National Park (Yosemite), and toxic cyanobacteria threaten this goal. During 2021, toxic benthic cyanobacteria were detected in multiple streams in Yosemite. Cyanobacteria can produce many different toxic compounds (cyanotoxins), and toxigenic cyanobacteria that proliferates across a streambed can negatively impact humans and aquatic species. In California, cyanobacterial mats have been linked to numerous dog illnesses or deaths. Our research goal is to collect and analyze relevant data that will help Yosemite develop a management plan for cyanobacteria and cyanotoxins. We deployed solid phase adsorption toxin tracking (SPATT) samplers at six locations in 2022 to measure dissolved cyanotoxins. In 2023, we conducted monthly visual surveys for toxigenic cyanobacteria, water chemistry sampling in 12 locations, and two multi-day backcountry surveys to characterize the spatial distribution of cyanobacteria in Yosemite. When potentially toxigenic cyanobacteria were found, samples were analyzed for the presence of toxin biosynthesis genes. Multiple cyanotoxins were detected. SPATT samplers detected microcystins, cylindrospermopsin, saxitoxin, and anatoxins, with all 2022 SPATT samplers detecting at least one cyanotoxin. The 2023 surveys microscopically identified the potentially toxigenic genera Microcoleus, Tolypothrix, and Nostoc. Genes were detected for anatoxin, cylindrospermopsin, and saxitoxin biosynthesis. Of the 25 samples analyzed for cyanotoxins by liquid chromatography tandem mass spectrometry, 13 detected anatoxins, 9 detected microcystins, 7 detected saxitoxins, and 6 detected nodularin. We will also present results on the environmental conditions associated with the presence of benthic cyanobacteria. Sampling will continue in 2024, and results of the project will inform park management on the extent and magnitude of cyanotoxin production potential across aquatic resources in Yosemite.

SPEAKER: **Keith Bouma-Gregson, USGS | kbouma-gregson@usgs.gov**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

EVIDENCE OF PACIFIC WALRUS EXPOSURE TO HAB TOXINS IN THE ALASKAN ARCTIC

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Harmful algal blooms (HABs) are posing an increasing threat to Arctic ecosystems as the region continues to warm rapidly. Pacific walruses (Odobenus rosmarus divergens), an ecologically and culturally important Arctic species, are exposed to HAB toxins at concerning levels through their consumption of filter- and detritus-feeding benthic prey. On a research cruise led by the U.S. Fish and Wildlife Service, U.S. Geological Survey, and in conjunction with the Eskimo Walrus Commission, food web samples were collected for HAB analysis (saxitoxin [STX] and domoic acid [DA]) from active walrus feeding grounds. Samples were collected in Alaskan waters from the Bering Strait and along sea ice margins in the Chukchi Sea during June 2023. Here, we report STX and DA concentrations from walrus scat and prey (benthic invertebrates), and examine Alexandrium catenella cell counts from surface seawater collected during this survey. Saxitoxin was detected in 88% of walrus scat, 93% of clam, and 83% of snail samples. Concentrations ranged from low to over the seafood safety regulatory limit (80 µg STX eq./100 g), including one scat sample at over 200 µg STX/100 g, collected about 150 km north of Wales, AK. Domoic acid was present in low concentrations in 43% of scat and 25% of clam samples, and was not detected in sampled snails. A. catenella cell counts were low at the time (<20 cells/L), suggesting that the walrus toxin exposure was to toxins accumulated and retained in the food web from an earlier bloom. These results will be supplemented with subsequent research cruise data and used to inform models predicting walrus exposure to HAB toxins in the Alaskan Arctic in the face of climate change.

SPEAKER: **Emily Bowers, NOAA Northwest Fisheries Science Center | emily.bowers@noaa.gov**

SPEAKER BIO: I am the lead technician for the Wildlife Algal-toxin Research and Response Network (WARRN-West) program at NOAA’s Northwest Fisheries Science Center in Seattle, WA. I support research investigating the impacts of HAB toxins on wildlife health on the U.S. West coast and in the Alaskan Arctic by analyzing food web and mammal gastrointestinal samples for domoic acid and saxitoxin, managing preparations for research cruise sampling, and overseeing lab operations.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

INTERNATIONAL GUIDANCE ON THE INTEGRATION OF QPCR INTO HAB MONITORING

SESSION: Poster Session, Tuesday

ABSTRACT: The international program GlobalHAB, which aims to coordinate international research on HABs, has identified the need to integrate the analysis of environmental DNA (eDNA) by molecular methods to improve monitoring and develop early risk alert systems. Given the need for taxon or gene-specific identification and precise abundance evaluation at low detection limits, molecular genetic quantitative PCR (qPCR) and digital (dPCR) methodologies have been considered suitable tools for HAB species molecular monitoring. To foster the integration and application of these approaches, GlobalHAB supported a workshop in Hiroshima, Japan on November 3-5, 2023 (prior to the ICHA conference) to augment several prior online meetings. Participants included international experts in the molecular field from several countries and continents. The aims of the workshop were to: 1) establish how and to what extent qPCR/dPCR could be used in monitoring of HABs considering the limits of the methods, 2) select target species to be monitored with qPCR at a global scale, 3) agree on common protocols adapted to HAB monitoring systems, and 4) identify gaps in knowledge for future research and expand on existing international guidelines. A manuscript was subsequently prepared to present consensus on these topics to an international body of researchers and managers.

SPEAKER: **Holly Bowers, Moss Landing Marine Labs | holly.bowers@sjsu.edu**

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VALIDATING THE AQUSENS IMAGING PLATFORM TO EXPAND NETWORKED CELL DETECTION CAPABILITIES

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES II

ABSTRACT: This project aims to compare and validate a new low-cost, portable digital holography based cell imaging platform (Aqusens) to the Imaging Flow CytoBot (IFCB) towards increasing capacity building for HAB cell detection within the context of routine monitoring and targeted deployments. This comparison is being carried out through three objectives: 1) laboratory experiments with a variety of cultured HAB and non-HAB species to provide foundational platform comparisons; 2) deployments throughout the year at the Santa Cruz Wharf monitoring site to test performance during varied conditions (e.g. algal blooms, upwelled sediment); and 3) in underway cruise operations aboard established USGS transects in San Francisco Bay (slated for 2025) targeting seasonal (3 cruises across winter, spring, autumn), and within season (3 cruises across June, July, August) succession of phytoplankton populations. These datasets provide avenues for new platform integration into well-established programs offering publicly available long-term data. Additionally, on-site demonstrations of the Aqusens are occurring with partners in aquaculture, consulting, and educational programs. Evaluation of this platform is being further facilitated through deployments within the Synchro framework - a co-designed testbed to deploy, evaluate, and improve systems in real-world conditions. All together, these efforts assess functionality of the platform in various settings and evaluate utility of this type of data set for a varied audience. This work allows us to explore system features that could enhance HAB observing needs, including defining image/chlorophyll triggers for adaptive sampling, tracking bloom stages using bulk fluorescence, and capturing a pool of imaged cells for downstream manipulation (genetics, culturing). A pathway is being developed for data integration into the CalOOS/HABDAC public portals.

SPEAKER: **Holly Bowers, Moss Landing Marine Labs | holly.bowers@sjsu.edu**

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AN EVALUATION OF PLANAR WAVEGUIDE BIOSENSOR FOR DETECTION OF CYANOTOXINS IN THREE DIFFERENCE FRESHWATER SYSTEMS

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Cyanobacterial harmful algal blooms (cHABs) have negative impacts on ecological, economic, and human health due to biomass and cyanotoxin production. Standard methods for cyanotoxin detection are time and laboratory equipment intensive, especially when multiple toxins are involved. There is a need for a rapid, multiplexed method for cyanotoxin detection. The LightDeck biosensor is a waveguide fluorescence-based immunoassay that simultaneously detects microcystins, cylindrospermopsins, and saxitoxins. Here we used volunteers to collect water samples from three lakes with different trophic status (hypereutrophic, meso-eutrophic, and meso-oligotrophic) that experienced toxic cHABs. Samples were collected in 2022 and 2023 and analyzed using the biosensor and LC-MS, LC-MS/MS or ELISA depending on the cyanotoxin. Cylindrospermopsins and saxitoxins were not detected in any of the lakes. In this regard, the biosensor provided an important screening function in that we would not need to further analyze the samples using more time and equipment techniques. Microcystins were detected in all three lakes and the role of the biosensor varied depending on the Lake trophic status. In oligotrophic Canandaigua Lake (n=87), cHABs only occurred during a limited two-week period and the biosensor was used to discard non-toxic samples from further consideration and to alert the lake association when toxic blooms were present. In hypereutrophic Lake Neatahwanta, all samples (n=32 in 2023 only) were toxic for microcystins and the biosensors rapidly identified high-toxicity samples that would exceed the recreational threshold. In mesotrophic Canandaigua Lake (n=290), the biosensor allowed us to focus on specific locations of concern, e.g. ignoring non-toxic Gleotrichia blooms, and fine-tune our sampling strategy to protect drinking water and recreational use. It also provided assurance that PSP toxins previously reported in the lake were not present. In summary, the use of the biosensor may be lake-dependent and change with the monitoring need that must be addressed.

SPEAKER: **Gregory Boyer, SUNY ESF | glboyer@esf.edu**

SPEAKER BIO: Greg Boyer is a Emeritus Professor of Biochemistry at SUNY-ESF. He has worked on both marine and freshwater HABs for more than 40 years, with an emphasis on toxin chemistry, involving community scientists in HAB monitoring, and the biological role of the algal toxins.

CO-AUTHORS:
Sydney Hall, Gregory G. Lewis, Cassandra L. Petrou, and Anna M. Melvin

LAKE GUARD DEW EFFICACY TOWARDS NUTRIENT AND HARMFUL ALGAL BLOOM REDUCTION

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: Cyanobacterial blooms are the most common form of Harmful Algal Blooms (HABs) in freshwater systems throughout the US. Human exposure to these HABs can cause a wide range of health risks including skin and eye irritation, adverse effects on liver and kidney function, and flu-like symptoms. Lake Jesup is the largest lake in Seminole County, Florida and is considered a hypereutrophic lake as it receives high concentrations of nutrients from nearby agricultural runoff. It is subject to frequent cyanobacterial HAB events and is listed as impaired by the Florida Department of Environmental Protection. Peak HAB events in Lake Jesup are typically found in Spring and Winter and can be seen throughout the entire lake. Ongoing restoration efforts are imperative for the health of the Lake Jesup system and include evaluating methods to prevent or remove HABs. Lake GuardTM DEW, developed by BlueGreen Technologies, is a product that is encapsulated in a thin, inert, biodegradable coating which causes it to float on the water's surface. The floating characteristic of Lake GuardTM Dew serves to mimic the movement of impurities that are transported in the water by wind and current and allows the product to slowly release over time. As opposed to traditional forms of Alum (slurry) that immediately sink to the sediment bottom and necessitates the use of larger quantities, the increased binding potential of Lake GuardTM Dew means that only minimal quantities are required to achieve the maximum impact of coagulating impurities before sinking to the sediment bottom. This product will be tested on a cyanobacteria bloom in Lake Jesup in the following year with a goal of studying the nutrient fluctuations associated with the hypothesized removal of the cyanobacterial bloom with a goal of removal of nutrients as well. This HAB mitigation effort will have positive effects on the commercial market in Florida, with farmers and homeowners who may have previously been devastated by these blooms having a successful mitigation tool without causing additional harm to the environment.

SPEAKER: **Kelley Breeden, Mote Marine Laboratory | kbreeden@mote.org**

SPEAKER BIO: Ms. Breeden recently began her professional career in the world of water quality and research. After receiving her Bachelor's degree in Biochemistry from Florida Southern College, she moved to Florida Atlantic University, where she received her Masters Degree in Environmental Science under the guidance of Dr. J. William "Bill" Louda. Her Masters thesis work focused on Microcystis aeruginosa and the nutrients that contribute to these blooms, specifically in Lake Okeechobee and South Florida. Utilizing her technical skills and knowledge of freshwater algal systems, she is now working as a Staff Chemist in the Chemical and Physical Ecology Program at Mote Marine Lab under Dr. Emily Hall. Kelley analyzes water quality samples and determines nutrient levels using an auto analyzer system. These samples come from a variety of projects and can span a large level of nutrient fluctuations. She also participates in field work and other analyses throughout the lab. She is extremely interested in freshwater and marine Harmful Algal Blooms (HAB)s and continues to pursue a greater understanding of how differing nutrients play a role in HAB production, mitigation and prediction.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

INTENSIFICATION AND SPREAD OF INSHORE ALEXANDRIUM CATENELLA BLOOMS IN CAPE COD, MASSACHUSETTS

SESSION: BLOOM DYNAMICS & DRIVERS I

ABSTRACT: Over the last decade, recurrent blooms of Alexandrium catenella in the Nauset Marsh (Cape Cod, MA USA) have been intensifying, beginning earlier and causing greater levels of shellfish toxicity than in preceding decades. In 2023 and 2024, this trend accelerated dramatically with blooms forming four months earlier and persisting more than three times longer than historical norms. The 2023 Nauset event actually began in December 2022 and was still ongoing when Alexandrium cells and paralytic shellfish toxins (PSTs) were detected in neighboring Pleasant Bay, Stage Harbor, Nantucket Harbor, and Lagoon Pond (Martha's Vineyard) in April and May 2023. Event response surveys documented massive production of new cysts within terminal kettle holes of the Nauset and Pleasant Bay systems. Blooms developed again in these areas beginning in late November 2023. The extraordinarily early initiation of these events coincides with wintertime warming across the region. Water temperatures still decrease sufficiently to release A. catenella resting cysts from dormancy but no longer suppress germination or vegetative growth until spring. Because springtime temperatures have warmed less, Nauset cyst beds remain active late into April and May, driving repeated cycles of bloom development, new cyst production, and then renewal through continued cyst germination. Ongoing work aims to resolve whether apparent expansion of PSP on Cape Cod is due to spread of A. catenella from Nauset or if the longer duration of this organism's seasonal niche is stimulating previously established, cryptic cyst populations in other areas. Observations elsewhere on Cape Cod and in southeast Massachusetts have documented widespread occurrence of A. catenella in plankton samples, suggesting that cryptic cyst deposits may already be widespread. If recent climate conditions persist, the number and size of these populations is likely to grow, driving development of new embayment-localized, self-seeding blooms like those that cause annually recurrent PSP in Nauset Marsh.

SPEAKER: **Michael Brosnahan, Woods Hole Oceanographic Institution | mbrosnahan@whoi.edu**

SPEAKER BIO: I am an Associate Scientist in Biology Department at the Woods Hole Oceanographic Institution. My research is focused on phytoplankton ecology and I have particular interests in HAB dynamics and the development of automated observing systems. I have served on the National HAB Committee and am currently a member of the National HAB Observing Network (NHABON) Community of Practice Steering Committee.

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METAGENOMICS OF SAXITOXIN-PRODUCING PHYTOPLANKTON COMMUNITIES

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Freshwater saxitoxins, a suite of neurotoxins produced by cyanobacteria, are a present and growing threat in Ohio lakes and eutrophic waterbodies throughout the US and worldwide. Due to greater surveillance, detections of saxitoxins are more widespread in Ohio than the national average. While the drivers of saxitoxin production are poorly understood, cool autumn temperatures may select for cyanobacteria that are capable of producing saxitoxins. To more systematically assess the effects of key environmental variables on saxitoxin-producing cyanobacteria, nutrient addition and light intensity bioassays were conducted using water from Evans Lake (northeast Ohio) during September and October of 2020. From extracted microbial DNA of bioassay samples, key cyanotoxin gene copies were enumerated using quantitative PCR and community compositions were determined using shotgun metagenomic sequencing. In September, sxtA, mcyE, and cyrA genes were all detected, with sxtA observed at the highest concentration and increasing with both P&NO3 and P&NH4 nutrient addition. In contrast, October samples contained mainly mcyE genes, but in higher concentrations than September. In September, key cyanobacterial taxa were Planktothrix, Dolichospermum, Raphidiopsis, Sphaerospermopsis, and Nodosilinea, while in October the cyanobacterial community consisted of Planktothrix, Dolichospermum, and Raphidiopsis. Cyanobacterial reads made up more of the total microbial metagenomes in bioassay samples in September compared to October; consequently, cyanobacteria had a greater contribution to microbial metabolisms for most biogeochemical cycles in September. Together, molecular analysis of bioassays revealed that the cyanobacterial community in Evans Lake exhibited relatively minor taxonomic changes over one month, but in that time toxin gene composition changed significantly.

SPEAKER: **Kate Brown, BGSU | browkat@bgsu.edu**

SPEAKER BIO: Kate is a PhD candidate at Bowling Green State University. Her research focuses on using molecular and sequencing techniques to explore cyanobacterial communities and their associated bacteria.

CO-AUTHORS:
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DETERMINING THE VIABILITY AND RECOVERY OF ROUNDED KARENIA BREVIS CELLS AFTER EXPOSURE TO NATURAL AND ARTIFICIAL STRESSORS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Monitoring of Karenia brevis blooms heavily relies on the enumeration and identification of cells for accurate and timely reports. Karenia brevis morphology however, can vary depending on life stage and environmental conditions, making accurate confirmation increasingly difficult. The documentation of spherical K. brevis cells, thought to be the result of various unfavorable conditions, has been recorded in the literature and observed by several laboratories. Conditions in which rounded cells have been observed include low salinity, low light, temperature variations, and nitrogen deficiency. In our efforts at developing mitigation strategies for K. brevis, we have observed similar morphological changes in cells exposed to the amine putrescine, the algaecide curcumin, and synthetic rubbers. Although many dinoflagellate species form cysts in response to unfavorable conditions, the ability of K. brevis to form cysts has not been conclusively determined, nor has the viability and fate of these rounded cells been examined. The objective of this study was to determine the viability of these cells by evaluating brevetoxin production, cell division, and to assess whether or not these cells can morphologically recover. In addition to broadening criteria for K. brevis cell identification, results from this study can shed light on the possibility of cells recovering from natural and artificial stressors, such as those used in various mitigation strategies.

SPEAKER: **Devin Burris, Florida Gulf Coast University; Mote Marine Laboratory | dburris@mote.org**

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DEVELOPMENT OF DEEP LEARNING MODELS FOR HARMFUL ALGAL BLOOMS MONITORING IN A NORTH-EASTERN RESERVOIR, USA.

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Effective monitoring of HABs entails robust approaches to mitigate their impacts. In addition to laboratory analysis and identification of harmful species to guide management plans, mechanistic models have also been used to understand algal dynamics and predict their occurrence. However, these models are limited in their prediction accuracy due to the complex nature of HABs in varying water bodies. With the global breakthrough in technology and data analytics aided by immense computing prowess, machine learning models hold significant potential in accurately predicting and forecasting algal biomass, even days before their occurrence. In this study, we explored the use of two different deep learning models (Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU)) for the prediction of chlorophyll-a concentration as an index of HABs in Allegheny reservoir, monitored by the United States Army Corps of Engineers (USACE). Multistep ahead chlorophyll-a prediction was performed using predictors such as pH, dissolved oxygen, oxidation-reduction potential, temperature, saturated dissolved oxygen, turbidity, Blue Green Algae (BGA), and specific conductivity. Preliminary results showed that both selected models were able to capture the trends of chlorophyll-a, with the LSTM model achieving a root mean square error (RMSE) of 4.31 µg/l and a mean absolute error (MAE) of 3.51 µg/l. Meanwhile, the GRU model exhibited slightly higher errors, with an RMSE of 5.95 µg/l and an MAE of 3.92 µg/l. These findings suggest that the LSTM model performed slightly better in capturing chlorophyll-a's variability than the GRU model, as the lower error metrics indicated. However, further analysis and validation are needed to confirm these results and assess the models' overall performance. Upon validation, these models will serve as an excellent decision-support tool for swiftly implementing management actions to combat the menace of HABs.

SPEAKER: **Ibrahim Busari, Clemson University | ibusari@g.clemson.edu**

SPEAKER BIO: I am a third-year PhD candidate at Clemson University, with research focused on detecting, predicting, and monitoring harmful algal blooms (HABs) in freshwater bodies. I have a master's in Water and Coastal Management from the University of Cadiz, Spain, and a master's in Environmental Assessment and Management from the University of Bologna, Italy. My research embodies the use of patterns in water quality and remotely sensed data to understand the triggers of HABs, predict their occurrence, and as a decision-support tool. I am also passionate about citizen science and research application, hence my involvement in extension activities that promote the application of research findings for societal development.

CO-AUTHORS:
Debabrata Sahoo, Jodi Ryder

IMPROVING HARMFUL ALGAL BLOOMS MONITORING THROUGH ENHANCED CHLOROPHYLL-A PREDICTIONS WITH DATA ASSIMILATION TECHNIQUE

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The complexity of Harmful Algal Bloom (HAB) dynamics emphasizes the necessity for effective monitoring techniques. Deep learning models have been employed to detect high-frequency water quality data patterns by leveraging indicators such as chlorophyll-a, phycocyanin, and algal cells commonly associated with HABs. This work incorporated data assimilation as an additional layer to enhance the accuracy of chlorophyll-a prediction in a lake. Data assimilation is a technique that combines models with new sources of observations to estimate the evolving state of a system over time. This research aimed to forecast chlorophyll-a one day in advance by employing Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) as proxies for prevalent dynamical numerical models utilized in data assimilation. The Ensemble Kalman Filter (EnKF) approach was used to assimilate chlorophyll-a concentrations into the system to improve the model predictions at every timestep. The assimilation strategy was performed so that the new observation was assimilated daily, every two, five, and seven days, with improved prediction compared with the open loop AI model (no assimilation) and actual observation. The result showed that for both models, the chlorophyll-a predictions upon assimilation (RMSE: 0.96 µg/l – 10.53 µg/l) were better than the open loop predictions (RMSE: 11.25 µg/l for LSTM and 11.36 µg/ for GRU). In addition, the results showed that prediction errors increase as assimilation frequency increases, with the highest accuracy obtained when new observations are assimilated daily. The study revealed the potential application of data assimilation strategy to enhance data-driven model water quality predictions. In the presence of new observations such as remotely sensed chlorophyll-a, findings from this research inform on the appropriate frequency to which such information can be incorporated into an HABs prediction model framework. This process ensures the model provides timely and accurate predictions to support effective HABs management and decision-making efforts.

SPEAKER: **Ibrahim Busari, Clemson University | ibusari@g.clemson.edu**

SPEAKER BIO: I am a third year PhD candidate at Clemson University, with research focused on the detection, prediction and monitoring of harmful algal blooms (HABs) in freshwater bodies. I have a Master degree in Water and Coastal Management from the University of Cadiz, Spain, and a Master in Environmental Assessment and Management from the University of Bologna, Italy. My research embodies the use of patterns in water quality and remotely sensed data to understand the triggers of HABs, predict their occurrence and as a decision support tool. I am also passionate about citizen science and research application, hence my involvement in extension activities that promotes the application of research findings for societal development.

CO-AUTHORS:
Debabrata Sahoo, Narendra Das

PLASMA PROTEOMICS OF LOGGERHEAD SEA TURTLES (CARETTA CARETTA) AND KEMP'S RIDLEY SEA TURTLES (LEPIDOCHELYS KEMPII) STRANDED DURING RED TIDE EVENTS FOR IDENTIFICATION OF DIAGNOSTIC BIOMARKERS

SESSION: Poster Session, Tuesday

ABSTRACT: Karenia brevis, better known as the Florida red tide organism, is a harmful marine dinoflagellate that blooms almost annually along the west coast of Florida. This organism produces the brevetoxins, a suite of potent neurotoxins that can cause serious health concerns for many species of wildlife, including sea turtles. The dinoflagellate cells and the brevetoxins can be transferred through the marine food web to reach carnivorous loggerhead and Kemp's ridley sea turtles, causing significant impacts on various physiological systems including immune, nervous, and muscular systems of these turtles once exposed. Sea turtles stranded during red tide can be rescued, transported to rehabilitation facilities, and given palliative care with the ultimate goal of release back to the wild. However, there are no definitive diagnostic criteria for brevetoxicosis in sea turtles other than stranding and association with red tide, and often sea turtles experience delayed exposure multiple weeks after a bloom because of the long temporal scale of trophic transfer of toxins. Our hypothesis is that brevetoxicosis can cause alterations in protein abundance in the plasma of sea turtles, and certain proteins with significant differences in abundance can be used as diagnostic biomarkers. Plasma samples that were taken from red-tide exposed and healthy sea turtles were analyzed via bottom-up labelled quantitative liquid chromatography tandem mass spectrometry-based proteomics to identify such biomarkers. We were able to conclude that the abundances of multiple plasma proteins are significantly altered when exposed to the red tide for sea turtles. With predicted increases in severity and duration of red tide blooms due to climate change, the threatened and critically endangered status of the loggerhead and Kemp's ridley sea turtles, and demonstration of plasma protein alterations after red tide exposure, this study can result in more accurate diagnoses and insights into mechanism-based treatments for wildlife with brevetoxicosis.

SPEAKER: **Celina Ceballos, Florida Gulf Coast University | cceballos3193@eagle.fgcu.edu**

SPEAKER BIO: Ms. Ceballos is a graduate student in the Master of Science, Environmental Science Program at Florida Gulf Coast University, presenting part of her master's thesis at the U.S. Symposium on Harmful Algae. She holds a Bachelor of Science in Marine Science from Eckerd College, which first allowed her to gain skills within the marine science field, participating in research projects, like a mangrove restoration lab and a herpetology lab. She analyzed the spatial and foraging ecology of gopher tortoises that culminated in a senior thesis, which eventually became her first peer-reviewed scientific publication in Herpetological Conservation Biology Journal (Ceballos and Goessling, 2023). As a Barry Goldwater Scholar and US Fulbright Scholarship recipient, she has numerous accolades that showcase her drive within the field. Ms. Ceballos has worked as a sea turtle nesting technician, currently with Collier County Parks & Recreation Department as an Environmental Specialist, and the summer of 2022 at Loggerhead Marinelife Center as a Morning Field Technician. In these two field positions, she has gathered data on more than 18,000 loggerhead, green, and leatherback crawls and nests, excavating nests, inventorying eggs and hatchlings, educating the public, and assisting with sea turtle strandings. From November 2022 to August 2023, she worked at the Georgia Sea Turtle Center as an Education Interpreter, teaching the public about sea turtles and completing husbandry and rehabilitation tasks for recovering hospital patients. She also participated in an NSF REU at the Marine Biological Laboratory in Woods Hole, MA studying coral resilience to climate change.

CO-AUTHORS: Kelly Rein

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TOXINS OF CONCERN IN SOUTHEAST ALASKA: A SOVEREIGN APPROACH TO SAFETY AND DATA COLLECTION

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: With a lack of testing available for the large coastal regions of Alaska, rural communities face great risk for food insecurity and food safety. Sitka Tribe of Alaska, in conjunction with the Southeast Alaska Tribal Ocean Research (SEATOR) network, have been testing shellfish for the presence of Paralytic Shellfish Toxins (PSTs) since 2016 to help ensure safe harvest of these culturally significant resources. Through this methodology, tribal governments throughout Southeast Alaska have been able to inform their communities about PST bloom activity and make recommendations about shellfish harvest. With changing climate and ocean conditions, rural and indigenous communities are faced with concerns about access to their natural resources. Emerging toxins of concern to these Alaskan communities include Diarrhetic Shellfish Poisoning (DSP) and Amnesic Shellfish Poisoning (ASP). Using NOAA MERHAB grant funding, Sitka Tribe of Alaska was able to analyze shellfish collected from over 400 miles of coastline for the presence of these biotoxins. The phytoplankton species known to produce these illnesses have been observed and recorded in Southeast Alaska for years, but there has previously been no baseline monitoring of the toxin levels within subsistence harvested resources. With increasing climate threats more pronounced at higher latitudes, Alaskan waters are at great risk for monumental impacts to its resources and therefore the health and safety of its communities. It is vital that we gain a greater understanding of the threats facing Alaskan food systems, to provide food security and cultural security to the many that call Alaska home.

SPEAKER: **Shannon Cellan, Sitka Tribe of Alaska | shannon.cellan@sitkatribe-nsn.gov**

SPEAKER BIO: Shannon Cellan is the Environmental Lab Manager for the Sitka Tribe of Alaska. Since 2021 she has found herself working and living on Lingít Aaní, the unceded lands of the Sheetk’á K̲wáan. Her work focuses on food security and the environmental threats that faces subsistence harvest, namely phycotoxins. In her free time, Shannon enjoys exploring the Alaska by foot, bike and kayak to take in all of its natural beauty.

CO-AUTHORS:
Claire Sears, Tod Leighfield, Kari Lanphier

U.S. National Office for Harmful Algal Blooms

SAXITOXINS IN LAKE ERIE

SESSION: EMERGING TOXINS & SPECIES

ABSTRACT: Cyanobacterial blooms in Lake Erie have been well studied with a focus on planktonic Microcystis and the cyanotoxins microcystins, but recent research has shown that blooms are not entirely Microcystis. Furthermore, cyanobacterial blooms in rivers and benthic cyanobacteria have historically been overlooked in Lake Erie. Saxitoxin (STX) is a cyanotoxin of emerging concern in freshwater. We conducted multiple studies in the Maumee River (which flows into the western basin of Lake Erie), western basin that included both plankton and benthic studies, and the central basin. We found the sxtA gene, which encodes for STX production, in all habitats, and the detections of sxtA were ephemeral in nature and lasted up to 3 weeks. In the Maumee River, sxtA gene copies/mL was negatively correlated with river discharge rate (r -0.44). We also detected STX (by ELISA) in the Maumee River. In the western basin, sxtA showed “hotspots” that lasted only a few weeks, and sxtA gene copies/mL did not correlate with Dolichospermum or Aphanizomenon biovolume. We deployed nutrient diffusing substrata (NDS) to determine the impact of nutrients, depth, and season on potential-STX producing benthic cyanobacteria. In the NDS, STX (ng/cm2) and cyanobacteria biomass were inversely correlated with the highest STX in September and at the deeper depth, whereas cyanobacteria biomass was highest during June and at the shallower depth. In the central basin, the cyanobacterial community shifted from Dolichospermum in the early summer to Microcystis in the late summer, and sxtA was only detected when Dolichospermum was present. This research suggests continued monitoring is needed to determine drivers of STX in the Maumee River-Lake Erie system, and we recommend that future Lake Erie cyanobacteria research and management should not solely focus on microcystins and planktonic blooms.

SPEAKER: **Justin Chaffin, The Ohio State University | chaffin.46@osu.edu**

SPEAKER BIO: Justin is the research coordinator at Ohio State University's Stone Lab located on South Bass Island in Lake Erie. Justin does research on HABs and coordinates visiting researchers using Stone Lab's facilities and vessels.

WALRUSES ARE EXPOSED TO PARALYTIC SHELLFISH TOXIN LEVELS THAT MAY IMPACT THEIR HEALTH DURING SUMMER ALEXANDRIUM BLOOMS IN THE ALASKAN ARCTIC

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS II

ABSTRACT: The continuing reduction in seasonal sea ice due to the warming marine environment in the Alaskan Arctic waters (Northern Bering, Chukchi, and Beaufort Seas) have resulted in summer conditions hospitable for massive harmful algal blooms (HABs) of the dinoflagellate Alexandrium catenella that produce paralytic shellfish toxins (PSTs). Paralytic shellfish toxin exposures from these blooms to key marine wildlife species harvested for subsistence purposes by Alaskan Arctic coastal communities are unknown. The Pacific walrus (Odobenus rosmarus divergens), is a marine mammal that preys on known vectors of PSTs (benthic invertebrates), making walruses an important model for assessing HAB activity with PST exposure. Here, we use paired phytoplankton (Alexandrium cell and cyst densities and PST content) and PSTs measured in benthic invertebrates collected throughout the Alaskan Arctic during a research cruise in summer 2022 to develop steady-state trophic transfer models of PSTs within the phytoplankton, benthic invertebrate, and walrus food chain. During the study period, adult walruses were exposed to daily PST oral doses ranging from 0.16 to 11.64 µg STX eq./kg based on PSTs measured in walrus prey. We also simulated a 6-week Alexandrium bloom in the Ledyard Bay region, which is close to a summer walrus haulout and a large Alexandrium cyst bed, using observed water temperatures during the cruise as baseline environmental conditions. This ecologically-relevant simulated bloom resulted in walruses exposed to a wider range of daily PST oral doses over 6 weeks with maximum doses up to 23.76 µg STX eq./kg. Results of model variability as well as PST exposure implications for walruses will be discussed. Preliminary findings indicate that walruses are exposed to PSTs during Alexandrium blooms that may impact their health; however, health effects and walrus-specific PST dose thresholds are currently unknown.

SPEAKER: **Patrick Charapata, NOAA Northwest Fisheries Science Center | patrick.charapata@noaa.gov**

SPEAKER BIO: I am a National Academies (NRC) Postdoctoral Researcher at the Northwest Fisheries Science Center in Seattle, WA. My current research focuses on building models to predict algal toxin (saxitoxin and domoic acid) movement among Alaskan Arctic foodwebs.

CO-AUTHORS:
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WATERBORNE METABOLITE BIOMARKERS OF HARMFUL ALGAL BLOOM INITIATION

SESSION: BLOOM DYNAMICS & DRIVERS III

ABSTRACT: Harmful algal blooms (HABs) are a public health threat increasing in longevity, intensity, and geographic range as the climate changes. Various bloom-forming phytoplankton species produce potent toxins. Exposure to these toxins harms humans and wildlife. Prediction of HABs would enable advanced public warnings to avert harm; however, we lack predictive methods prior to bloom onset. Specific microbial communities co-occur with HABs. Phytoplankton and bacteria partake in a range of interactions—often mediated by the exchange of small, diffusible metabolites in the water column—which can impact algal growth in model systems. Leveraging the algal microbiome via metabolic biomarkers in the water column may provide novel insight for predicting the timing and location of HABs. We hypothesized that the dissolved metabolomic profile shifts in the days preceding HAB formation. This hypothesis was investigated utilizing time series datasets from samples collected over one full cycle of a Chaetoceros sp. bloom and leading up to a second in Eastsound, Washington in 2021. We sampled every 12 hours to capture the waterborne metabolites and every 4 hours for nutrients and microbial community metaproteomics and metagenomics. Waterborne metabolite samples were analyzed via liquid chromatography–mass spectrometry to track temporal metabolite dynamics. The waterborne metabolomic profiles shifted in composition leading up to bloom formation. Importantly, some metabolites that were more constant in abundance increased or decreased in concentration as the bloom neared. Several metabolites exhibited diel rhythmicity, peaking in abundance at the evening timepoint. The rhythmicity of some of these days leading up to HAB formation. The metabolites exhibiting significant periodicity as the HAB approaches are biomarker candidates that can be tested in other bloom systems. Identifying metabolic biomarkers for predicting HAB formation will expand our capability to protect the public from exposure.

SPEAKER: **Gabriella Chebli, Georgia Institute of Technology | gchebli3@gatech.edu**

SPEAKER BIO: Gabriella Chebli earned her Bachelor of Science degree in Biology and Chemistry from Agnes Scott College. Currently, she is pursuing a PhD in Biology under Dr. Julia Kubanek at Georgia Tech in Atlanta. From 2021 to 2023, she was a fellow of Georgia Tech's Integrative and Quantitative Biosciences Accelerated Training Environment NIH T32 training grant program. In Dr. Kubanek's lab, she combines her interests in biology and chemistry to explore marine chemical ecology, specifically focusing on harmful algal blooms. Her research aims to understand harmful algal bloom dynamics in the context of algal-bacterial interactions and dissolved metabolites. She has had the pleasure of participating in two field seasons studying HABs with collaborators at the University of Washington on Orcas Island, WA, in 2021 and 2022. Outside of the lab, Gabriella is passionate about public outreach. She volunteers as a science fair judge at local middle and high schools in the greater Atlanta area, where she enjoys engaging with students and fostering their interest in STEM. Post-graduation, Gabriella hopes to continue her career in marine or aquatic science and research.

CO-AUTHORS:
Gabriella Chebli, Miranda Mudge, Emma Timmins-Schiffman, Brook Nunn, Sam Moore, David Gaul, Julia Kubanek

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

A COMMON TOOLKIT FOR HARMFUL ALGAL BLOOM MONITORING AND MANAGEMENT IN NATIONAL PARKS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: National Park units nationwide have experienced harmful algal bloom (HAB) events, with severity ranging from excess biomass to wildlife mortality. These events have been increasing in frequency and occurring in remote locations and water bodies with no previous history of HABs. To address these wide-ranging environmental health issues, a team of U.S. Geological Survey and National Park Service researchers developed a common Toolkit that all parks can use when faced with HABs. This toolkit provides a suite of HAB and toxin monitoring options, templates for signs and other public outreach, and an internal website of resources, such as training videos on phytoplankton identification and water collection. Despite unique environments and individual park resources, the Toolkit has proved useful to monitor, assess, and mitigate the effects of HABs in park units. Other Federal agencies, universities, tribes, and grass-roots organizations collaborated on the research behind the Toolkit. This interdisciplinary approach allowed a more complete comprehension of HABs, including an understanding of the occurrence and biogeography of common toxic and bloom-forming species. This presentation will provide an overview of the HAB Toolkit, first-hand accounts from park managers about their experiences, and commonalities across a wide range of marine and freshwater environments.

SPEAKER: **Victoria Christensen, USGS | vglenn@usgs.gov**

SPEAKER BIO: https://www.usgs.gov/staff-profiles/victoria-glenn-christensen

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

SPECIES-SPECIFIC & ECO-FRIENDLY GENE SILENCING FOR MITIGATION OF HARMFUL CYANOBACTERIAL BLOOMS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Harmful cyanobacterial blooms (HCBs) exert detrimental impacts on both freshwater ecosystems and human health. Conventional approaches to control HCBs involve chemical, physical/mechanical, and biological interventions. While these methods have proven effective in managing HCBs, there remains a pressing imperative to develop innovative and effective technologies capable of selectively targeting cyanobacteria responsible for HCB formation. To address this technological gap, we developed a novel gene silencing biotechnology to selectively control HCB-forming cyanobacteria. As a proof-of-concept study, we designed and assessed multiple gene silencing agents such as antisense oligos (ASOs) to disrupt the expression of essential genes in Microcystis aeruginosa, a common cyanotoxin-producing cyanobacterium. We incubated the gene specific ASOs with a M. aeruginosa culture for up to 7 days and analyzed both gene expression and physiological endpoints, including optical intensity, chlorophyll a content, phycocyanin, and quantum yield. Testing results showed a dose-response relationship between ASO treatments and measurement endpoints as increasing ASO concentrations caused elevated reduction in cell density, chlorophyll contents, and photosynthetic efficiency in M. aeruginosa. We also determined the lowest effective concentration for each ASO. Visual observations indicate clear-cut, dose-dependent growth inhibition, corroborating analytical endpoints. These results suggest that ASO-based gene silencing provides a promising gene- and species-specific, environmentally benign solution. We are currently conducting microcosm and mesocosm studies to further investigate the scalability and efficacy of this technology on Microcystis blooms.

SPEAKER: **Seung Ho Chung, US Army Engineer Research and Development Center | Seung.H.Chung@usace.army.mil**

SPEAKER BIO: Dr. Seung Ho Chung is a research biologist with the US Army Engineer Research and Development Center in Vicksburg, Mississippi. He obtained a Ph.D. in Entomology from Pennsylvania State University with a dissertation on elucidating plant-bacteria-insect interactions. During his academic career, he employed biochemical and molecular approaches (including RNA interference) to understand multi-species interactions. His research currently focuses on the discovery and application of gene-silencing agents for the control of toxin-producing cyanobacteria and invasive plants.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ALLEVIATION OF PHYTOPLANKTON LIGHT LIMITATION BY SALINITY INTRUSION IN A CDOM RICH, OLIGOHALINE ESTUARY

SESSION: Bloom Dynamics & Drivers I

ABSTRACT: Oligohaline zones of estuaries are often subject to harmful algal blooms. The Chowan River-Albemarle Sound is an oligohaline, eutrophic estuary in northeastern North Carolina. In recent summers, toxigenic cyanobacterial blooms have threatened the ecosystem and its value as an important commercial fishery. Typically, salinity is very low (0-2 psu) throughout what is normally a well-mixed water column. However, intrusions of saltier bottom water (4-8 psu) occur episodically during summer and autumn when river flow is low. High concentrations of colored dissolved organic matter greatly reduce light penetration in the water column. With such strong light attenuation, periodic salinity intrusion events that create a shallower mixed layer might be important for alleviating light limitation. In summer 2023, we measured photosynthetic rates under different irradiances to determine the light limitation status of phytoplankton in the Chowan River-Albemarle Sound and investigated the influence of a salinity intrusion event on light limitation. Phytoplankton production was light-limited even in summer when incident solar radiation was high. The salinity intrusion resulted in a 51% decrease in mixed layer depth and a 59% increase in mean water column irradiance within the mixed layer, thereby partially alleviating light limitation. The dominant algal genus changed from dominance by the high-light adapted cyanobacteria, Dolichospermum, during the salinity intrusion to the low-light adapted cyanobacteria, Pseudanabaena, after the salinity intrusion ended. Phytoplankton growth rates following the salinity intrusion were higher than during the salinity intrusion indicating that the effect of reduced light in the absence of salinity intrusion was offset by higher photosynthetic efficiency of the shade-adapted taxa. Understanding these community-level phytoplankton responses to physically-forced changes in light availability will help explain bloom dynamics and increase the predictability of blooms.

SPEAKER: **Mingying Chuo, University of North Carolina | mchuo@unc.edu**

SPEAKER BIO: I'm a third-year Ph.D. candidate in Marine Sciences at the University of North Carolina at Chapel Hill. I have been doing research on harmful algal blooms since 2016. In 2021, I began to investigate nutrient and light limitation of phytoplankton growth in Albemarle Sound, North Carolina. Increased knowledge of the drivers of harmful algal blooms will provide information for design of bloom prevention strategies that will be globally relevant to improving water quality for drinking, recreation, fishing, and protecting aquatic life.

CO-AUTHORS:
Nathan S. Hall

SINGLE NUCLEI RNA-SEQUENCING REVEALS MICROCYSTIN-LR INDUCES LIVER CELL TYPE-SPECIFIC EFFECTS IN HEALTHY VERSUS METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE MICE

SESSION: CELLULAR & MOLECULAR TECHNOLOGY

ABSTRACT: Microcystin-LR (MCLR) is a potent hepatotoxin that may contribute to the progression of metabolic dysfunction-associated steatotic liver disease (MASLD). Although MCLR hepatotoxicity has been investigated for several decades, knowledge of cell type specific effects of MCLR is limited. The current study utilized single nuclei RNA sequencing to determine the cell type specific effects of MCLR in the livers of healthy versus pre-existing MASLD mice. Mice were administered either a control or a high fat/high cholesterol diet for 14 weeks, followed by oral gavage of vehicle or MCLR (0.8 mg/kg) for 14 days. A total of nine different cell types were identified and included endothelial cells, cholangiocytes, stellate cells, B-cells, T-cells, macrophages, dendritic cells, and two groups of hepatocytes. MCLR and the MASLD diet caused an additive decrease in the proportion of hepatocytes (p=0.003) and an additive increase in the proportion of macrophages (p=0.006). The number of differentially expressed genes in hepatocytes caused by MCLR was higher in the healthy livers compared to the MASLD livers (4,908 versus 3,626, respectively), whereas the opposite was observed in cholangiocytes (178 vs 336, respectively). Stellate cells followed the same trend as hepatocytes, while B-cells, T-cells, dendritic cells, macrophages, and endothelial cells followed the same trend as cholangiocytes. These data demonstrate a greater hepatocyte and stellate cell response to MCLR in healthy livers, but greater immune cell response to MCLR in pre-existing MASLD livers. Despite the overall number of MCLR dysregulated genes being greater in healthy hepatocytes, many mitogen activated protein kinase (Mapk), matrix metalloprotein (Mmp), and collagen (Col) genes were induced by MCLR to a greater degree in the MASLD hepatocytes compared to the healthy hepatocytes, suggesting a potential greater susceptibility to MCLR-elicited fibrosis in pre-existing MASLD. These data highlight potential differences in MCLR hepatotoxicity in at-risk populations with pre-existing liver disease.

SPEAKER: **John Clarke, Washington State University | j.clarke@wsu.edu**

SPEAKER BIO: Dr. Clarke is an Associate Professor and Vice-Chair of the Department of Pharmaceutical Sciences at Washington State University Health Sciences campus in Spokane, WA. He received his B.S. in biology from Brigham Young University-Idaho and his Ph.D. in Molecular and Cellular Biology from Oregon State University. He completed a postdoctoral fellowship in the department of Pharmacology and Toxicology at the University of Arizona with Dr. Nathan Cherrington. His research interests and expertise are focused on elucidating the mechanisms of inter-individual variability in xenobiotic metabolism, disposition, and toxicity. This includes extensive research with microcystins. He has been funded for his microcystin research through the NIEHS-funded Southwest Environmental Health Sciences Center pilot project and career development awards, through an NIEHS-funded K99/R00, and an NIEHS-funded ONES award. He has previously served in the Society of Toxicology as the Postdoctoral Representative to the Mechanism SS (2012-2013), as a Councilor for the SOT Postdoctoral Association Executive Board (2014-2015), and in the Presidential chain of PANWAT (2021-2024). He was the recipient of the 2023 Society of Toxicology Achievement Award.

CO-AUTHORS:
Katherine D. Lynch, M. Ridge Call, Michael Goedken, Rance Nault, Timothy Zacharewski

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

MODEL LOGIC VALIDATION OF RESPIRATORY IRRITATION FORECAST (RIF) IN SOUTHWEST FLORIDA FROM 2006 - 2023

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: On nearly an annual basis, blooms of Karenia brevis produce negative impacts to beach-goers and wildlife alike, including respiratory irritation along the southwest Florida coast. In response, NOAA developed a respiratory irritation forecast (RIF) model to provide beach-goers with a category-based forecast of respiratory irritation risk at individual beaches in the Gulf Coast region. The RIF model is based on: 1) monitoring of K. brevis cell counts collected at individual beaches by state and county agencies plus local community scientists; 2) high resolution wind forecasts provided by NOAA's National Weather Service (NWS); and (3) point-based beach shoreline orientation used to designate onshore and offshore winds. In order to test the model logic, an analysis of modeled respiratory irritation hindcasts were compared to same-day reports of respiratory irritation, based on frequency of coughs at individual beaches, from the Beach Conditions Reporting System (BCRS). Overall, the RIF model demonstrated strong skill and proved to be 88% accurate when K. brevis blooms were present along the SW Florida coastline. In addition, validation efforts confirm the overall assumptions of the model logic, including: 1) reports of higher respiratory irritation correlate with higher cell count concentrations; and 2) when cells are present, onshore winds lead to higher respiratory irritation. However, we found that individual model categories, particularly hindcasts of 'low' and 'moderate' respiratory irritation, were less robust and will need to be reassessed. Furthermore, BCRS is not a direct measure of aerosol presence, so some coughing (i.e., modeled false negatives) may result from other factors such as swimming. Taken together, validation results suggest the RIF model logic accurately predicts 'very low' and 'high' risk of respiratory irritation at beaches across the SW Florida coast, but that additional research is needed to better capture environmental conditions when respiratory irritation is 'low' to 'moderate'.

SPEAKER: **Kathrine Collins, CSS-Inc., under contract to NOAA National Centers for Coastal Ocean Science | kathrine.collins@noaa.gov**

SPEAKER BIO: A native of the Eastern Shore of Maryland, Katie's passion for weather led her to Penn State for her undergrad in Meteorology and University of Maryland for her graduate degree in Atmospheric and Oceanic Science. She spent 3 years at NASA researching vector based mosquito disease outbreaks and their environmental conditions as detectable by satellites. The next 3 years she transitioned back to UMD and performed data processing and GIS work for the Global Land Cover Facility team. And since 2015, Katie has been supporting the National Centers for Coastal Ocean Science as a Scientific Computer Programmer in the Harmful Algal Bloom Forecasting branch. Her hobbies include reading, learning foreign languages, and if the mood strikes painting/drawing.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

USING COMMUNITY SCIENCE TO MONITOR HARMFUL ALGAL BLOOMS IN MONMOUTH COUNTY, NJ

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: New Jersey's coastal lakes are found directly adjacent to and connected with the Atlantic Ocean in urbanized watersheds. These waterbodies are valued by surrounding communities, but historically have degraded water quality due largely to stormwater runoff. Degradation presents itself in many ways, including nutrient pollution, eutrophication, and harmful algal blooms. Past monitoring efforts were done on a lake-by-lake basis, with little inter-lake communication, leading to a disjointed understanding of coastal lakes overall. The Coastal Lakes Observing Network (CLONet) was created to foster a collaborative, unified approach to lake monitoring that includes engaging community scientists in participatory research.

The CLONet at Monmouth University provides Monmouth County volunteers with water quality test kits to measure Secchi depth, temperature, conductivity, dissolved oxygen, and atmospheric conditions. One volunteer per lake is equipped with a Fluorometer to measure phycocyanin levels in a direct effort to monitor potentially harmful algal blooms. Data are uploaded to a common database through a web-based portal and then shared back to the community through a public shiny app. Community scientists help monitor their local lakes while developing a better understanding of what each parameter means for the overall health of their lakes. Opening this communication allows the CLONet to have local knowledge of each lake, coordinate partnerships, and help define a regional approach to future restoration projects. Community scientists can use CLONet data collected over the past five years, in addition to data from a parallel University / State monitoring program, to observe changes in water quality as restoration projects proceed.

SPEAKER: **Erin Conlon, Monmouth University | econlon@monmouth.edu**

SPEAKER BIO: Erin graduated from Monmouth University in May 2020 with a B.S. in Marine and Environmental Biology and Policy. She worked on many undergraduate research projects including phytoplankton comparisons in the Shrewsbury / Navesink Two Rivers System, and HAB studies in 10 Monmouth County coastal lakes. She became the community science coordinator for a coastal lakes monitoring program in 2020 (Coastal Lakes Observing Network) with the Urban Coast Institute at Monmouth University, and has been growing that program ever since. She has since added a second community science program focusing on eDNA collection of shoreline samples to monitor fish community composition throughout offshore wind development.

CO-AUTHORS:
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USEPA REGION 1 CYANOBACTERIA MONITORING AND ANALYSIS IN NEW ENGLAND AND BEYOND

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Harmful algae blooms (HABs), formed by toxin producing cyanobacteria are currently one of the largest threats to freshwater systems and those who rely on them. As climate change progresses HABs are predicted to become more prevalent in New England and across the country. EPA Region 1 has been addressing this issue through multiple programs such as the Cyanobacteria Monitoring Collaborative (CMC), a multi-tiered approach to monitoring HABs. Through the CMC, EPA has utilized, regional state and National Park Service partnerships to distribute kits for cyanotoxin sampling to a vast network of citizen scientist. Kits provided include all materials needed to collect samples as well as educational resources for participants to identify HABs. Sampling kits are then shipped back to the EPA New England Regional Laboratory in North Chelmsford, MA where they are analyzed for multiple cyanotoxins, fluorometry, and taxonomic identification. This collaborative effort has provided critical cyanobacteria data for waterbodies to state, local and federal partners as well as stakeholders who rely on the freshwater systems and their services.

SPEAKER: **Corey Conville, USEPA Region 1 | conville.corey@epa.gov**

SPEAKER BIO: Corey is a biologist at USEPA's New England Regional Laboratory. He holds a bachelor's and master's degree in biology from Bloomsburg University of Pennsylvania. His work primarily focuses on biologic and water quality monitoring surveys as well as harmful algae bloom research.

GEOGRAPHIC VARIABILITY AND SEASONAL PATTERNS OF PARALYTIC AND DIARRHETIC SHELLFISH TOXIN CO-OCCURRENCE IN THE PUGET SOUND REGION

SESSION: PUBLIC HEALTH

ABSTRACT: Shellfish are of utmost cultural, recreational, and commercial importance in Washington State. However, the accumulation of marine biotoxins in shellfish, which often occurs after a bloom of toxin-producing algae, can pose severe health risks to shellfish consumers. While Paralytic Shellfish Toxins (PSTs) have been well monitored for decades, Diarrhetic Shellfish Toxins (DSTs) were only recently detected in Washington but were soon found to be widespread throughout the Puget Sound and neighboring marine basins. This study investigates the frequency, intensity, and variability of PSTs, DSTs, and their co-occurrence across various marine basins in Washington State's Puget Sound during the first decade of co-monitoring. Biotoxin monitoring data for PST and DST were sourced from the Washington Department of Health and were used to identify when and where toxin co-occurrence was observed from 2012 to 2022. Additionally, Bayesian Hierarchical autoregressive models were created to parse out the effects of month, year, and marine subbasin on PST and DST concentrations. The findings reveal distinct geographic patterns in toxin occurrences. The Eastern Strait of Juan de Fuca, North Puget Sound, and Central Puget Sound emerge as hotspots for both PSTs and DSTs, with consistently high toxin activity observed over the study period. In contrast, Saratoga/Whidbey Basin and Hood Canal display notably low frequencies of toxin events, with sporadic spikes in toxin concentration punctuating long periods of inactivity. Furthermore, the study identifies seasonal trends in both toxins, suggesting temporal alignment of PST and DST peaks. Additionally, certain basins exhibit unique month effect patterns, indicating basin-specific environmental influences on toxin concentration. Overall, these findings provide valuable insights into the spatial and temporal dynamics of shellfish toxins in the Puget Sound region and support the Washington Department of Health (WDOH) in assessing the necessity for further investigation into the health implications of toxin co-exposure.

SPEAKER: **Lauren Cortez French, University of Washington | lrcfrench1@gmail.com**

SPEAKER BIO: Lauren is a recent master's graduate of University of Washington's School of Marine & Environmental Affairs where she focused on the intersection between ecosystem and human health related to marine biotoxins in the Puget Sound. She is pursuing a career in water resources management with the goal of improving human health outcomes associated with freshwater and marine systems.

CO-AUTHORS:
Ryan Kelly

EXPANDED GENETIC RESOURCES FOR HARMFUL ALGAL BLOOM RESEARCH

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Alexandrium spp. from Bigelow Laboratory's NCMA culture collection were genotyped by long-read amplicon sequencing to validate and standardize the genetic information associated with these valuable biological resources. A dual-indexing approach was used to prepare PCR amplicons from each culture, which allowed for cost-effective DNA sequencing of multiple gene targets on the Oxford Nanopore Technologies MinION sequencer. Sequences were also generated for Alexandrium cultures that were isolated recently from the coast of Maine (USA), confirming their identity as Alexandrium catenella. Gene copy numbers per cell of cultured A. catenella were estimated for both ribosomal RNA and saxitoxin genes to allow for the estimation of cell abundances from gene abundance measurements in environmental samples. Using this quantitative molecular approach, the abundance of Alexandrium catenella was estimated from numerous sites along Midcoast Maine that were sampled between 2021 and 2024 as part of the Maine-eDNA project. Development of expanded genetic resources from algal culture collections, (e.g., long-read DNA sequences, estimates of gene copies per cell, and mixed-species DNA standards) will allow for faster developments of new monitoring technology, faster responses to HAB events, and a greater understanding of HAB ecology.

SPEAKER: **Peter Countway, Bigelow Laboratory for Ocean Sciences | pcountway@bigelow.org**

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NEW INSIGHTS INTO THE NATURE OF KARENIA BREVIS BLOOMS: PERIODICITY IN CELL CONCENTRATION AND HOW RED TIDES ARE DIFFERENT FROM ORDINARY BLOOMS.

SESSION: BLOOM DYNAMICS & DRIVERS IV

ABSTRACT: Applying a low-pass filter to the Florida FWC time series of K. brevis cell concentrations reveals limit-cycle oscillations with periods of 40-100 days. These periods are consistent with the time-delay logistic equation, a non-linear differential equation used to describe single-species population growth where the effect of a change in population size on growth rate is not immediate. The delay time required to explain the observed oscillation period of 40-100 days is 6-10 days, about twice the time required for a K. brevis cell cycle. It is hypothesized that this is caused by asymmetric cell division creating non-reproductive cells that are optimized for photosynthesis and undergo programmed cell death in order to supply nutrients for the reproductive cells.
K. brevis bloom severity is defined as the product of bloom average Kb concentration in millions of cells L-1 and bloom duration in number of days from first to last cell concentration ≥1 × 105 cells L-1: only red tides have severities >100. Red tides differ from ordinary blooms in two additional respects: they consume more nitrogen (N) than can be supplied by known sources and their severity is related to bloom-year precipitation, especially in Lee County where offshore submarine groundwater discharge (SGD) is likely. Both of these observations can be explained by accumulation of SGD N in benthic biomass through dissimilatory nitrate reduction to ammonium (DNRA) using sediment labile organic carbon (LOC) as the electron donor. When DNRA is active, groundwater N is captured by benthic biomass, so precipitation has little effect on bloom severity and not enough N is available to support a red tide. When LOC is exhausted, DNRA ceases, N is released to support a red tide, and N transported by precipitation-driven SGD passes directly into the water column so that increased precipitation increases red tide severity.

SPEAKER: **James Culter, Mote Marine Laboratory | jculter@mote.org**

SPEAKER BIO: Mr. Culter joined Mote Marine Laboratory in 1979 to develop a Benthic Ecology Program specializing in marine/estuarine ecology and environmental assessment with emphasis on benthic habitats and invertebrate ecology. He is currently leading studies of karst features (blue holes) of the Gulf of Mexico, coupled with the investigation of submarine aquifer seepage on the southwest Florida continental shelf (WFS). These studies resulted in the discovery of possible benthopelagic nutrient coupling driven by submarine groundwater exchanges. He has made assessments of the impacts of red tide mitigation clay compounds on non-target invertebrate species. Over the course of a long career projects have included shellfish restoration, power plant impacts, quantification of benthic fauna on the WFS, benthic ecology of tidal rivers and estuaries, seagrass, reef and hydrological surveys and a benthic biodiversity survey of the greater Charlotte Harbor estuary. Mr. Culter is the chair of the Mote Diving Control Board and a deep trimix (100 meters) certified diver and organized a team of scientific technical divers to conduct the first scientific scuba dives on Pulley Ridge, the deepest coral reef (67 – 76 meters) in the continental U.S., for the purpose of collecting research materials.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ENHANCING HABSCOPE'S AI CAPABILITIES THROUGH INTERDISCIPLINARY COLLABORATION

SESSION: Applications of Emerging Technologies II

ABSTRACT: The HABscope project, an innovative initiative leveraging artificial intelligence (AI) to monitor harmful algal blooms (HABs), has evolved significantly from its inception in 2016 to the latest version, HABscopeV3, in 2023. This progression underscores a crucial lesson: the integration of diverse expert knowledge markedly enhances the project's scientific outcomes and operational efficiency. As HABscope transitioned from a simple device using minimal code to a sophisticated system employing complex AI algorithms and local classification, the need for specialized skills became increasingly apparent.

Biologists bring indispensable expertise to HAB projects, offering deep insights into ecological dynamics, species behaviors, and environmental impacts. Their contributions are fundamental in defining the biological parameters crucial for AI models that predict and analyze HAB occurrences. However, the rigorous development and training of these AI models often fall outside the traditional skill set of biology professionals. Data scientists, with their expertise in machine learning algorithms, data handling, and computational modeling, fill this gap. They ensure that AI systems are not only built on solid algorithmic foundations but are also capable of robust, scalable performance under varied environmental conditions.

Collaboration between biologists and data scientists creates a synergy where each expert addresses aspects of the project that align with their specialized knowledge. For HABscope, this interdisciplinary approach has led to substantial improvements in the accuracy of bloom detection and the usability of the system in diverse settings, even extending its applications to study phenomena like microplastics and shellfish larvae. Moreover, the integration of these fields facilitates a more comprehensive understanding and application of AI, driving forward innovations that are technically sound and biologically relevant.

This presentation will delve into specific instances from the HABscope project, illustrating how collaborative efforts between data scientists and biologists not only bridge the gap between two distinct fields but also significantly enhance the project’s scientific rigor and practical impact. Through this case study, we advocate for a model of interdisciplinary collaboration as a cornerstone for future AI-driven environmental research projects.

SPEAKER: **Robert Currier, TAMU / GCOOS | robertdcurrier@gmail.com**

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TOXICITY AND UNDERLYING TRANSCRIPTIONAL DYNAMICS AMONG POPULATIONS OF THE BIOLUMINESCENT HAB SPECIES PYRODINIUM BAHAMENSE FROM THE INDIAN RIVER LAGOON, FL

SESSION: BLOOM DYNAMICS & DRIVERS IV

ABSTRACT: P. bahamense is a toxic, bioluminescent dinoflagellate that bloomed in the Indian River Lagoon (IRL), along the east coast of Florida, for years with no known record of saxitoxin (STX) production. In the mid-2000s, STX was identified in P. bahamense populations in Florida, marking the first documented occurrence of toxin production. No molecular data exist on P. bahamense populations from this time. SxtA4 is a key gene required for toxin biosynthesis. Previous single cell analysis revealed that both sxtA4+ and sxtA4- cells were present within IRL P. bahamense populations. Here, we performed sxtA4 genotype analysis from multiple sites during the 2022 season. We also sampled exclusively at one of the sites over consecutive (3-4) days over several months in 2023. Data collected included cell abundance; toxin quota, normalized to a per cell basis; sxtA4 genotyping (2022, among multiple sites); and sxtA4 and RubisCo (rbcL) transcript abundance. Toxicity varied both spatially and temporally, even among consecutive days. There was a significant negative correlation (Spearman Rank Correlation, $r = 0.434$, $p < 0.02$) between cell abundance and toxin quota per cell. When normalized to the number of samplings per site, the sxtA4- genotype occurred more frequently (or always) at two locations particularly known for their strong bioluminescence. The underlying mechanism for toxin decrease with increased cell abundance remains unknown. However, a strong, statistically significant negative correlation (-0.692, $p = .008$) was found between stxA4 transcripts and the sxtA4/rbcL ratio for each individual samplings in 2023. This suggests: (1) cells are making less sxtA4 transcripts, or (2) more sxtA4- cells are present. Based on these results, a model is proposed that links the combined traits of toxicity and bioluminescence in P. bahamense bloom development.

SPEAKER: **Kathleen Cusick, University of Maryland | kcusick@umbc.edu**

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EVALUATING AN ESTUARINE MAT-FORMING CYANOBACTERIUM FOR SECONDARY METABOLITE PRODUCTION USING GENOMIC AND CHEMOINFORMATIC ANALYSES

SESSION: BENTHIC HABS

ABSTRACT: Cyanobacterial harmful algal blooms (CHAB) commonly produce toxic secondary metabolites (SM) which threaten the well-being of humans, livestock, and wildlife. Most toxin monitoring programs rely on ELISA-based and targeted tandem mass spectrometry (LC-MS/MS) analyses to identify CHAB SM from surface water collections. However, such analyses often neglect benthic proliferations and do not identify emerging biologically active SM classes of interest.

Recently, our collaborators at the U.S. EPA identified an expansive benthic cyanobacterial mat occurring along the banks of Pensacola Bay, FL, USA and established representative strains in culture. This proliferation has recurred annually over several years and appears to be predominated by a single filamentous cyanobacterial genus. During Fall 2021, cylindrospermopsin and microcystin LR were detected near the collection site using passive sampling but were not detected in laboratory cultivated extracts of the filamentous strain using untargeted HR-ESI-LC-MS/MS. Chemoinformatic analyses were used to identify multiple unknown peptidic SM.

Major SM will be obtained using cytotoxicity- and MS-guided purification, with structure elucidation carried out using HR-MS, NMR spectroscopy, 15N isotopic labeling, and genomic analyses using antiSMASH. Shallow shotgun sequencing will be used to evaluate inter- and intraspecies diversity present at the time of initial sample collection and compared with the taxonomic assessment of the filamentous strain based on the partial 16S rRNA gene. This investigation highlights the potential impacts that benthic mat-forming cyanobacteria have on the production of new SM, particularly from understudied locations.

SPEAKER: **Lydia Davis, University of North Carolina | davisla@uncw.edu**

SPEAKER BIO: Dr. Lydia Davis is currently a postdoctoral scholar at the University of North Carolina Wilmington (UNCW) under the guidance of Dr. Wendy Strangman. Dr. Davis earned her doctorate in Pharmacognosy at the University of Illinois at Chicago under the aegis of Dr. Jimmy Orjala where she focused on anticancer drug discovery and MS-based metabolomics from cultured freshwater filamentous cyanobacteria. Currently, her research involves the metabolomic characterization of dissolved organic matter on marine reefs and natural products drug discovery from cultured microbes using classical techniques (bioassay-guided isolation, NMR, HR-MS) and chemo- and bioinformatic approaches.
Linktree: https://linktr.ee/lydia.davis?utm_source=linktree_profile_share

CO-AUTHORS:
Avery O. Tatters, Wendy Strangman

COMPANION ANIMAL MORTALITY FROM ORAL EXPOSURE TO PALYTOXIN WITH FIRST CONFIRMATION OF EXPOSURE IN CLINICAL SAMPLES

SESSION: PUBLIC HEALTH

ABSTRACT: Palytoxin and related compounds, herein referred to as PLTX, are an extremely potent group of marine biotoxins produced by select cnidarian zoanthids (colonial anemones) as well as Ostreopsis spp. dinoflagellates. The toxic activity of PLTX results from binding to sodium potassium ATPase converting this critical cellular ionic pump into a non-selective pore causing a multitude of downstream negative effects ranging from the cellular to organismal level, depending on dose and route of exposure. Potential routes of exposure to PLTX include dermal, ocular, and respiratory during blooms of PLTX producing Ostreopsis and exposure to PLTX producing zoanthids in home and commercial aquaria. Although less common, oral exposure typically results from the consumption of PLTX contaminated seafood. We report a case of companion animal mortality from oral exposure to PLTX during the maintenance of a home aquarium containing toxic zoanthids with the first report of PLTX detection in clinical samples. Exposed animals (dogs, n=2) reportedly licked rocks containing attached zoanthids that had been previously air-dried outdoors. Animal 1 became ataxic, collapsed, and died almost immediately while animal 2 presented with ataxia and died within 12 hours of exposure. Necroscopic examination of animal 2 revealed acute, multifocal hemorrhage of the thymus, pancreas, mucosa of the urinary bladder and pericardium of the heart, and acute congestion in the small and large intestines, submandibular lymph nodes, lung, kidney, liver, and spleen with death likely due to severe internal hemorrhage. PLTX was confirmed by HPLC-UV and LC-HRMS analysis in dried zoanthid samples removed from the rock associated with the exposures (300-600 µg PLTX/g dry weight zoanthid). Analysis of stomach content and drained blood samples from liver and kidney tissue from animal 2 using a magnetic bead-based sandwich immunoassay detected PLTX at an approximate concentration of 3 ng/mL in kidney samples and 0.3 ng/mL in liver samples.

SPEAKER: **Jonathan Deeds, US FDA | jonathan.deeds@fda.hhs.gov**

SPEAKER BIO: Dr. Jonathan Deeds is a research biologist at the United States Food and Drug Administration Center for Food Safety and Applied Nutrition, located in College Park, Maryland, USA, where he serves as a principal investigator and subject matter expert for marine and freshwater biotoxins and food safety. A primary focus of Dr. Deeds' laboratory is the development and validation of methods for the detection of biotoxins in FDA regulated products including seafood and products potentially contaminated with freshwater cyanotoxins.

CO-AUTHORS:

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BETWEEN THE BENCH AND THE BAY: METHODS AND CONSIDERATIONS FOR CONDUCTING LARGE-SCALE MESOCOSM EXPERIMENTS FOR HAB MITIGATION PERMITTING PURPOSES

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: Throughout the United States, a variety of compounds and technologies are currently being investigated in state and federal programs for the purpose of mitigating harmful algal blooms (HABs). These products and techniques undergo rigorous testing in laboratory settings for their efficacy against cells and toxins, and for their potential effects on water quality, and must meet certain standards of environmental safety before they can be tested in situ. The requirements to obtain permits for in situ testing can vary by state, and often include some form of animal testing, whether it be LD50's or measurements of behavioral or physiological responses. In the Red Tide Mitigation Initiative, a state-funded program, we have created standard protocols for testing mitigation products with macroinvertebrates (clams, urchins, and crabs) in mesocosms, which has led to mesocosm experiments becoming an expected prerequisite for obtaining field permits by the state. Here, we present the development of our protocols and methods for testing HAB mitigation products for permitting purposes, and the lessons learned in the process. We aim to share with other researchers the questions and considerations that we have encountered in conducting mesocosm tests with macroinvertebrates, and the balances that must be struck between scale, cost, time, and statistical power in experimental design when working with large aquaria, large numbers of animals, and small replicate sizes.

SPEAKER: **Victoria Devillier, Mote Marine Laboratory | victoria.roberts@ucf.edu**

SPEAKER BIO: Victoria M. R. Devillier is a marine biologist with a Ph.D. in Biology from the University of Central Florida and a B.S. in Biology and Environmental Studies from St. Mary's College of Maryland. Currently conducting post-graduate research at Mote Marine Laboratory in Sarasota, FL, she specializes in harmful algal blooms, mitigation techniques, and marine ecosystem dynamics. Dr. Devillier has made significant contributions to the field of red tide mitigation through her research on the effects of modified clay, curcumin, and other products on Karenia brevis cells and toxins, water quality, and physiological responses of macro-invertebrates.

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MANAGING WATER QUALITY IN AN URBAN LAKE: EVALUATION OF THE LARGEST NANOBUBBLE TECHNOLOGY DEPLOYMENT IN THE U.S. AT LAKE ELSINORE, CA

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Because it does not involve the use of artificial chemicals, nanobubble technology is increasingly being used as a novel, sustainable tool for algae control and environmental remediation in lakes and ponds. Recently, nanobubble treatment was applied to Lake Elsinore in the City of Lake Elsinore, CA, representing the largest demonstration to date of the technology in the U.S. Lake Elsinore is a 3,000-acre natural, freshwater lake that is a popular recreation destination. Historically, the lake has been plagued by moderate to severe harmful cyanobacterial blooms that have resulted in repeated lake closures and unpleasant odors impacting nearby communities. In response, the City of Lake Elsinore implemented a multi-faceted approach to remediate water quality in the lake, including treatment of the Elm Grove Beach Lake area with nanobubble technology. This treatment, installed and commissioned on February 8th, 2024, consists of a barge-mounted, containerized oxygen and ozone nanobubble injection system. The equipment recirculates water at 2,400 GPM. To determine treatment effectiveness, multi-parameter sondes were deployed in seven locations in the treatment area to continuously monitor water quality. Periodic sediment hardness mapping was also conducted. As of this abstract submission, only the first month of operational data has been analyzed. Lake clarity (i.e. Secchi depth) increased by over 200%, from a historical average of 0.2m-0.3m to 0.8m. Oxidation-reduction potential (ORP) also more than doubled, while relative Chl a fluorescence was approximately eight times lower than at the start of treatment (ORP: 263 vs. 119 mV; Chl a: 0.38 vs. 3.20 RFU). This presentation will cover deployment of the nanobubble treatment, the contribution of this treatment to the City's overall lake management plan, and water quality results from the first six months of operation.

SPEAKER: Denise Devotta, denise@moleaer.com | denise@moleaer.com

SPEAKER BIO: Dr. Denise Devotta Moleaer's dedicated limnologist. In this role, she develops and refines ways to apply Moleaer's nanobubble technology to freshwater ecosystems across the U.S. and worldwide. Also, she conducts research regarding the impacts of Moleaer's technology on freshwater ecosystems. Dr. Devotta holds PhD and Masters in Environmental Sciences, with a focus on Ecology, Evolution, and Conservation Biology from the University of Illinois at Urbana-Champaign. With over 15 years' expertise, she has led groundbreaking research and applied freshwater science to tackle global water quality challenges with remarkable success. Known for her collaborative spirit, Dr. Devotta has partnered with organizations such as the United Nations Environment Programme, U.S. Congress, governments of both the U.S. and Singapore, as well as various private industries, and NGOs, addressing a spectrum of water-related issues.

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DETERMINING THE IMPACT OF BLOOM STAGES ON THE CIRCADIAN RHYTHM OF NATURAL POPULATIONS OF MICROCYSTIS AERUGINOSA IN LAKE ERIE

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The cyanobacterium Microcystis aeruginosa is a dominant, toxic, bloom-forming competitor in many aquatic ecosystems. It has the capability to form massive algal blooms that can choke out critically important vegetation and lead to dead zones in freshwater and brackish ecosystems. It also has the capacity to release a potent liver toxin, microcystin, as a secondary metabolite that can be toxic to animals, including humans. Abiotic factors contributing to its competitive success such as light, temperature, and nutrient availability, have been intensely studied. Although biotic factors have been investigated, the contribution of a circadian rhythm over a diel cycle to bloom succession is still somewhat of a black box. This study aims to identify specific genes in natural populations of Microcystis aeruginosa that are controlled by an internal clock regulation and if that varies by stage of bloom development and/or the activity of the associated bacterial microbiome. Samples for RNA-Seq representing three stages of bloom development (June 2023, pre-bloom; August 2023, peak bloom; late September 2023, bloom decline) were collected from Lake Erie for both day and night timepoints to capture differences in community structure, overall function, and circadian rhythm. These molecular samples were paired with traditional microbial limnological samples, including photosynthetic pigments (chlorophyll a, phycocyanin), cell counts, nutrients, and toxin concentration for a robust ecophysiological profile of the differences in circadian rhythm of Microcystis bloom communities over the course of an entire bloom season. These findings can expand upon current knowledge of the competitive success of M. aeruginosa, but also guide our understanding of the role of circadian rhythm in the ecology of harmful algal blooms.

SPEAKER: **Chelsea Donovan, James Madison University | donovace@dukes.jmu.edu**

SPEAKER BIO: Incoming second year graduate student at James Madison University in the Masters of Biology program working in both Dr. Louie Wurch's and Dr. Morgan Steffen's labs. My proposed masters thesis is investigating the role of circadian rhythm in the competitive success of high-biomass forming harmful algal blooms (HABs). I will be specifically looking at the potential circadian rhythm cycles of Microcystis aeruginosa and Aureococcus anophagefferens. This poster will be focusing on looking at natural populations of Microcystis aeruginosa to determine which genes could be controlled by a circadian clock. Completed undergraduate degree at JMU (B.S. in Biology), completed undergraduate research with Dr. Louie Wurch assisting on a variety of projects regarding harmful algal blooms. Field experience includes traveling to Put-in-Bay, OH to collect water samples from the Western-Basin of Lake Erie, OH (for this project specifically). Experienced in Scanning Electron Microscopy (SEM) of microbes, trained under Dr. Harry Hu in the Chemistry department at JMU. Work experience: 2 years working as an administrative assistant in the biology department at JMU, 5 years working as a physical therapy technician and orthopedic assistant technician at Center for Advanced Orthopedics - MMI Division in Frederick, MD.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

UNDERWAY DETECTION OF PARTICULATE MICROCYSTINS IN LAKE ERIE BY SURFACE PLASMON RESONANCE SENSOR ONBOARD AN UNCREWED SURFACE VEHICLE

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Surface plasmon resonance (SPR)-based technologies for detection and quantification of freshwater and marine biotoxins have generally been restricted to laboratory use. By building on advances in optoelectronic sensors and microfluidics, we developed a compact, low power, field-deployable SPR instrument for near real-time detection and reporting of particle-associated microcystin concentrations. This device employs a competitive enzyme-linked immunosorbent assay performed on miniature, reusable toxin-specific SPR chips prepared by immobilizing microcystin-LR on a molecular scaffolding deposited on the gold-coated sensor surface. This custom-built SPR module, when integrated with MBARI's 3rd Generation Environmental Sample Processor (3G ESP), enables autonomous end-to-end biotoxin reporting including sample collection, processing, analysis and data transmission to shore in less than 2 hours and is extensible to detecting a wide range of phycotoxins.
Previous deployments of the 3G ESP-SPR onboard MBARI's Long-Range Autonomous Underwater Vehicle in western Lake Erie (WLE) demonstrated use of an uncrewed, submersible mobile platform to direct sampling to areas of suspected cyanobacterial harmful algal blooms (CHABs). Motivated by the need to access and operate autonomous vehicles in shallow regions of WLE where CHABs often occur, the 3G ESP-SPR was integrated into a SeaTrac Uncrewed Surface Vehicle (USV) for field trials conducted during 2023 and 2024. Modifications to the SeaTrac, including temperature regulation of the payload compartment as well as integration of a sample acquisition system, were required to meet mission requirements for CHAB monitoring and interrogation of toxin levels. Areas targeted in WLE for sampling were identified with hyperspectral imagery obtained using an Uncrewed Aerial System and satellite-based imagery products. We will present a summary of initial results and lessons learned for the field trials. Near real-time surveillance of CHAB toxin levels will provide resource managers with actionable information required for timely decision support to protect public health and minimize the economic impacts of these events.

SPEAKER: **Greg Doucette, NOAA / NOS / NCCOS | greg.doucette@noaa.gov**

SPEAKER BIO: Greg Doucette is a Research Oceanographer serving as Program Lead for HAB Sensor Development in the HAB Monitoring & Reference Branch of NOAA's National Centers for Coastal Ocean Science. He has over 35 years of experience in the HAB field and has published on diverse topics, including algal toxin assays, algicidal bacteria-HAB interactions, and toxin trophic transfer. His current focus is on developing and deploying sensors for HAB toxin detection on field-portable and uncrewed platforms in U.S. marine and Great Lakes coastal regions. Recently, he has worked with colleagues to formulate and advance implementation of a U.S. National HAB Observing Network and its associated Community of Practice.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ADVANCEMENT OF UN-CREWED SYSTEMS TO IMPROVE OUR UNDERSTANDING OF CYANOBACTERIA HABS: DEVELOPMENT OF THE SURFACE HARMFUL ALGAE RESEARCH CRAFT (SHARC)

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Cyanobacteria harmful algal blooms (cHABs) have had detrimental effects on freshwater and coastal ecosystems, public health, and economies, particularly in the Great Lakes region. In order to provide near real-time, in situ cyanotoxin detection we tested an uncrewed surface vehicle (USV) equipped with a third-generation Environmental Sample Processor (3G ESP) and a Surface Plasmon Resonance (SPR)-based system capable of determining particle-associated microcystin concentrations. The 3G ESP can also preserve filtered samples and archive these onboard for post-deployment ‘omics analyses. Several modifications were achieved to integrate the 3G ESP into the USV, including the design of a new agitator system to disaggregate algal colonies and improve sample collection. Known as the SHARC (Surface Harmful Algae Research Craft), the USV-3G ESP system is able to sample in water depths less than 1 m, allowing the system to access areas where human-bloom interaction is the highest, and that are inaccessible to the Long Range Autonomous Underwater Vehicles (LRAUV). In 2023, we tested the SHARC system in western Lake Erie for 10-days. During the deployment we were able to collect samples from shallow coastal water along the OH and MI shore. Of the 22 paired archive-toxin samples collected during deployment, four detected levels above recreational limits (8 µg L-1), while an additional two samples detected microcystin levels exceeding drinking water limits. In addition, we were able to use hyperspectral imaging to inform sampling locations during the mission. Data from the 2024 deployment will also be discussed. This project illustrates the transformative potential of autonomous technologies in HAB monitoring and management efforts.

SPEAKER: **Benjamin Downing, NOAA | benjamin.downing@noaa.gov**

SPEAKER BIO: Benjamin is an observations engineer for NOAA Great Lakes Environmental Research Laboratory. He has been conducting field work as an observations specialist for over 10 years in the fields of biology, hydrology and atmospheric science. He has conducted research all over the American Southwest and Great Lakes. At GLERL he is the lead for the Surface Harmful Algae Research Craft (SHARC) that is in development to advance monitoring and research of Harmful Algal Blooms in the Great Lakes. He studied biology at Fort Lewis in southern Colorado focusing on Plant Systematics and conducted Masters research from San Diego State University in Geomorphology in Los Laureles Canyon Watershed in Tijuana Mexico.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

NUTRIENT AND ENVIRONMENTAL CONTROLS ON CYANOBACTERIA COMMUNITY COMPOSITION AND TOXIN PRODUCTION IN LAKE ANNA, VIRGINIA

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Anthropogenic activity is responsible for changing environmental conditions in many water bodies. Impacts of human activities include nutrient over-enrichment in lakes and coastal waters, and elevated temperatures and carbon dioxide concentrations in the atmosphere and water. Due to these changes, many lakes have become increasingly stratified and eutrophic. These factors create a perfect environment for the proliferation of cyanobacterial harmful algal blooms (cyanoHABs) in freshwater systems. Lake Anna, a reservoir that was originally created to provide cooling water to a local nuclear power plant, also serves as a recreational swimming site for the surrounding area. This lake has experienced potentially toxigenic cyanoHABs almost annually since 2018, typically during the summer and early fall months. We sampled three stations in Lake Anna, located where blooms typically occur to examine potential factors causing changes in the phytoplankton community composition giving rise to cyanoHABs . Water quality parameters (pH, temperature, dissolved oxygen, and chlorophyll a), nutrient concentrations (dissolved organic and inorganic carbon and nitrogen), particulate nitrogen and carbon concentrations, and phytoplankton community composition were measured bi-monthly from November to April and then four times per month from May through October. Nitrogen uptake (including nitrogen fixation) and primary productivity were measured monthly from November to April and bi-monthly from May to October. Based on nitrogen depletion during the summer months when cyanoHABs, we hypothesize that nitrogen fixation plays a key role in cyanoHAB bloom initiation and proliferation and possibly the level of toxin production in Lake Anna.

SPEAKER: **Aliyah Downing, Old Dominion University | adown013@odu.edu**

SPEAKER BIO: Aliyah Downing's work focuses on bloom dynamics of Harmful Algal Blooms (HABs) in freshwater ecosystems. She obtained her M.S. in Biological Sciences from Old Dominion University in Fall 2019. During that time, she conducted kinetic studies on cyanobacterial bloom dynamics under elevated CO_2 conditions. Currently, she is a PhD student in the Ocean and Earth Sciences Department at ODU, exploring initiation and proliferation of HABs on Lake Anna, VA.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ORAL EXPOSURE TO MICROCYSTIN-LR INDUCED SUBLETHAL RESPONSES IN MALLARD DUCKS, ANAS PLATYRHYNCHOS.

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Algal blooms that produce toxins are increasingly reported in lakes, rivers, and other wetlands throughout the world. Water birds, because of their reliance on wetlands, often confront these toxic blooms. A better understanding of microcystin (MC) toxins effects in water birds is needed to evaluate the role of these toxins in the health of in these species. Microcystins are a prevalent cyanotoxins produced in freshwater and saltwater that can cause hepatotoxicity, even leading to cancer in mammals. In this study, we tested the hypothesis that an avian species would experience adverse outcomes by using gel caplets to orally dose 8 adult female mallards (Anas platyrhynchos) with approximately 0.75 mg of purified MC-LR daily for 7 days. Eight control birds were dosed with blank caplets and handled similarly. Following euthanasia and necropsies on day 8, carcasses were examined for gross lesions and tissues were collected for MC concentration analysis, and microscopic histopathology. Additionally, livers and cecal material were collected and sent for additional testing to evaluate health effects with regard to cellular activity and microbiome, respectively. No clinical signs of toxicity were observed over the study. Detections of MC in livers from dosed ducks ranged from 722 to 2142 ng/g. While no differences were observed between control versus exposed groups on histopathology, functionally we did observe several differences. Hepatocytes from exposed birds showed unanticipated ploidy heightening, decreased metabolism in one of the three hepatocyte subpopulations, increased live apoptotic cells, and inhibited PP1/PP2A activity. Cecal microbiome examination also yielded differences in the virome composition due to a decline in a single commensal viral virus and proliferation of two viruses. Additional research will further investigate these results using longer term exposure and determine whether these findings may be sustained over a longer period after exposure to the same levels of toxins.

SPEAKER: **Robert Dusek, U.S. Geological Survey, National Wildlife Health Center | rdusek@usgs.gov**

SPEAKER BIO: Robert Dusek is a wildlife biologist at the U.S.G.S. National Wildlife Health Center, in Madison, Wisconsin, where he has conducted research in wildlife for 30 years. He has been study effects of algal toxins in wildlife since 2018. Previous research included effects of West Nile virus and avian influenza in birds.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

EXPLORATION OF SHORT-TERM, HIGH-INTENSITY DISTURBANCES ON CYANOBACTERIA HABS IN LAKE ERIE

SESSION: BLOOM DYNAMICS & DRIVERS II

ABSTRACT: Short-term disturbance, such as heat waves or storms, have been increasing in frequency and intensity in coastal systems. In 2023, we conducted a 10-day geostationary research cruise in Lake Erie exploring impacts of short-term disturbances on cyanobacteria bloom development. The Diel Assessment of Life in Lake Erie (DALLE) cruise conducted 24-hour observations of the plankton community, while simultaneously collecting a variety of environmental and water quality parameters. Inorganic nutrients (P, N, and Carbon) were significantly reduced during the DALLE cruise, with storm disturbance events leading to brief nutrient increases. Initial data analysis suggest shifts in phytoplankton communities were dependent on the type of disturbance (storm or heat induced) and intensity. Two limnocorral experiments were also performed over a 36-hour period to provide details on the bloom conditions in a discrete section of the water column. Genetic changes, shifts in toxin profiles and nutrient dynamics will also be discussed.

SPEAKER: **Reagan Errera, NOAA / GLERL | Reagan.Errera@noaa.gov**

SPEAKER BIO: https://www.glerl.noaa.gov/about/pers/profiles/errera.html

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

UNDERSTANDING PUBLIC KNOWLEDGE AND INFORMATION PREFERENCES REGARDING WATER QUALITY AND HARMFUL ALGAL BLOOMS – PORTER NOVELLI VIEW 360+ SURVEY, 2021

SESSION: PUBLIC HEALTH

ABSTRACT: Harmful algal blooms (HABs) are a substantial One Health issue causing thousands of reported human and animal illnesses each year, negative socioeconomic impacts, and environmental damages. Public knowledge of HABs, including how to stay informed and where to find reliable information about water quality, is critical for minimizing the adverse effects of HABs. To understand public information seeking, knowledge, and preference for receiving communications related to water quality and HABs, we analyzed data from a Porter Novelli View 360+ Survey of U.S. adults (N=1007). This nationally representative survey was conducted in September 2021. This survey covered individuals' perceptions, attitudes, and behaviors regarding water quality and HABs. Our analysis revealed that most respondents expected local/state governments (64%) or beach/park staff (61%) to communicate when lakes, rivers, or oceans are unsafe for swimming. However, 20% of respondents did not know testing results were available and 23% reported never checking a public beach's water testing results before getting in the water. Respondents expected to find water testing results at public beaches at access points (35%) or lifeguard stands (29%). Regarding online sources for water quality information, respondents preferred public beach websites or social media (38%), and the health department's (36%) websites or social media. To increase public awareness, local/state governments, beach/park staff, and other partners should consider making water quality and testing information available across a variety of platforms, especially online and through social media. Such information can inform the public's decision-making and information planning needed to mitigate the risks associated with HABs and ensure safer recreational water use.

SPEAKER: **Robyn Espinosa, CDC | pnk2@cdc.gov**

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

INTERANNUAL VARIABILITY IN ALEXANDRIUM CATENELLA BLOOM DYNAMICS IN PACIFIC ARCTIC WATERS

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: Amidst the many ecological shifts resulting from warming waters as climate changes, harmful algal blooms of Alexandrium catenella have emerged as a significant threat to human and ecosystem health in the Pacific Arctic region. In recent years, large-scale blooms of A. catenella have been detected in Alaskan waters of the Bering and Chukchi seas, and paralytic shellfish toxins (PSTs) produced by this species have been documented throughout the Arctic food web. In this presentation, we will summarize bloom observations compiled over six years of field efforts (2018 - 2023) through mixed methodologies (Imaging FlowCytobot, discrete sediment and water samples, toxin profiling) and place these data in context with the Alexandrium life cycle and regional environmental drivers. In several years (2019, 2022, 2023), blooms of A. catenella have been detected as they are advected northward through the Bering Strait from warmer waters of the Bering Sea. These advected blooms provide a significant source of cysts to the benthos of the Chukchi Shelf, which can serve as the inoculum for northern blooms in years when bottom temperatures are warm enough (>4°C) to promote germination. In other years, cool bottom temperatures on the Chukchi Shelf suppress cyst bed activity. Consistency in PST profiles (with high relative proportions of gonyautoxins 1&4 and neosaxitoxin) measured in bloom populations across years points to a common source for these advected blooms, likely from Russian waters of the Gulf of Anadyr or further south in the Bering Sea, although the definitive source remains a topic of investigation. Furthermore, these Arctic A. catenella are highly toxic relative to populations from other regions, driven by a combination of congener potency and an overall high toxin load. These collective results highlight the growing relationship between climate change, bloom dynamics, and risks of HABs in Arctic waters.

SPEAKER: **Evangeline Fachon, Woods Hole Oceanographic Institution | efachon@whoi.edu**

SPEAKER BIO: Evangeline (Evie) Fachon is a PhD candidate in Don Anderson's lab at the Woods Hole Oceanographic Institution. Her research focuses on Alexandrium catenella bloom dynamics and toxicity in the Alaskan Arctic. She also works with other HAB species, including Pseudo-nitzschia and Gambierdiscus, and her past research involved studies of macroalgal ecology and physiology in the Gulf of Maine, Estonia, and New Zealand. When she is not out on research vessels or sitting at the microscope, you can find her shellfishing, mushroom hunting, or training her rescue dog.
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

HABS AND OCEAN ACIDIFICATION IN LONG ISLAND WATERS: DETERMINING THE RELATIONSHIP AND IMPACT

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: As the climate continues to change, the world’s oceans are warming, acidifying, and deoxygenating. These processes are often more severe in coastal zones, accelerated by heat waves, upwelling, and eutrophication. This study exposed cultured Alexandrium catenella and Margalefidinium polykrikoides, two common harmful algal bloom species on Long Island, to varying nutrient (inorganic nitrogen and phosphorus) and pCO_2 levels (~400 µatm, ~1500 µatm, and ~2500 µatm) representative of current coastal oceans. Additionally, A. catenella and M. polykrikoides bloom water collected from Northport, NY, and Shinnecock Bay, NY, was also exposed to both high and low nutrient and pCO_2 levels. Experiments with M. polykrikoides bloom water showed that increased nutrients and pCO_2 levels had a positive effect on cell growth ($p<0.05$ and $p<0.01$, respectively). Experiments with A. catenella cultures also showed that both nutrients and pCO_2 level had a significant effect on cell growth ($p<0.001$). These findings demonstrate that as climate change and eutrophication continue, A. catenella and M. polykrikoides, among other HAB species, will continue to increase in severity.

SPEAKER: **Mairead Farrell, Stony Brook University | mairead.farrell@stonybrook.edu**

SPEAKER BIO: Mairead Farrell is a Master’s student pursuing a degree in Marine Sciences through Stony Brook’s School of Marine and Atmospheric Sciences. She attended Colby College for her undergraduate degree and majored in Environmental Studies and Science, Technology, and Society. Her research focuses on harmful algal blooms (HABs) and the ways in which anthropogenic factors such as climate change and excess nutrients may impact them. She has done work studying Pseudo-nitzschia at Bigelow Labs and Karenia brevis at Mote Marine Lab’s Red Tide Institute. She hopes to help educate others on HABs and the ways in which we can help to reduce their severity.

CO-AUTHORS:
Dr. Christopher J. Gobler; Adrienne N. Tracy

DEVELOPING AN IMAGING FLOWCYTOBOT MONITORING PROGRAM FOR HABS IN ALASKA

SESSION: CLIMATE CHANGE

ABSTRACT: Oceans play an integral part in the social, cultural, and economic well-being of Alaska. Marine living resources are a primary source of food throughout the state, and harmful algal blooms (HABs) are a growing but unpredictable risk to many stakeholders and communities. Subsistence and recreational shellfish harvesting, commercial aquaculture operations, and wildlife are all potentially impacted by the toxins produced by HABs. As climate change continues to impact the physical characteristics of Alaska's coastal waters, HABs are responding in unpredictable ways and there is a growing need to better monitor for HABs and understand the factors that lead to HAB events. However, the length and remoteness of Alaska's coastline, particularly in the Arctic regions, makes monitoring and research difficult and expensive.

One approach to facilitate the detection of HABs is the use of Imaging FlowCytoBots (IFCB). During the summer of 2024, an IFCB was deployed on research vessels conducting work in the Bering, Chukchi and Beaufort Seas. The IFCB continuously sampled the seawater intake of the vessel and provided near-real time estimates of the cell densities of Alexandrium spp. A plan for communication with coastal communities was put in place to describe the work, and provide advisories in case a HAB was detected. This work constitutes the beginning of an Alaska IFCB program, which will grow in the coming years to include both land-based and ship-based deployments, and will fit within a larger HAB monitoring and research framework being developed by members of the Alaska Harmful Algal Bloom Network. This presentation will review the results from the IFCB deployments in Alaska, and describe the monitoring needs, difficulties, and capabilities in Alaska.

SPEAKER: **Thomas Farrugia, Alaska Ocean Observing System | farrugia@aoos.org**

SPEAKER BIO: Thomas has a background in marine ecology and fisheries, and first came up to Alaska in 2005 to become a fisheries observer in the Aleutian Islands and the Bering Sea. In 2020, he joined the Alaska Ocean Observing System (AOOS) as a program manager and the first coordinator of the Alaska Harmful Algal Bloom (AHAB) Network. Through the AHAB Network, Thomas has been supporting research efforts and monitoring programs for HABs in Alaska, providing equipment, funding, and data management services. The AHAB Network (https://ahab.aoos.org/) now provides a statewide platform to increase HAB awareness, research, and monitoring in Alaska, and support response to HAB events. In the coming years, AOOS will expand monitoring efforts by deploying Imaging FlowCytoBots to detect HABs. This will complement existing phytoplankton sampling and toxin testing to better understand and mitigate the threat of HABs in Alaska – a crucial issue impacting public health, food safety and security, and wildlife populations.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

CAPE COD'S CYANOBACTERIA POND MONITORING PROGRAM 2017-2024

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Cape Cod's freshwater kettle hole ponds are part of the Atlantic Coastal Pine Barrens Ecosystem threatened by increased development and nutrients that have resulted in cyanobacteria blooms becoming more common with our warming climate. In 2017 the Association to Preserve Cape Cod created a pilot project with guidance from EPA Region I and the University of New Hampshire to address the health and ecological risks posed by harmful cyanobacteria blooms (HCBs) in Cape Cod, MA ponds. The program's objectives include raising public awareness, guiding responses to cyanobacteria concerns, monitoring priority ponds, and motivating community action to improve water quality. What began as a pilot project monitoring five ponds has expanded significantly, with 134 ponds of the 890 Cape Cod ponds monitored biweekly in 2024. All 15 towns on Cape Cod are currently engaged in this program which not only serves residents but also addresses the needs of millions of summer visitors.

The monitoring program employs robust methodology described in the recently EPA- and MassDEP-approved Cape Cod Cyanobacteria Monitoring Quality Assurance Project Plan (CCCMP QAPP). Citizen engagement is pivotal; with local Pond Groups actively collecting water samples, community members informing APCC of potential HCB's and advocating to make this work possible.

Public communication of monitoring results is facilitated through the CyanoMap, an interactive, informative online map, which is updated after each sampling event through APCC's website https://apcc.org/our-work/science/community-science/cyanobacteria/. If official Public Health Advisories are issued, alerts are disseminated via a CyanoAlert email by APCC. The collected data on phycocyanin and microcystin is utilized to estimate predicted toxin levels, and further use of the data to better understand HCBs in Cape Cod's freshwater ponds is underway. Funding for the program is provided by the Eddy Foundation, local pond associations, towns, residents, and the Barnstable County Lab, supporting interns, equipment, and operational costs.

SPEAKER: **Sophia Feuerhake, Association to Preserve Cape Cod** |sfeuerhake@apcc.org

SPEAKER BIO: I am in my second year at the Association to Preserve Cape Cod (APCC), MA, where I started as Senior Water Quality Analyst with the Cape Cod Regional Pond Monitoring Program, monitoring general water quality of freshwater ponds with the assistance of volunteers. I have since transitioned into the role of Freshwater Science Coordinator, which entails managing data, training, and overseeing quality control of data collection, processing and analysis. Prior to working with APCC, I served at the Cape Cod National Seashore, U.S. Fish and Wildlife Service and graduated with a M.Sc. in Marine Biology from the Rijkuniversiteit Groningen, Netherlands.

CO-AUTHORS: Julie Hambrook Berkman, PhD and Lynn Francis

EXAMINING HARMFUL CYANOBACTERIAL ALGAL BLOOMS IN DES MOINES, IOWA: REGIONAL RESILIENCY ASSESSMENT PROGRAM (RRAP) PROJECT

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: For several consecutive years, Des Moines Water Works (DMWW) has detected microcystin in its two primary water sources, the Des Moines River and Raccoon River. The DMWW supplies drinking water to approximately 600,000 people in Central Iowa. To date, DMWW has successfully managed microcystin at levels below the Environmental Protection Agency's (EPA) Health Advisory of 1.6 ug/L by alternating between the two sources. However, simultaneously cyanobacterial harmful algal bloom (cyanoHABs) occurrences in the two river systems could potentially jeopardize DMWW's ability to provide safe drinking water to its customers. To help address this issue, the Cybersecurity and Infrastructure Security Agency (CISA) initiated a Regional Resiliency Assessment Program (RRAP) project in fall of 2022 to better understand the causes and impacts of cyanoHABs on water infrastructure in Iowa. The project aims to assess current research and analyze available data to ascertain the likely physical and chemical drivers of cyanoHABs in the Des Moines and Raccoon River Watersheds, including the potential anticipated compounding impacts from climate change. This work will serve as the basis for the development of resilience enhancement options, such as upstream mitigation measures, operational considerations, and decision support tools, which can assist DMWW and emergency management agencies at the state and local level with the safe management of Iowa's drinking water infrastructure.

SPEAKER: **Molly Finster, Argonne National Laboratory | mfinster@anl.gov**

SPEAKER BIO: Molly Finster, Ph.D. is an Environmental Systems Engineer within the Infrastructure Security & Risk Analytics Group in the Decision and Infrastructure Sciences (DIS) Division at Argonne National Laboratory. She has worked on a variety of national programs and technical projects to solve complex environmental challenges, sustainably manage resources, increase resiliency of key infrastructure, address climate related challenges, and assure regulatory compliance. With a background in Environmental and Chemical Engineering, Molly has conducted laboratory research, field studies, classroom training, facility investigations, and computer-based modeling to advance both research and practice. Current areas of research include infrastructure vulnerability and resiliency analysis; dam safety planning and preparedness; risk and community analysis; public education and outreach; resource management and sustainability; and environmental impact assessment and compliance.

CO-AUTHORS:
Elizabeth Bolton, Mark Grippo

ASSESSING THE SOURCE OF MICROCYSTIN IN THE DES MOINES RIVER

SESSION: Poster Session, Wednesday

ABSTRACT: Determining the origin of cyanobacterial harmful algal blooms (cyanoHABs) is critical for their successful management and mitigation. However, the complexities of algal growth patterns in flowing waters and the uncertainty of transport rates downstream make this characterization particularly complicated in riverine systems. The cyanotoxin microcystin has been detected in the downtown reach of the Des Moines River below Saylorville Reservoir since 2015. Unable to determine its origins, officials had hypothesized that the problematic cyanoHABs likely originated from the reservoir, eleven miles upstream of the city's drinking water intake. As part of the Cybersecurity and Infrastructure Security Agency's (CISA) Regional Resiliency Assessment Program (RRAP) project in Iowa, existing research and data were evaluated and assessed to determine if Saylorville Reservoir behaves as the source of Des Moines' cyanoHABs. The project team examined water quality parameters and microcystin concentrations (ug/L) collected within Saylorville Reservoir (2009-2021), directly downstream of the Saylorville Dam (2021), and at the Des Moines Water Works (DMWW) water intake in downtown Des Moines (2015-2023). Preliminary results based on available data do not support the hypothesis that microcystin producing cyanoHABs originate within Saylorville Reservoir. Time series data for the reservoir indicates that while chlorophyll-a levels spike during microcystin peaks, chlorophyll-a concentration peaks also occur when no microcystin is present. In addition, flow rates and nitrate concentrations had the strongest relationship with microcystin concentrations collected downstream at the Des Moines Water Works (DMWW) water intake. However, with limited data available, more data is needed, including information on stratification and seasonal turnover in the reservoir and more extensive spatial and temporal data collected in the Des Moines River downstream of the reservoir and upstream of the DMWW intake.

SPEAKER: **Molly Finster, Argonne National Laboratory | mfinster@anl.gov**

SPEAKER BIO: Dr. Elizabeth Bolton is an Infrastructure Risk Analyst in the Decision and Infrastructure Sciences Division of Argonne National Laboratory. She has worked on multiple technical projects and national programs to assess risk and increase resiliency of critical infrastructure, with a primary focus on water and energy infrastructure. She has a background in sociotechnical systems analysis, with expertise in complex systems analysis techniques, survey-based research, and inverse modeling approaches.

Molly Finster, Ph.D. is an Environmental Systems Engineer within the Infrastructure Security & Risk Analytics Group in the Decision and Infrastructure Sciences (DIS) Division at Argonne National Laboratory. She has worked on a variety of national programs and technical projects to solve complex environmental challenges, sustainably manage resources, increase resiliency of key infrastructure, address climate related challenges, and assure regulatory compliance. With a background in Environmental and Chemical Engineering, Molly has conducted laboratory research, field studies, classroom training, facility investigations, and computer-based modeling to advance both research and practice. Current areas of research include dam safety planning and preparedness; risk and community analysis; public education and outreach; infrastructure vulnerability and resiliency analysis; resource management and sustainability; and environmental impact assessment and compliance.

CO-AUTHORS:
Molly Finster, Mark Grippo

THE COMPLEX ECOLOGY AND OMNIPRESENCE OF DINOPHYSIS SPP. IN PUGET SOUND, WA

SESSION: BLOOM DYNAMICS & DRIVERS IV

ABSTRACT: Species of the kleptoplastidic dinoflagellate Dinophysis produce diarrhetic shellfish poisoning toxins (DSTs) and pectenotoxins (PTX) that threaten human health and the aquaculture industry. This study investigates the bloom dynamics of Dinophysis spp. and its ciliate prey Mesodinium spp. in Puget Sound, WA from spring through early fall over three years. Continuous observations by an Imaging FlowCytobot (IFCB) and environmental sensors were paired with near weekly manual sample collections for toxin quotas, nutrients, and microscopy. Seven species of Dinophysis were observed with D. fortii and D. acuminata being most abundant. The IFCB detected Dinophysis spp. at low background levels throughout the monitoring period, including days when they were absent from manually collected samples. Detection of starved Dinophysis spp. cells by the IFCB, however, was sensitive to instrument settings. Patchy blooms of Dinophysis spp. typically began in June/July each summer and were either preceded by or co-occurred with blooms of Mesodinium spp., but had no clear relationship with observed environmental parameters. Until robust biological or environmental predictors of blooms are identified, managers must continue to rely on shellfish tissue testing to protect human health against the omnipresent risk of DSTs in Puget Sound.

SPEAKER: **Stephanie Moore, NOAA Fisheries | stephanie.moore@noaa.gov**

SPEAKER BIO: Steph joined NOAA Fisheries in 2017 as a Research Oceanographer. Previously, she studied climate effects on harmful algal blooms at the University Corporation for Atmospheric Research and the University of Washington. She holds a B.Sc. with honors in Advanced Environmental Science and a Ph.D. in Biological Science from the University of New South Wales, and is an alumni of the JPB Environmental Health Fellowship Program with the Harvard T.H. Chan School of Public Health. She is a mum to an infinitely-wise daughter. She loves being outside in nature, but hates the cold. She sometimes gets seasick.

CO-AUTHORS:
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THE MEASUREMENT AND QUANTIFICATION OF CHAB TOXINS IN LAKE SPRAY AEROSOLS

SESSION: PUBLIC HEALTH

ABSTRACT: Cyanobacterial harmful algal blooms (CHABs) are occurring globally with increasing frequency in aquatic environments. During CHABs, spray aerosol (SA) produced via wind blowing over the water and bubble bursting processes can incorporate intact cells, cell wall fragments with endotoxins (lipopolysaccharides) and intracellular exudates including toxins, many of which exist in respirable size fractions PM10 and PM2.5. Even at low concentrations those toxins may promote acute respiratory distress, and once aerosolized can be carried tens to hundreds of km from source blooms. Here we report on a novel approach to field-based collection of aerosolized particles using a high-volume air sampler system that allows size-segregated particle size sampling, as well as the combined use of a Scanning Mobility Particle Sizer and Optical Particle Sizer that allows for accurate accounting of ambient aerosol distribution on an eastern Long Island, NY, USA, lake, where CHABs form annually. This sampling system allows spatiotemporal size discriminated collection of aerosolized particles including sufficient mass, while minimizing sampling time and ensuring sample integrity. The particle sample size allows measurement of toxins and endotoxins using commercial assay kits that can be further validated by mass spectroscopy. This approach also allows collection of particles for compositional and chemical identification as they are modified by photochemical oxidation. Microcystin has been detected in all aerosol samples analyzed to date, with an average concentration of 5.4 x 10-2 µg m-3. The highest concentration by particle size was consistently measured in the lowest particle size range (< 0.49 µm). Future laboratory experiments using an aerosol flow reactor experimental system will allow us to study in detail chemical aging process of spray aerosol containing toxins which is important for determining the lifetime for potency of toxins in the atmosphere.

SPEAKER: **Jacob Flanzenbaum, Stony Brook University | jacob.flanzenbaum@stonybrook.edu**

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CO-AUTHORS:
Josephine Y. Aller, Christopher J. Gobler, and Daniel A. Knopf

CYANOTOXIN TESTING OF MISSISSIPPI'S SEAFOOD DURING A CYANOBACTERIA BLOOM

SESSION: PUBLIC HEALTH

ABSTRACT: The Bonnet Carré Spillway, situated northwest of New Orleans, Louisiana, was opened twice in 2019, resulting in a combined total of 123 days of discharge. This diversion directed large volumes of freshwater from the Mississippi River to Lake Pontchartrain, ultimately draining into the western Mississippi Sound. The continuous influx of freshwater facilitated the rapid and temporary colonization of the Mississippi Sound by cyanobacteria, previously assumed to be unaffected by these freshwater phytoplankton. Cyanobacteria blooms can produce various cyanotoxins, raising concerns about seafood toxicity managed by the Mississippi Department of Marine Resources (MDMR) within state waters. Following the first sighting of Microcystis spp. on June 12, 2019, water samples were collected by MDMR staff and confirmed for species identification by NOAA's Phytoplankton Monitoring Network. Positive tests for cyanotoxins from water samples by the Dauphin Island Sea Lab (DISL) prompted MDMR to assess seafood for toxicity. The cyanobacteria bloom persisted for several months, during which 1,333 water samples were analyzed for the genus, and 92 seafood samples and 77 water samples were tested for cyanotoxins. Testing was conducted by DISL and Green Water Labs. Seafood species tested included various finfish species, Eastern Oyster, Blue Crab, and two penaeid shrimp species (Brown and White). The results from the tissue samples exhibited highly variable values, likely influenced by tissue type, the animal's position in the water column, trophic level, and the condition and density of the bloom. Further research is necessary to quantify cyanotoxin-induced fish toxicity and establish thresholds for consumption.

SPEAKER: **Megan Fleming, Mississippi Department of Marine Resources | megan.fleming@dmr.ms.gov**

SPEAKER BIO: I am a Environmental/Natural Resource Specialist Team Lead in the Finfish Bureau within the Mississippi Department of Marine Resources. I am also a member of the HAB Response Team.

CO-AUTHORS:
Kristina Broussard, Alicia Carron, Nestor Raul Anzola, Kat Glover

MAPPING THE LANDSCAPE OF DATA SOURCES FOR HARMFUL ALGAL BLOOM-RELATED DISEASES IN SOUTHEAST ASIA: A SCOPING REVIEW ON THE PHILIPPINES, INDONESIA AND MALAYSIA

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The incidence of Harmful Algal Blooms (HABs) is not only a concern for Southeast Asia's environment, but also for its population's health. Assessing the HAB-related burden of disease remains challenging due to unawareness, underreporting and unclear diagnostic methods. Thus, this scoping review will address the issue of data collection in Southeast Asia, by mapping the data ecosystem in the Philippines, Indonesia and Malaysia for illnesses that result from the exposure to HABs.
Building on Young et al.'s (2020) systematic scoping review, this study employs the 5-stage framework by Arksey and O'Malley and adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist. A comprehensive search was conducted in May 2024 across PubMed, Web of Science, and Scopus, using keywords for: Philippines; Indonesia; Malaysia; Harmful Algal Blooms (HABs); Azaspiracid, Amnesic, Diarrhetic and Paralytic Shellfish Poisoning; Ciguatera; Palytoxicosis; Ostreopsis, and associated toxins and seafood. Records will be screened independently by three authors, with conflicts resolved by consensus. Included studies must report cases of HAB intoxications in the specified countries, from which the data sources consulted by authors will be extracted and described, thereby reconstructing the current data ecosystem. This process will consolidate information on data resources and potentially provide a basis for conversations about how to strengthen HAB-related diseases monitoring efforts, to meet regional needs.

SPEAKER: **Lora Fleming, European Centre for Environment and Human Health, University of Exeter Medical School | l.e.fleming@exeter.ac.uk**

SPEAKER BIO: Emerita Professor Lora Fleming CBE MD PhD MPH MSc FAAFP PFHEA is a co-founder of the European Centre for Environment and Human Health and Emerita Professor and Chair of oceans, epidemiology and human health at the University of Exeter Medical School, and Emerita Professor at the University of Miami Schools of Medicine and Marine Sciences. Intensely involved in research, training and other activities in the new interdisciplinary metadiscipline of Oceans and Human Health, she is also a board certified occupational and environmental health physician and epidemiologist with over 30 years of experience and expertise in environment and occupational exposures and human health research and training.

CO-AUTHORS:
Alisha Morsella, Lota Creencia, Matthew O. Gribble, Walter Ricciardi, Chiara Cadeddu, Lora E. Fleming

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

NUTRIENT AND CARBONATE CHEMISTRY PATTERNS ASSOCIATED WITH KARENIA BREVIS BLOOMS IN THREE WEST FLORIDA ESTUARIES 2020-2023

SESSION: ECOPHYSIOLOGY & BIOGEOCHEMISTRY

ABSTRACT: Ocean acidification, driven by eutrophication, riverine discharge, and other threats from local population growth that affect the inorganic carbonate system is already affecting the eastern Gulf of Mexico. Long-term declines in pH of ~ -0.001 pH units yr-1 have been observed in many southwest Florida estuaries over the past few decades. Coastal and estuarine waters of southwest Florida experience high biomass harmful algal blooms (HABs) of the dinoflagellate *Karenia brevis* nearly every year and these blooms have the potential to impact and be impacted by seasonal to interannual patterns of carbonate chemistry. Sampling was conducted seasonally along three estuarine transects (Tampa Bay, Charlotte Harbor, Caloosahatchee River) between May 2020 and May 2023 to obtain baseline measurements of carbonate chemistry prior to, during, and following *K. brevis* blooms. Conductivity, temperature, and depth data as well as discrete water samples for *K. brevis* cell abundance, nutrients, and carbonate chemistry were evaluated to identify seasonal patterns and linkages among carbonate system variables, nutrients, and *K. brevis* blooms. *Karenia brevis* blooms were observed during six samplings, and highest *p*CO2 and lowest pHT were observed either during or after blooms in all three estuaries. There was strong influence of net community calcification (NCC) and net community production (NCP) on the carbonate system; and NCC : NCP ratios in Tampa Bay, Charlotte Harbor, and the Caloosahatchee River were 0.83, 0.93, and 1.02, respectively. This study is a first step towards connecting observations of high biomass blooms like those caused by *K. brevis* and alterations of carbonate chemistry in Southwest Florida. Our study demonstrates the need for integrated monitoring to improve understanding of interactions among the carbonate system, HABs, water quality, and acidification over local to regional spatial scales and event to decadal
time scales.

SPEAKER: **Jessica Frankle, Mote Marine Laboratory | jfrankle@mote.org**

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CO-AUTHORS:
Emily R. Hall, Kimberly K. Yates, Katherine A. Hubbard, Matthew J. Garrett

MAPPING HAB EXPOSURE RISK IN RECREATIONAL AND SOURCE WATERS IN COMMUNITIES WITH EJ CONCERNS AT A NATIONAL SCALE

SESSION: SOCIOECONOMIC IMPACTS

ABSTRACT: Harmful algal blooms (HABs) are increasing in magnitude, extent, and frequency across the country's freshwater systems, but these events only represent one of many environmental hazards that threaten community health. Unpleasant odors, nuisance algae, or cyanotoxins may create imperfect or unsafe conditions for recreation and drinking water consumption for communities near impacted waterbodies. Existing research has established that people of color, low-income, and indigenous communities are disproportionately impacted by environmental hazards like air pollution and extreme heat; however, large-scale surveys of HAB risk in communities with environmental justice (EJ) concerns have not yet become available. Here we introduce a project to spatially identify communities at the census block level that exhibit high HAB exposure risk. Annual average cyanobacterial index values (a satellite-based, spatiotemporal mean of 7-day max cyanobacteria dominated algal biomass) were calculated for about 2,200 of the largest lakes in the contiguous U.S. based on the CyAN dataset to estimate HAB risk. Recreational HAB risk for each census block was calculated as the inverse distance weighted average of CyAN lake HAB risk values from a 100 mi buffer around the centroid of each lake in the CyAN population. Source water HAB risk for each census block was calculated using the same CyAN lake HAB risk values linked with public water service areas sourcing water from CyAN lakes. Our goal for these risk maps is to bring attention to areas with water infrastructure needs and potentially strengthen existing tools like the EPA's EJScreen.

SPEAKER: **Brenna Friday, US EPA | Friday.Brenna@epa.gov**

SPEAKER BIO: Brenna Friday is a 2024 NOAA Sea Grant Knauss Fellow currently placed in the U.S. EPA Office of Water's Office of Science and Technology. During her fellowship, she has primarily supported the National HABs Program and Numeric Nutrient Criteria Program within the Health and Ecological Criteria Division. Previously, she received her Bachelor of Science from University of Maryland in Biology with a concentration in Ecology and Evolution. She is currently completing her PhD from Wayne State University where she studies the impact of cyanotoxins on native amphibian development in the Great Lakes region. Please learn more or connect with Brenna through Linked In
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CO-AUTHORS:
Kathryn Lopez, Michael Paul, Aralia Pawlick, Mario Sengco

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

SIMPLIFYING DATA ANALYSIS FOR MARINE BIOTOXINS USING R: ADVANCING THE NEURO-2A CELL-BASED ASSAY

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Marine biotoxins produced by harmful algae are prevalent contaminants challenging global seafood safety. Their rapid detection is crucial for the protection of consumers and for preventative market surveillance. The Neuro-2a (N2a) cell-based assay is a high-throughput method designed for the detection of marine biotoxins, particularly those acting on sodium channels in excitable cells. Semi-purified extraction and accurate endpoint analysis are essential steps in going from 'sample to analyte', but how endpoint data is processed and interpreted is frequently overlooked and outsourced to commercial statistical software. Many research laboratories lack the necessary software training or do not have access to proprietary analytical programs or instrumentation with the ability for complex computational assessments. Therefore, the conditions for data analysis and its subsequent interpretation have not been customized to meet the specific needs and requirements for marine biotoxin detection or data throughput standardization. A lack of standardization can result in discrepancies of toxin analysis qualification or quantification. n2a is a customized R extension package developed for final toxin determination through rapid dose-response analysis, offering an ease-of-use and free-of-charge alternative approach in analyzing endpoint data generated through the N2a-assay, ensuring streamlined and uniform analysis. The n2a-package was tested against other proprietary software packages, using output from both naturally incurred seafood samples and synthetic data. Harmonizing, standardizing, and expediting the data analysis for the N2a-assay will bolster data comparability between research groups, while simultaneously reducing data assessment time, increasing sample throughput, and strengthening consumer health protection worldwide.

SPEAKER: **Synne Thorbjørnsen Frøstrup, The German Federal Institute for Risk Assessment (BfR) | Synne.Frostrup@bfr.bund.de**

SPEAKER BIO: Educated via the University of Oslo, Seoul National University, and University of Potsdam in the field of biological sciences, with a finalized masters in Toxicology. Currently pursuing a PhD in Toxicology and Pharmacology through the University of Potsdam and the BfR. Experienced in cell biology and toxicity methodologies, but also have long practical experience in data analysis and statistical programming through R. My main focus is directed towards marine biotoxins; their detection, analysis, and mode of action, via various methods both computational and analytical. My project that I wish to share is an effort in improving upon the N2a in vitro assay for the detection of sodium-channel acting toxins, (e.g., Ciguatoxins, Brevetoxins), specifically in creating a uniform and effective method for data analysis, increasing throughput time.

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CO-AUTHORS:
Oliver Kappenstein, Christopher R. Loeffler

GENETIC DIVERSITY OF ALEXANDRIUM CATENELLA IN COASTAL EMBAYMENTS IN CAPE COD, MA

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Alexandrium catenella is a cyst-forming dinoflagellate that produces saxitoxins. When consumed by filter-feeding bivalves, these cells can cause paralytic shellfish poisoning (PSP) and are responsible for shellfish harvest closures around the world. In the northeast U.S., blooms develop first within inshore embayments along the coast, then later in open coastal waters of the Gulf of Maine (GoM). Blooms are initiated by the germination of its diploid, benthic resting cyst life cycle stage. The production and dispersal of new resting cysts by blooms is critical for both the recurrence and spread of this species in response to environmental change. A recent example is the apparent expansion of PSP in Cape Cod. Historically, PSP in this area has been confined to an embayment system called Nauset Marsh. Coincident with exceptionally warm wintertime temperatures in 2023, PSP contamination of Nauset shellfish reached a record level and toxicity was also observed in neighboring Pleasant Bay. An event response survey documented widespread deposition of new resting cysts across both the Nauset and Pleasant Bay systems. In this work, a microsatellite-based genotyping approach was applied to germinated resting cysts collected from both areas in the weeks following the 2023 PSP event. Results are used to examine genetic connectivity across the Nauset system and between Nauset and Pleasant Bay. Results are also compared to past studies characterizing the diversity of GoM and Nauset blooms to assess the possible role of coastal populations as the source of Pleasant Bay Alexandrium cells.

SPEAKER: **Sylvain Gaillard, Woods Hole Oceanographic Institution | sylvain.gaillard@whoi.edu**

SPEAKER BIO: Postdoctoral Investigator at WHOI studying toxic phytoplankton and marine invertebrates –

https://www.researchgate.net/profile/Sylvain-Gaillard-2

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A GROWTH LIMITING APPROACH FOR PREDICTING CYANOBACTERIA GROWTH ON WILLIAM H. HARSHA LAKE

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Liebig's Law of the Minimum states that growth is dictated not by total resources available, but by the scarcest resource, or the "limiting factor". Cyanobacterial growth has been modeled using Liebig's Law in which either light, temperature or nutrients is the growth limiting factor, and we apply this approach to four environmental datasets collected at William H. Harsha Lake in Clermont County, Ohio between 2015 and 2019. Measurements of daily average temperature, total NO2,total NO2-3, and total reactive phosphorus (TRP) concentrations, and a 30-day cumulative sum of photosynthetically active radiation (PAR) are compared against daily observations of phycocyanin fluorescence (measured by a water quality sonde). We fit a quantile regression model to relate the upper end of cyanobacterial growth to each environmental metric, and these growth limiting functions (GLFs) tend to exhibit threshold effects, where algae growth is low unless the environmental metric exceeds a certain value. The growth limiting functions are then overlaid and the minimum function determines the prediction and indicates the limiting factor on any given day. We find that nutrients tend to limit cyanobacterial growth in the early stages of a bloom, while light and temperature tend to limit more often in the later stages of a bloom at William H. Harsha Lake. This approach lends conceptual understanding of cyanobacteria growth dynamics and can provide advance predictions of phycocyanin fluorescence at any stage of a bloom.

SPEAKER: **Leslie Gains-Germain, Neptune and Company, Inc. | lgermain@neptuneinc.org**

SPEAKER BIO: Leslie is a statistician with broad interests in environmental statistics and data science. She has over ten years of experience building predictive models for environmental applications, and her work has included collaborations with DOE, EPA, and the private sector. She works on multidisciplinary teams to integrate physical or concept-based models into statistical modeling frameworks for prediction and system understanding.

CO-AUTHORS:
Travis Linscome-Hatfield, Tom Stockton, H. Joel Allen

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

LAKE WELCH HAB MITIGATION EFFORTS

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: In 2022, Harriman State Park's Lake Welch experienced a lake-wide harmful algal bloom (HAB) that caused the beach to shut down for the duration of the summer (July-September). In response to this HAB occurrence, the New York State Office of Parks Recreation and Historic Preservation (NYS Parks) Division of Environmental Stewardship & Planning (DESP) undertook monitoring efforts and collaborated with NYS DEC as well as consultants (UFI and Ramboll) to investigate possible mitigation solutions. In 2023, NYS Parks took a multistep approach that included short-term and long-term mitigation strategies. Short term mitigation strategies used in 2023 were the use of ultrasonic buoys April-September, a physical boom May-October, and algaecide treatment in June. These mitigation efforts allowed the beach at Lake Welch to be fully operational for the 2023 season. The long-term mitigation strategies involve enhanced monitoring of the wastewater treatment plant effluent along with additional treatment interventions, continued monitoring of the lake, and assessment to reduce stormwater runoff and enhance other elements to benefit lake water quality.

SPEAKER: **Lauren Gallagher, NYS Parks | lauren.gallagher@parks.ny.gov**

SPEAKER BIO: Lauren Gallagher is an Environmental Program Specialist, with the Water Quality Unit (WQU) for the New York State Office of Parks, Recreation, and Historic Preservation's (NYS Parks) Division of Environmental Stewardship and Planning (DESP). Lauren's work largely involves coordinating beach monitoring and reporting for NYS Park regulated beaches, as well as Harmful Algal Bloom identification and reporting for NYS Parks statewide. Lauren provides guidance and trainings to agency staff, manages NYS Parks beach monitoring and HAB data, and assists NYS Parks in HAB mitigation efforts. Lauren's position involves supporting safe aquatic recreation, along with the agency's efforts to protect, restore, and enhance natural ecosystems.

CO-AUTHORS:
Sarah Moss

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

INTERAGENCY WORKING GROUP ON HABS AND HYPOXIA: ADDRESSING REGIONAL BLOOMS WITH A NATIONAL HAB AND HYPOXIA STRATEGY

SESSION: AGENCY PROGRAM APPLICATIONS

ABSTRACT: NOAA's National Centers for Coastal Ocean Science (NCCOS) co-chairs the Interagency Working Group on the Harmful Algal Bloom and Hypoxia Research and Control Act (IWG-HABHRCA). The IWG-HABHRCA promotes a coordinated HABs and hypoxia response by harnessing the expertise and capabilities of 16 member agencies. Under the IWG-HABHRCA, federal agencies develop strategies that identify research gaps and management priorities often in direct coordination with state and Tribal governments and local resource managers. For example, NOAA continues to work closely with IWG partners to complete, at the request of Congress, a national assessment of the state of science and management of HABs and related issues.
The overarching purpose of this poster is to provide information on HABs of concern across the Nation and to provide an overview of the IWG-HABHRCA's national strategy to observe, forecast, prevent, control, and respond to HAB and hypoxia events. Specifically, we aim to provide insight on the 2024 National HABs and Hypoxia Assessment that is provided to Congress and the objectives of the IWG to combat HAB challenges nationally. The poster will inform participants about 10 regions experiencing HAB or hypoxia challenges that will be discussed in the report, as well as the goals of the National Strategy to address these challenges. As a result, participants will better understand the types of HABs in each region, the impacts HABs have nationally, and what the IWG-HABHRCA aims to accomplish to mitigate these risks and impacts.

SPEAKER: **Josie Galloway, NOAA / NCCOS | josie.galloway@noaa.gov**

SPEAKER BIO: https://www.linkedin.com/in/josie-galloway-50690598/
I am a multi-disciplinary ecologist and natural resource manager with broad knowledge in applied research, conservation biology, global change biology, science communication, and federal policy. I started working for NOAA in 2020 as a Congressional Affairs Specialist, then as a Program Analyst providing communications expertise. Most recently, I joined NCCOS as an Environmental Scientist working to coordinate harmful algal bloom research and activities with federal, state, and local partners.

CO-AUTHORS:
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SPATIOTEMPORAL VARIATIONS AND DRIVERS IN PHYTOPLANKTON COMPOSITION DURING KARENIA BREVIS BLOOMS IN SOUTHWEST FLORIDA REVEALED BY AUTOMATED IMAGING FLOW CYTOMETRY

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Karenia brevis blooms occur nearly annually along the West Florida Shelf (WFS). Given the extensive variability in bloom duration and extent, understanding how phytoplankton community diversity changes over the progression of K. brevis blooms is essential toward building more comprehensive evaluations of regional primary production and biogeochemical cycling. Imaging FlowCytobots (IFCB) were deployed at a submerged station in Sarasota Bay and on bimonthly 6-day research cruises on the WFS from 2022 to 2023, to (1) investigate the spatiotemporal variation of phytoplankton taxa by tracking changes in taxon abundance, biomass, and community composition before, during and after K. brevis bloom passage; (2) evaluate correlations among environmental parameters and community composition. In Sarasota Bay, the diatom Chaetoceros, dinoflagellates, and other flagellates were dominant prior to bloom onset. From late autumn 2022 to early spring 2023, lower community diversity and evenness was observed and K. brevis was the most abundant taxon, contributing up to 95% of daily total phytoplankton biomass. An abrupt decline in K. brevis abundance at the beginning of March coincided with rapid replacement by Chaetoceros, flagellates and ciliates. Phytoplankton assemblages in Sarasota Bay with K. brevis were clearly differentiated from those without. Seasonal differences manifested as well, with winter assemblages dominated by K. brevis clearly differentiated from those observed during other seasons. Spring and summer assemblages were significantly correlated to salinity and temperature respectively, while autumn assemblages were associated with both. Given that advection and localized development likely play a role in K. brevis bloom dynamics, analysis of spatiotemporal dynamics in Sarasota Bay phytoplankton assemblages relative to those on the WFS surveys is ongoing. These high-resolution datasets provide a unique opportunity to characterize inshore and offshore microplankton communities and parameterize values used in ecological models for the WFS.

SPEAKER: **Yida Gao, Florida Fish & Wildlife Research Institute | yida.gao@myfwc.com**

SPEAKER BIO: I'm an assistant research scientist working for the Harmful Algal Group in Florida Fish & Wildlife Research Institute.

https://myfwc.com/research/redtide/labs-people/current/gao/

CO-AUTHORS:
Yida Gao[1], Eric Muhlbach[1], Julie Koester[1], Alexa Iorillo[1], Savannah Barnard[1], Matt Garrett[1], Yonggang Liu[2], Chuanmin Hu[2], Michael Brosnahan[3], Maria Célia Villac[1], Karen Henschen[1], Stephanie Keller Abbe[1], Laura Markley[1], Emily Hall[4], Katherine Hubbard[1]

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DEGRADATION OF EMERGING PHYCOTOXINS IN RESPONSE TO ENVIRONMENTAL VARIABLES AND IMPLICATIONS FOR MANAGEMENT

SESSION: EMERGING TOXINS & SPECIES

ABSTRACT: Phycotoxins are generally viewed as stable due to their resistance to degradation during cooking. Except for a few marine and freshwater toxins, HAB toxin stabilities within aquatic environments have not been thoroughly investigated. Additionally, research until now has largely focused on the stability of toxins in matrices used for storage or reference standards, e.g., shellfish meat. The current study aims to fill existing knowledge gaps by determining environmental stabilities of four major phycotoxins (pectenotoxin-2, yessotoxin, azaspiracid-2, and okadaic acid) under various UV, temperature, pH, and salinity conditions. While okadaic acid was stable under all experimental conditions, all treatments for each condition resulted in the degradation of the other three toxins in the order: azaspiracid-2 > yessotoxin > pectenotoxin-2. For both salinity and temperature, the highest treatment levels (S=30 and T=35°C) resulted in significantly faster degradation than the lowest treatment levels (S=5 and T=15°C), while degradation rates did not differ over a range of pH (pH = 6, 8, 10). Toxins that were coincidentally exposed to light and humics degraded more quickly than light treatments without humics. This suggests dissolved organic matter enhances photodegradation of these toxins. Targeted and non-targeted methods were used to putatively identify degradation products and pathways. Measuring stability under varying environmental conditions will help to elaborate knowledge surrounding persistence, distribution, and fate of both emerging and well-documented HAB toxins within aquatic systems and under future climate scenarios. Expanding research in this area will provide regulators more information needed for management decisions, and further understanding of which toxins pose the highest human health threat through prolonged persistence.

SPEAKER: **Joshua Garber, Virginia Institute of Marine Science | jagarber@vims.edu**

SPEAKER BIO: Joshua Garber is a fourth year Ph.D. student in Dr. Juliette Smith's lab at the Virginia Institute of Marine Science. He received his Bachelor of Science degree in Chemistry from SUNY College of Environmental Science and Forestry where he got his introduction to research involving phytoplankton related compounds. Josh's research at VIMS focuses on the fate, distribution, and toxicity of multiple classes of phycotoxins. He is interested in the chemical behavior of toxins once they have been produced and released into the water column and how that impacts severity of blooms.

CO-AUTHORS:
Michael A. Unger
Robert C. Hale

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

EVALUATING MULTISPECTRAL IMAGE DATA FOR MARKERS ASSOCIATED WITH HARMFUL ALGAL BLOOMS

SESSION: REMOTE SENSING

ABSTRACT: Riverine harmful algal blooms (HABs) historically have received considerably less attention than those in lentic waters but can have similar negative effects on drinking water supplies, recreational use, and ecological health. The U.S. Geological Survey (USGS) Next Generation Water Observing System (NGWOS) testbed sites in the Illinois River Basin were selected to study HABs and test sensors that could be used to detect them. Multispectral data collection in this study focuses on relating imagery data to potential proxies for algae blooms and suspended sediment. Because traditional measures such as chlorophyll a and biomass are not always good predictors of HABs, additional proxies were evaluated from various sensors and discrete sampling. Multispectral cameras were deployed in conjunction with fixed-station sensor monitoring, discrete water and benthic sampling campaigns throughout the watershed, and nutrient-limitation experiments. Single-band and various combinations of reflectance values were evaluated, similar to spectral indices used for satellite remote sensing of chlorophyll. These reflectance values and spectral indices were correlated with sensor values and discrete sampling results including chlorophyll fluorescence, phycocyanin fluorescence, turbidity, nutrient ratios, biomass, relative algal species abundance, and presence of toxins.

SPEAKER: **Jessie Garrett, USGS | jgarrett@usgs.gov**

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CO-AUTHORS:
Carolyn Soderstrom

EVALUATING MULTISPECTRAL IMAGE DATA FOR MARKERS ASSOCIATED WITH HARMFUL ALGAL BLOOMS

POSTER SESSION: WEDNESDAY

ABSTRACT: Riverine harmful algal blooms (HABs) historically have received considerably less attention than those in lentic waters but can have similar negative effects on drinking water supplies, recreational use, and ecological health. The U.S. Geological Survey (USGS) Next Generation Water Observing System (NGWOS) testbed sites in the Illinois River Basin were selected to study HABs and test sensors that could be used to detect them. Multispectral data collection in this study focuses on relating imagery data to potential proxies for algae blooms and suspended sediment. Because traditional measures such as chlorophyll a and biomass are not always good predictors of HABs, additional proxies were evaluated from various sensors and discrete sampling. Multispectral cameras were deployed in conjunction with fixed-station sensor monitoring, discrete water and benthic sampling campaigns throughout the watershed, and nutrient-limitation experiments. Single-band and various combinations of reflectance values were evaluated, similar to spectral indices used for satellite remote sensing of chlorophyll. These reflectance values and spectral indices were correlated with sensor values and discrete sampling results including chlorophyll fluorescence, phycocyanin fluorescence, turbidity, nutrient ratios, biomass, relative algal species abundance, and presence of toxins.

SPEAKER: **Jessie Garrett, USGS | jgarrett@usgs.gov**

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CO-AUTHORS:
Carolyn Soderstrom

KARENIA IN VIRGINIA WATERS: AN EMERGING ISSUE

SESSION: EMERGING TOXINS & SPECIES

ABSTRACT: In the late summer and early autumn of 2017, the first observations of the potentially toxigenic dinoflagellate, Karenia papilionacea, were made in samples collected at the mouth of the Chesapeake Bay and along the Bay side of Virginia's Eastern Shore. Despite long-term water quality monitoring programs in this region (Chesapeake Bay Monitoring Program, monthly or twice monthly, 1985 – present and Virginia Department of Health, semi-monthly, 1998 – present) Karenia had not previously been reported withing Chesapeake Bay or along the Virginia coastline despite blooms occurring along the Maryland or Delaware coastlines in 2007, 2010, and 2016. The K. papilionacea and K. mikimotoi blooms that occur along the Delmarva Peninsula appear to be patchy and short-lived (~ two weeks). Blooms have occurred almost annually since 2016 along the coastlines of Delaware, Maryland, or Virginia, but rarely along multiple states within the same year. The peaks of all previously recorded Karenia blooms occurred in late August or early September. From October through December 2023, K. papilionacea was detected in several locations on Virginia's Eastern Shore. Cell concentrations peaked in mid-November (1.4 x 105 cells L-1) in Bay side waters and both K. papilionacea and K. mikimotoi were identified within the bloom. The unusual timing of this bloom prompted an investigation into the bloom origin and the potential impacts to the region's shellfish. To date, there have been no reported cases of biotoxin poisonings or exceedances of toxin thresholds in shellfish harvested from regional waters, but there is conflicting data on if brevetoxin is produced by the Delmarva population of K. papilionacea. The use of autonomous monitoring assets, such as imaging flow cytobot and satellite remote sensing, to assist resource managers in assessing this bloom will be discussed.

SPEAKER: **Leah Anne Gibala-Smith, Old Dominion University | lgibalas@odu.edu**

SPEAKER BIO: Leah is an aquatic ecologist and algal taxonomist who has over 25 years experience related to water quality analysis, drivers of aquatic community structure, and the identification of macrophytes, phytoplankton, and algae in fresh, tidal, and marine systems. She ran a water quality and nutrient laboratory in Wisconsin for over 5 years prior to joining the Phytoplankton Analysis Laboratory at Old Dominion University in 2014. Since becoming the laboratory supervisor in 2016, Leah has worked with the local, state and federal partners by conducting taxonomic enumerations and toxin assays in the state's fresh, tidal, and coastal waters for monitoring, rapid response, and research efforts. Her research interests include drivers of harmful algae blooms in estuarine and coastal waters, the use of imaging technology in monitoring and HAB detection, transport of cyanotoxins along the freshwater to marine continuum, and the verification of satellite products for HAB forecasting, detection, and monitoring.

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U.S. National Office for Harmful Algal Blooms

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

GENETIC DIAGNOSTICS FOR RAPID DETECTION OF DOMOIC ACID-PRODUCING PSEUDO-NITZSCHIA SPECIES

SESSION: CELLULAR & MOLECULAR TECHNOLOGY

ABSTRACT: Pseudo-nitzschia, a pennate diatom found globally, is known to produce the neurotoxin domoic acid (DA) linked to causing Amnesic Shellfish Poisoning (ASP) in both humans and marine life. Current monitoring efforts use light microscopy to enumerate cells but are unable to identify which species are present and whether or not they are toxic, as DA levels within the bloom can fluctuate, creating a need for rapid detection of DA production. Existing lab-based genetic tests for determining which species are present and accurate toxicity tests require technical expertise and have long testing times (>24 hours), leading to delayed response. Alternative genetic methods like isothermal amplification coupled with CRISPR/Cas detection have high sensitivity and specificity using minimal equipment that can be converted to user-friendly, field-deployable formats for detecting multiple genetic targets in less than 1 hour. We developed LAMP + CRISPR assays and qPCR assays to detect if specific toxin genes (DabA) are present in a population and if these are being actively expressed, indicating likelihood of DA production. We have tested a range of samples from synthetic target, genomic extracts from cultures, and field samples, and are able to detect DNA and RNA targets similarly across LAMP + CRISPR assays and qPCR. Alongside improved monitoring efficiency, these tests could allow resource managers to have earlier knowledge of toxic events and species present to make more informed decisions for the benefit of local ecosystems, shellfish harvesters, and public health.

SPEAKER: **Taylor Gibson, Gloucester Marine Genomics Institute | taylor.gibson@gmgi.org**

SPEAKER BIO: link to career page: https://gmgi.org/team/research-team/taylor-gibson/
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

CYANOBACTERIAL HARMFUL ALGAL BLOOMS IN LOW-NUTRIENT NEW YORK LAKES: COMBINED APPROACHES TO EXAMINE THE HISTORY OF AN EPHEMERAL PHENOMENON

SESSION: Poster Session, Wednesday

ABSTRACT: Cyanobacteria are natural components of aquatic ecosystems, but there is a paucity of research focused on understanding the historical occurrence of cyanobacterial harmful algal blooms (cyanoHABs) and whether bloom-forming taxa have always been present in plankton assemblages of oligotrophic lakes or if they are recent additions. Quantifying the history of cyanoHAB occurrence in oligotrophic systems is essential to understanding the role of nutrients and climate change in the development of cyanoHABs. While there are several hypotheses for how blooms might arise, the occurrence and causes of cyanoHABs in nutrient-poor systems are not well understood. In response to increased cyanoHABs in lakes with relatively low nutrient concentrations, the U.S. Geological Survey (USGS) has developed several research projects in the Adirondack Park region of New York State (NY), using water- and sediment-based methods appropriate to the challenges of capturing episodic cyanoHABs. These include genetic assays, paleolimnological approaches, and assessments of historical data to investigate current and historical patterns. Results indicate that cyanoHAB detection in low nutrient systems is challenging; however, several lines of evidence converged to help inform observed patterns at the lake surface and within the water column. Results from these NY-focused studies provide tools for managers and lake users to understand drivers and patterns of cyanoHABs in low nutrient systems.

SPEAKER: **Sabina Gifford, U.S. Geological Survey | srgifford@usgs.gov**

SPEAKER BIO: Sabina is a Biologist with the New York Water Science Center researching the occurrence and distribution and environmental drivers of Cyanobacteria blooms in New York. Prior to coming to USGS, Sabina received her Masters degree from the University of New Hampshire researching the ecology and toxicity of deep-water cyanobacteria blooms occasionally found on clear New Hampshire Lakes.

CO-AUTHORS:
Rebecca Gorney

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

MAKING THE WATERSHED CONNECTION: THE INFLUENCE OF CYANOBACTERIA, SEDIMENT, AND NUTRIENT LOADING AND HYDROLOGY ON CYANOBACTERIAL BLOOM INITIATION IN THE NEARSHORE ENVIRONMENT

SESSION: BLOOM DYNAMICS & DRIVERS II

ABSTRACT: Nearshore algal blooms appearing along the southern coastline of the western arm of Lake Superior ranging from Duluth Harbor to the Apostle Islands appear to coincide with large storm events that flush sediment and nutrients from the watershed into the nearshore. The concept of “fluvial seeding” has been hypothesized, but the limited available data have not always agreed on the influence of riverine cyanobacteria on open lake algal bloom initiation. Using cultivation and genomics, our work assessed fluvial flow of cyanobacteria with nutrient and sediment loading from the Siskiwit and Bois Brule tributaries to the Lake Superior nearshore. Water and sediment samples were collected and added to selective cyanobacteria media. Additionally, DNA from environmental samples and cultivations were sent for Bacteria 16S rRNA amplicon sequencing to characterize and compare the cyanobacteria community along the tributary to nearshore continuum. Quantitative PCR targeting Cyanobacteria 16S rRNA was analyzed to determine cyanobacteria relative abundance in relation to sediment and nutrient loading. Viable cyanobacteria cells were cultivated from tributary samples and genomically similar signatures of Cyanobium, Pseudanabaena, and Nostocaceae species were detected from tributary environmental samples and cultivations. Additional data are needed to understand whether cyanobacteria seeding originates in the tributaries themselves, whether fluvial flow is simply transporting these cells to the nearshore from upstream, or if there are multiple sources seeding the nearshore.

SPEAKER: **Carrie Givens, USGS | cgivens@usgs.gov**

SPEAKER BIO: Carrie Givens is the Environmental Microbiology Team Lead at the United States Geological Survey Upper Midwest Water Science Center. She leads and collaborates on research exploring bacterial pathogens and antibiotic resistance in the environment, microbial communities associated with harmful algal blooms, and the influence of the environment and chemical contaminants on the host microbiome. She has a B.S. in Biology from the University of South Carolina Honors College and a Ph.D. in Marine Science from the University of Georgia.

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KARENIA BREVIS AND ITS INTERACTION WITH VIRUSES, BACTERIA AND OTHER PHYTOPLANKTON AT DIFFERENT TEMPERATURES: FINDING THE SWEET SPOT FOR GROWTH IN CHALLENGING ENVIRONMENTS

SESSION: MICROBIAL INTERACTIONS

ABSTRACT: Karenia brevis, the toxigenic dinoflagellate common to the Gulf of Mexico, rarely blooms in the heat of mid-summer. However, in 2021, such a bloom did occur, yielding the opportunity to examine relationships between K. brevis and other phytoplankton, as well as two different bacteria and three viruses as a function of temperature. Here, summer bloom water (>400,000 cells L-1) was diluted with non-bloom, offshore water in varying proportions and incubated for 24 hr in near ambient temperature (25oC and 30oC), a temperature nearshore waters experienced with midday warming (33oC), and an extreme cooler temperature (15oC). At all temperatures, K. brevis experienced stress, including nutrient stress. Direct temperature stress was apparent for the coolest and warmest treatments. At the warmest treatments, K. brevis also had increased mortality due to infection by specific viruses, including a giant virus. Grazing by K. brevis on Synechococcus spp. and Prochlorococcus spp. was inferred from cell abundance changes over the 24 hr incubation periods at 30oC. Grazing was not apparent at the other temperatures. However, there was also evidence that Synechococcus spp. may also have been susceptible to specific viral infection in the warmest temperatures. Slow growth or survival of K. brevis may have been possible when infection of both predator and prey were balanced by growth of prey at near ambient temperatures, thereby providing a substrate for K. brevis under the otherwise inorganic nutrient limited conditions of the natural waters. The data herein provide a glimpse into the dynamic interactions between K. brevis and its associated microbial consortia and how they can change with temperature and other interactions.

SPEAKER: **Pat Glibert, University of Maryland | glibert@umces.edu**

SPEAKER BIO: Pat Glibert is a Professor at the University of Maryland Center for Environmental Science (UMCES), Horn Point Laboratory. She received her Ph.D. from Harvard University and was a Postdoctoral Scholar and an Assistant Scientist at the Woods Hole Oceanographic Institution prior to moving to Maryland. She is an oceanographer whose work has centered around questions related to nutrient dynamics and phytoplankton physiology and ecology, especially HABs. She is an elected Fellow of the American Association for the Advancement of Science and a Sustaining Fellow of the Association for the Sciences of Limnology and Oceanography (ASLO). She also served as President of ASLO (2022-2024). She received an honorary doctorate for her work on algal physiology from Linnaeus University, Sweden, in 2011. In addition to authoring over 200 papers, she is the author of the book Phytoplankton Whispering: An Introduction to the Physiology and Ecology of Microalgae.

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NITROGEN FIXATION WITHIN MICROCYSTIS COLONIES SUPPORTS HARMFUL CYANOBACTERIAL BLOOMS IN NORTH AMERICAN LAKES

SESSION: BLOOM DYNAMICS & DRIVERS II

ABSTRACT: Microcystis is the most common cyanobacterial harmful algal bloom (CHAB) across the US. As a non-diazotrophic cyanobacterium, Microcystis relies on exogenous nitrogen (N) to form CHABs. Although N can control the growth and microcystin content of Microcystis, blooms of this genera can persist for extended periods when the levels of bioavailable N (nitrate, ammonium) are low, suggesting an ability to access non-traditional forms or pools of N and/or superior N assimilation rates compared to competing plankton. This project studied the dynamics of N utilization, including diazotrophy, by Microcystis colonies, free-living bacteria (< 20µm), and the whole plankton community during CHABs in six lakes across North America, including Lake Erie, over a three-year period. We concurrently characterized the nifH-containing bacteria via high throughput sequencing. Across all lakes and dates, there were measurable levels of N2-fixation within Microcystis colonies and, for five of six systems, rates within colonies were significantly greater than rates measured among free-living bacteria (<20µm; $p<0.05$). Ammonium enrichment significantly reduced N2-fixation rates within Microcystis colonies by 26-74% in 4-hr ($p<0.001$) demonstrating the suppression of diazotrophy when N-replete conditions were created. Using a curated pipeline capable of distinguishing non-functional nifH genes, we detected both heterotrophic bacterial and cyanobacterial nifH sequences within Microcystis colonies. The relative abundance of cyanobacterial vs. non-cyanobacterial sequences in colonies differed from the free-living fraction and differed between higher and lower latitude lakes. Compared to nitrate and ammonium assimilation, N2-fixation rates accounted for a significant fraction of total N assimilation, evidencing its ability to influence CHABs.

SPEAKER: **Christopher Gobler, Stony Brook University | christopher.gobler@stonybrook.edu**

SPEAKER BIO: Christopher Gobler is a SUNY Distinguished Professor and an Endowed Chair within the School of Marine and Atmospheric Sciences (SoMAS) at Stony Brook University. He received his M.S. and Ph.D. from Stony Brook University in the 1990s and began his academic career as a professor at Long Island University (LIU) in 1999. In 2005, he joined Stony Brook University as the Director of Academic Programs for SoMAS on the Stony Brook – Southampton campus. In 2015, he was named Director of the New York State Center for Clean Water Technology. He has been editor-in-chief of the peer-reviewed Elsevier journal, Harmful Algae, since 2018. His research aims to understand how anthropogenic activities (climate change, eutrophication, overharvest of fisheries) alter the ecological and biogeochemical functioning of coastal ecosystems and to discover approaches for restoring impaired coastal ecosystems. He has published more than 250 manuscripts in international, peer-reviewed journals and has graduated more than 50 graduate students.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

COMBINING NANOPORE SEQUENCING WITH QPCR FOR ACCURATE AND SITE-SPECIFIC MONITORING OF HARMFUL CYANOBACTERIAL GENERA IN FRESHWATER FIELD SAMPLES

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: Cyanobacteria, also known as blue-green algae, are photosynthetic microorganisms whose overgrowth often leads to harmful algal bloom (HAB) events in freshwater ecosystems. Early, rapid, and accurate detection of HAB-causing cyanobacteria is imperative for timely and effective mitigation of adverse impacts of HABs. To meet this demand, we previously developed novel taxon-specific primers for quantitative polymerase chain reaction (qPCR) assays based on target and non-target cyanobacterial 16S rRNA gene sequences in public databases, including NCBI RefSeq, Cydrasil, SILVA, and CyanoSeq. Although these primers have been strictly screened and tested using a collection of our laboratory pure cyanobacterial cultures, we encountered unexpected inconsistence between qPCR results and microscopic and visual observations. To resolve such inconsistence, we applied the Nanopore technology to sequence the community-wide 16S rRNA full-length amplicons and assigned the sequencing reads to their best aligned taxonomic groups, mostly at the genus level. Further bioinformatic analysis revealed significant field-specific genetic mutations/variabilities of the target taxa as well as the limitations of their sequences deposited in public databases, causing mismatches between designed primers and actual target sequences. The performance, i.e., sensitivity and specificity, of refined, site-specific qPCR primers after integrating Nanopore sequencing data was greatly improved for field samples. Our studies suggest the importance and necessity of including full-length target gene amplicon sequencing data in taxon-specific qPCR primer design. We recommend running a 16S rRNA full-length amplicon sequencing to obtain the background information of the cyanobacterial community composition, e.g., dominant species or genera, relative population density, and genetic heterogenicity and divergence of 16S rRNA gene for species of concerns, prior to the application of developed primers to a new, uncharacterized field site.

SPEAKER: **Ping Gong, US ACE ERDC | Ping.Gong@usace.army.mil**

SPEAKER BIO: Dr. Ping Gong is a Senior Research Biologist and Principal Investigator with the Environmental Laboratory of U.S. Army Engineer Research and Development Center in Vicksburg, Mississippi. He earned a Ph.D. in Environmental Toxicology from Chinese Academy of Sciences in 1995, followed by postdoctoral research at the Technology University of Berlin (TU Berlin), Swedish University of Agricultural Sciences (SLU), and Biotechnology Research Institute of National Research Council of Canada. He specializes in bioengineering, synthetic biology, environmental genomics, bioinformatics, and mechanistic and predictive toxicology. He developed 8 bioinformatics and computational biology tools and published over 100 peer-reviewed articles and book chapters with 3097 citations and an h-index of 33 as of 5 December 2023 (Scopus). He served on the Board of Directors for the MidSouth Computational Biology and Bioinformatics Society (MCBIOS) as well as Editorial Boards of Frontiers in Genetics, Frontiers in Plant Sciences, Frontiers in Bioengineering and Biotechnology, Experimental Biology and Medicine, and Environmental Toxicology and Chemistry. He held adjunct faculty positions at the University of Massachusetts Chan Medical School, East Carolina University, University of Southern Mississippi, and University of Mississippi. His current research interests focus on the development of novel biotechnologies for invasive species detection and mitigation and deep learning-guided protein engineering.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

DEFINING THE LIKELY LOCATION AND SEASONAL TIMING OF SELECT HARMFUL ALGAL BLOOM-FORMING SPECIES IN COASTAL TEXAS USING HABITAT SUITABILITY MODELING

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Harmful algal blooms (HABs) negatively affect the health of marine life, pose a threat to human health, and have negative consequences for coastal economies. On the Texas coast, the primary toxin-producing HABs are Karenia spp. and Dinophysis sp., while blooms of the non-toxic but ecosystem disruptive Aureoumbra lagunensis are common in the Baffin Bay-Laguna Madre complex. In addition to these species, episodic blooms of other potential HAB taxa have been observed. Unfortunately, routine monitoring for coastal HABs in Texas has generally been limited to investigator-led initiatives, leading to large gaps in spatial and/or temporal coverage thus hindering our ability to understand when and where conditions are suitable for blooms of various taxa. To address this issue, this study utilized an approach that has previously been applied to various higher organisms and more recently to HABs in select regions, known as habitat suitability modeling. This approach integrates existing data on HAB-environmental relationships, with data that defines the general environmental conditions (in this case, temperature and salinity) of Texas estuaries that lie along a freshwater inflow gradient and vary by season. Results will be presented showing locations (including specific estuaries and regions within these estuaries) that are potentially suitable for different HAB taxa, as well as the seasonal window for each species under present and future environmental conditions. Findings from this study will help inform design of future monitoring efforts and aquaculture development plans, among other benefits.

SPEAKER: **Susana Gonzalez, Harte Research Institute, TAMUCC | sgonzalez86@islander.tamucc.edu**

SPEAKER BIO: Susana M. Gonzalez is a NOAA EPP/MSI, CCME-II Scholar, pursuing a PhD in Coastal and Marine System Science at Texas A&M University, Corpus Christi. She began her career in Pre-veterinary Medicine with a bachelor’s degree from Cal Poly, San Luis Obispo, where her interest in harmful algal blooms (HABs) arose, while working with affected marine mammals. This catapulted her towards a career in ecological and marine sciences, later earning a master’s degree in Conservation Medicine from Tufts University where she supplemented her research and education with a certificate in Water: Systems Science, and Society, giving her foundational knowledge in water quality problems and solutions. Her latest research is founded on the relationships between harmful algal blooms (HABs), ecosystem health, and social structures. She intends to integrate the use of community science and geographic information systems (GIS) to inform the public and decision-makers, tackling this complex issue in comprehensive and effective manner.

CO-AUTHORS:
Michael Wetz, Laura Beecraft

COMPARISON OF TWO INVERTEBRATES SENSITIVITY TO ALGAECIDE AND CYANOTOXIN AT ELEVATED SURFACE WATER TEMPERATURES

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS II

ABSTRACT: Cyanobacteria harmful algal blooms (cyanoHABs) are a problem of increased concern across freshwater bodies in the United States, especially when taking climate change into consideration. Currently there are many methods for chemical or mechanical treatment of cyanoHABs, including copper sulfate and hydrogen peroxide. Hydrogen peroxide is thought to be less toxic to non-target organisms because it does not produce toxic radicals or have metal byproducts like copper sulfate, however, its effects have not been examined at high temperatures or in combination with toxin while organisms are present. This study exposed two different freshwater cladocerans, Ceriodaphnia dubia and Daphnia magna, to nominal concentrations of 0 to 256 µg/L of Microcystis aeruginosa lysate as well as a daily 3 mg/L dose of hydrogen peroxide to mimic daily treatment of a cyanoHAB event over 7 days and 4 days, respectively. These assays were performed at 27°C after a period of organism culture acclimation. For C. dubia, the average IC25 was 15 µg/L and for D. magna, it was 101 ug/L. This study will help better understand how aquatic organisms interact with their environment during cyanoHAB events and if synergistic effects are present between all the different variables of temperature, toxin, and algaecide.

SPEAKER: **Sarah Goodrich, University of Cincinnati | goodrisg@mail.uc.edu**

SPEAKER BIO: Sarah Goodrich is a new PhD candidate at the University of Cincinnati in the Department of Geography and GIS. Her research interests lie in harmful algal bloom management practices.
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RECREATOR PERSPECTIVES ON HARMFUL ALGAL BLOOMS IN OHIO

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Harmful algal and cyanobacterial blooms (HABs) are found in freshwater lakes and rivers across the United States. In recent years, their frequency and intensities have increased. They are caused by cellular overgrowth that may result in toxin production, which can be harmful to aquatic organisms, livestock, and human life. When toxins reach a certain threshold, no-swim or no visit advisories may be issued for an area. As of to date, there is little study on the human psychological and behavioral aspects surrounding HABs. It is also unclear as to what recreators know and understand about HABs. However, since recreators use the waterbodies for various activities, they may be exposed to or in direct contact with this environmental risk. As such, it is paramount that they must be aware of the possible health impacts of HABs and behave sensibly to protect not only themselves, but also their children and pets. This study interviewed recreators at Lake Harsha in Ohio which is known to have HABs to better understand public awareness and HABs psychology. The findings can contribute to HABs management as they will help water managers bridge the gaps in communication and create better and more efficient methods of disseminating knowledge and warnings about HABs.

SPEAKER: **Sarah Goodrich, University of Cincinnati | goodrisg@mail.uc.edu**

SPEAKER BIO: Sarah Goodrich is a new PhD candidate in the Department of Geography and GIS at the University of Cincinnati. Her research interests are focused on human-environment interactions with a specialty in harmful algal bloom management strategies. Her LinkedIn can be found here: https://www.linkedin.com/in/sarah-goodrich-6b61a2b0

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MYSTERY IN THE FLORIDA KEYS - THE 2023/2024 ABNORMAL FISH BEHAVIOR EVENT

SESSION: PLENARY

ABSTRACT: Abnormal fish behavior described as "spinning" was first observed in nearshore waters in the lower Florida Keys in November 2023. As observations of spinning fish increased, reports of distressed or dead endangered smalltooth sawfish (Pristis pectinata) began at the end of January 2024. Recognizing the importance of collaborative response efforts, an ad hoc working group with expertise in event response, marine fisheries, fish health, harmful algal blooms, toxicology, habitat, water quality, and communications was formed to plan and execute event response and investigate multiple lines of inquiry. As a result of these collaborative efforts, local and state reporting mechanisms helped capture the timing, location, and intensity of the event with >450 reports of abnormal behavior and >40 sawfish mortalities, while local fishing guides provided their resources and expertise to support sampling efforts. Collaborative sampling allowed for paired benthic and water sampling, and collection of affected fish for necropsy and analysis. Necropsy results to date show no apparent signs of a communicable pathogen, and specimens have been negative for bacterial infection. Environmental factors such as changes in dissolved oxygen, salinity, pH, or temperature are not suspected. Testing of water, benthic algae, and fish tissue have not indicated brevetoxins, cyanobacterial toxins, or saxitoxins as a cause. The working group continues to investigate the most promising lead of benthic HABs and their associated algal toxins (abstract submitted by Alison Robertson, USA). Elevated Gambierdiscus levels (abstract submitted by Michael Parsons, FGCU), along with the presence of other potential HABs including Protoceratium reticulatum, Pyrodinium bahamense, Coolia sp., Ostreopsis sp., multiple Prorocentrum species, Pseudo-nitzschia spp.) were observed. While the reports of abnormal behavior and sawfish mortalities began to slow in April 2024, the working group continues to monitor, investigate, and prepare for winter 2024/2025 in case reports of abnormal behavior and sawfish mortalities continue.

SPEAKER: **Caroline Gorga, Florida Fish and Wildlife Conservation Commission - Fish & Wildlife Research Institute | Caroline.Gorga@MyFWC.com**

SPEAKER BIO: Caroline Gorga is the Ecosystem Assessment and Restoration Section Leader for the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute, directing research groups focused on harmful algal blooms, fish and wildlife health, and Florida's diverse terrestrial, freshwater, estuarine, and marine habitats. Ms. Gorga received a B.S. in biology from the University of North Carolina at Chapel Hill and earned her M.S. in wildlife and fisheries biology from Clemson University. She has worked for the FWC since 2012 in various roles for both the management and research divisions and is based in St. Petersburg, Florida.

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3 NOAA Fisheries, Office of Protected Resources
4 Florida Gulf Coast University
5 Lower Keys Guides Association
6 Florida Department of Environmental Protection
7 University of South Alabama
8 Dauphin Island Sea Lab

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

CENTRAL PARK TAKES CENTER STAGE

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Central Park, in New York City, New York, is the most visited urban park in the United States. Of the six lakes in the park, three routinely experience toxin-producing cyanobacterial blooms for up to six months each year. However, the variability in water-quality conditions, cyanobacterial community assemblages, and cyanotoxin concentrations among lakes have not been well characterized. During summers 2023 to 2025, several cyanobacterial-related research efforts will focus on Central Park waterbodies including: 1) describing the local microbial communities and their relations with Microcystis cells (the cyanosphere); 2) characterizing cyanobacterial communities and cyanotoxin composition in all six lakes; 3) investigating potential for groundwater-surface water interactions; and 4) experimentation regarding the design of passive samplers. To put Central Park into a global context, it was included in an international study spanning three continents and two climate zones to better understand the diversity of bacterioplankton communities in Microcystis-dominated blooms. In 2023, surface water samples were collected from Central Park (North America), Poland (Europe), and Singapore (Asia). The cyanosphere was characterized with 16S rRNA amplicon sequencing. Microcystis occurred in all lakes, however, associated bacterioplankton taxa were different among sites and climate zones. We used constructed metagenomes to infer the functional potential (nutrient-transforming processes) and hazard potential (antibiotic resistance genes) of the prokaryotic communities in these blooms. This presentation will describe our ongoing research in Central Park, with an emphasis on 2023 findings and preliminary 2024 results. This research was funded by USGS HABs Directed Cooperative Matching Funds and NSC 2022/47/NZ8/00689 “Intercontinental comparison of bacterial and archaeal communities associated with cosmopolitan cyanobacterium Microcystis - unveiling their ecological roles in anthropopressure and climate change.”

SPEAKER: **Rebecca Gorney, USGS | rgorney@usgs.gov**

SPEAKER BIO: Rebecca is an aquatic biologist and conducts research on cyanobacteria harmful algal blooms. She began working at the USGS New York Water Science Center in 2023 following several years as a research scientist overseeing HABs monitoring efforts at the NYSDEC. Previously, she received her Ph.D. in natural resource management from the University of Vermont and a M.S. from the Ohio State University. She has worked in a variety of ecosystems, from urban to rural, aquatic to terrestrial. Her current role is the technical HABs team lead for USGS efforts in NY, and she is involved in several national efforts as well.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

CHARACTERIZING HAB SPECIES WITHIN NEW YORK CITY'S SUPERFUND-DESIGNATED WATERWAYS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: New York City (NYC) is surrounded by 'urban estuaries' that receive excessive nitrogen (N) inputs from wastewater associated with combined sewer overflow (CSO) systems, non-point source runoff, atmospheric deposition, and other sources. This elevated N-load contributes to harmful algal blooms (HABs) and seasonal hypoxia from respiration of dissolved organic matter (DOM) in nearby embayments. However, the spatial and temporal dynamics of phytoplankton communities, particularly HAB species abundances and their impacts, are surprisingly understudied within the greater NYC metropolitan area itself. For example, CSOs induced by storm events are a major source of both fecal coliform and N-rich wastewater contamination to both the Lower Hudson River Estuary (LHRE) and Newtown Creek (NC). Since climate change is predicted to increase storm frequency and intensity, particularly in low elevation cities like NYC, elucidating linkages between CSO discharge, precipitation, and HABs is a critical public health need. Furthermore, both LHRE and NC have designated Superfund regions due to long-term industrial pollution, yet they are heavily used by the surrounding communities for recreation. Here we report progress in determining the influence of CSO outfalls on HABs and concomitant water quality in the LHRE and NC following both wet (heavy rainfall) and dry (minimal rainfall) conditions.

SPEAKER: **Dianne Greenfield, City University of New York | dgreenfield@gc.cuny.edu**

SPEAKER BIO: https://asrc.gc.cuny.edu/people/dianne-greenfield/

CO-AUTHORS:
Mariapaola Ambrosone, Nicholas Russell, Moonmoon Ahmed, Georgie E. Humphries

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

APPLICATION OF A QUANTITATIVE MOLECULAR METHOD TO CHARACTERIZE ABUNDANCE AND DISTRIBUTION OF ALEXANDRIUM CYSTS IN THREE REGIONS: GULF OF MAINE, PUGET SOUND AND KODIAK, ALASKA

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Alexandrium catenella is a paralytic shellfish poisoning-causing toxic dinoflagellate that overwinters as a benthic cyst in marine sediments and germinates into the water column in the spring and summer making cells available for filter feeding and toxin concentration by shellfish. A. catenella is present along portions the Pacific and Atlantic coastlines of the U.S and Canada and winter cyst distribution has been used in developing forecast tools in the Gulf of Maine (GOM) and as an early warning system in Puget Sound, Washington to mitigate human health risks and economic effects of shellfish closures. The current protocol for cyst enumeration by fluorescent microscopy is time consuming and requires highly specific training for cyst identification. This MERHAB project, funded by NOAA, includes development of a new quantitative polymerase chain reaction (qPCR) methodology for A. catenella cysts that was evaluated against the standard microscopy protocol with the goal of producing more rapid and accurate cyst abundance data. Assay development has shown the importance of using a qPCR standard curve based on cysts instead of a diluted amplicon, necessitating concentration of a large number of A. catenella cysts from the environment. Furthermore, interannual, seasonal and regional variability in rDNA gene copy number requires new standard curve construction for each cyst survey. qPCR standard curves were constructed and compared using cysts from GOM, Puget Sound and Kodiak, Alaska. Cyst maps and comparison of microscopy-based and qPCR-based cyst abundances will be presented for all three regions.

SPEAKER: **Cheryl Greengrove, University of Washington Tacoma | cgreen@uw.edu**

SPEAKER BIO: Cheryl Greengrove is Associate Vice-Chancellor for Research, an Associate Professor of Geoscience and founding faculty member of the Environmental Science Program at University of Washington, Tacoma (UWT). She is a physical oceanographer currently working with biological, chemical and geological oceanographers on studying Harmful Algal Blooms in Puget Sound and estuarine processes in Barkley and Clayoquot Sounds on the west coast of Vancouver Island. She also works on STEM based pedagogical studies that examine the impact of incorporating real world data and applied, experiential learning and field activities on student learning. Her favorite activity is taking students in the field and involving them in hands-on research.

CO-AUTHORS:
Cheryl Greengrove, Julie Masura, Steve Kibler, Julie Matweyou, Courtney Hart, Mark Vandersea, Tyler Harman and Lynn E. Wilking

SEASONAL PERSISTENCE OF LOW LEVELS OF PSEUDO-NITZSCHIA AUSTRALIS ON THE COAST OF MAINE EIGHT YEARS AFTER ITS FIRST APPEARANCE

SESSION: BLOOM DYNAMICS & DRIVERS I

ABSTRACT: In the diatom genus Pseudo-nitzschia, about half of the described species are capable of producing the potent neurotoxin domoic acid which is responsible for amnesic shellfish poisoning. Of these species, Pn. australis has the highest reported cellular domoic acid concentrations, making it a species of interest from a resource management perspective. However, Pseudo-nitzschia species cannot be easily distinguished by microscopy. We designed a real-time quantitative PCR assay for rapid and accurate detection and quantification of Pn. australis in environmental DNA samples. This assay targets the rbcS spacer region of the chloroplast for specificity and sensitivity. To relate qPCR data to cell count estimations, we determined the rbcS gene copy number experimentally in Pn. australis cultures. The limit of detection for this assay was determined to be equivalent to an estimated 1.2 cells per liter. We applied this novel assay to eDNA water samples collected in the Casco Bay region of the Gulf of Maine to detect and quantify Pn. australis from 2021-2023. In 2021 and 2022, Pn. australis eDNA peaked in abundance from mid September to early December and was below the limit of detection for the rest of the year. In 2023, Pn. australis peaked in abundance early in November but the signal was an order of magnitude lower than the prior years of our time series. Particulate domoic acid was highest in samples with the highest Pn. australis abundance, which supports the specificity of our qPCR assay. This study demonstrates how eDNA can be utilized for the early detection of a harmful algal bloom species, how qPCR can be calibrated with cell cultures, and provides a new tool for marine resource managers.

SPEAKER: **Sydney Greenlee, Bigelow Laboratory, University of Maine | sgreenlee@bigelow.org**

SPEAKER BIO: Sydney is a 4th-year PhD student at the University of Maine and Bigelow Laboratory for Ocean Sciences. Her research focuses on detection of harmful algal bloom species using molecular methods and the Imaging Flow Cytobot (IFCB).

CO-AUTHORS:
Robin Sleith, Peter Countway

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

SPATIAL AND TEMPORAL ANALYSIS OF ALGAL BLOOM OCCURRENCE IN THE CHESAPEAKE AND DELAWARE BAYS USING HISTORICAL REMOTE SENSING DATA

SESSION: PREDICTIVE MODELING - MARINE

ABSTRACT: Prior research suggests that increased urban and agricultural runoff within the Chesapeake and Delaware Bay watersheds have increased the frequency, duration, and intensity of HABs over the past several decades. It is critical to know the location and frequency with which blooms occur to adopt informed mitigation strategies. Historical assessments currently rely on repeated point-based observations of bloom occurrences, which is time and resource intensive. Leveraging remote sensing could greatly increase HABs identification efficiency. Mapping estuarine algal blooms with sufficient detail requires a higher spatial resolution than offered by ocean-color satellites, including MODIS and MERIS, which have previously demonstrated success identifying HABs in marine environments. Sensors such as Landsat possess higher spatial resolution (30 m) and provide an alternate option for studying optically complex waters. The relatively low spectral resolution of Landsat data limits the ability to identify HABs taxa. However, such data can be used to identify HAB proxies, specifically chlorophyll a, when paired with in-situ measurements and machine learning methods. To make detailed spatial and temporal assessments of algal bloom occurrences, chlorophyll a measurements from the Chesapeake Bay Program, Water Quality Portal, and LAGOS-NE datasets were matched with coincident Landsat acquisitions in the Chesapeake and Delaware Bay areas. A chlorophyll-Landsat matchup dataset containing over 100,000 observations spanning 1984-2018 was used to train and test a random forest model. The model was applied to all available low-cloud Landsat acquisitions between 1985 and 2021, creating a Landsat based time-series of modeled chlorophyll a values. Algal blooms were identified based on threshold chlorophyll a values (>15 µg/l), and the modeled time-series was used to quantitatively determine how blooms are changing in frequency, duration, and extent within the Chesapeake and Delaware Bay watersheds. This tool could also potentially be used with Sentinel 2 data and initial comparative results will be presented.

SPEAKER: **Natalie Hall, USGS | nhall@usgs.gov**

SPEAKER BIO: Dr. Natalie Hall is a Supervisory Geographer in the MD-DE-DC Water Science Center and holds a PhD in Environmental Science and Public Policy with an emphasis on molecular microbiology. Natalie's work at the USGS has been dedicated to water quality, including urban stormwater and hyperspectral identification and monitoring of HABs. Recent work has focused on predictive machine learning models to investigate HAB trend dynamics.

CO-AUTHORS:
Kendall Wnuk, Leah Staub, Matthew Cashman, John Hammond, Mark Nardi

DRIVERS OF SMALL SCALE VARIABILITY IN PARALYTIC SHELLFISH TOXIN CONCENTRATIONS IN BUTTER CLAMS (SAXIDOMUS GIGANTEA) IN SOUTHEAST ALASKA

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: Harmful algal blooms (HABs) are a reoccurring threat to subsistence and recreational shellfish harvest in Southeast Alaska. Recent Tribally managed toxin monitoring programs have improved understanding of the environmental drivers and toxicokintetics of shellfish toxins in the region, however there is considerable variability in paralytic shellfish toxins (PSTs) in some species which is cannot be easily explained by seasonal bloom dynamics. In particular, highly variable and persistent concentrations of PSTs in homogenized butter clam samples (n>6, Saxidomus gigantea) have been observed in several communities. In order to investigate potential sources of variability in PST concentrations from this subsistence species, we assessed individual concentrations of PSTs across a size gradient of butter clams during a period of relatively low HAB activity. We found that higher concentrations of PSTs were significantly associated with larger clams using a log-linear model. Using this empirically derived relationship, we then simulated random sampling from 3 size distributions, and found that for all distributions large clams had an outsized probability to contribute a significant proportion of the total toxicity in a 6-clam homogenized sample. While our results were obtained during a period of low HAB activity and cannot be extrapolated to periods of intoxication or rapid detoxification, they have significant ramifications for both monitoring programs as well as subsistence and recreational harvesters.

SPEAKER: **John Harley, University of Alaska | john.r.harley@gmail.com**

SPEAKER BIO: John was born in California where he developed an enduring fascination for the marine environment by poking sea anemones in tide pools. As a lover of wilderness, he moved to smaller and more remote cities until he began working as an Assistant Research Professor in at the University of Alaska Southeast in Juneau in 2021. He now gets to play in tide pools professionally.

CO-AUTHORS:
Kellie Blair, Shannon Cellan, Kari Lanphier, Lindsey Pierce, Cer Scott, Chris Whitehead, Matthew Gribble

CYANOSCOPE: AN OPEN-SOURCE, DEEP-LEARNING APPROACH TO AUTOMATE CYANOBACTERIA IDENTIFICATION AND ENUMERATION FROM MICROSCOPY IMAGING

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES II

ABSTRACT: Identification of cyanobacteria in mixed assemblages is time consuming, costly, and requires trained taxonomists as it is traditionally done by manual identification via light microscopy. As natural resource agencies increase monitoring efforts for harmful algal blooms (HABs) caused by cyanobacteria, this is becoming a significant bottleneck for adaptive management of bloom events. For example, sending samples out for micro identification and enumeration can take upwards of 30 days to receive results and cost several hundred dollars per sample. This lead time is not practical for monitoring early stages of cyanobacterial development, or for tracking cyanobacterial concentrations immediately after implementing in-lake management treatments. However, emerging deep-learning strategies can be explored to increase accuracy and achieve time-savings from traditional enumeration and identification methods to improve real-time responses to HABs. Therefore, CyanoSCOPE, a deep-learning imaging tool has been developed in the R programming language using Keras and UNet neural network modeling. This proof-of-concept tool can quickly identify single-cell and filamentous cyanobacteria from light microscopy images. Automated quantification tools are built from the cellcount library and using imaging tools and functions from EBImage. The current version of CyanoSCOPE can identify Microcystis, Dolichospermum, Anabaena, and Sphaerospermopsis genera. CyanoSCOPE aims to eliminate the time-consuming bottleneck of cell identification by microscopy, which can further delay HAB mitigation responses and reduce potential identification discrepancies between taxonomists. Given the initial success, future work aims to transition CyanoSCOPE to a monitoring network for resource managers to regularly screen for cyanobacteria species of interest; these additional features will help demonstrate overall accuracy, precision, and efficiency and ensure adoption into routine management programs moving forward.

SPEAKER: **Tyler Harman, CSS, Inc. | tyler.harman@noaa.gov**

SPEAKER BIO: Tyler Harman is an early career marine biologist focusing on disciplines related to climate change and harmful algal blooms. His current work for NOAA NCCOS focuses on developing harmful algal bloom forecasting tools in temperate coastal areas such as south-central Alaska, in addition to freshwater cyanobacteria across the continental United States. His assistance in projects utilize computational programming languages, imaging analysis, deep-learning mechanics (R/MATLAB/Python), phytoplankton taxonomy, and advanced technologies (IFCB) to answer questions pertaining to HABs and improve forecasting abilities. His previous experience details around coral biology, focusing on thermal resilience, innate immunity, and other physiological adaptations in temperate/tropical coral organisms.

CO-AUTHORS:
D. Ransom Hardison - NOAA NCCOS (Beaufort)
William C. Holland - NOAA NCCOS (Beaufort)
Rick Stumpf - NOAA NCCOS (Silver Spring)
Kaytee Pokrzywinski - NOAA NCCOS (Beaufort)

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

UNCOVERING PATTERNS AND MECHANISMS OF PARALYTIC SHELLFISH TOXICITY IN ALASKA'S GEODUCK CLAM FISHERY

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS II

ABSTRACT: This work explores the patterns and mechanisms of paralytic shellfish toxicity in commercially harvested geoduck clams caused by the toxin-producing dinoflagellate Alexandrium catenella in Southeast Alaska. Alaska's commercial fishery for geoduck clams (Panopea generosa) has annual ex-vessel values averaging US $3.9 million (2010-2022). In recent years, the presence of paralytic shellfish toxins (PSTs) in clam tissue resulted in declines in fishery openings and harvest. PSTs can bioaccumulate in the tissues of filter feeders when A. catenella blooms in the spring and summer seasons. However, high levels of toxicity in geoduck clams occur sporadically during the fishery in the fall and winter months long after toxic blooms have subsided. Levels of PSTs in geoduck clams vary substantially from week-to-week, and elevated PSTs are increasingly causing economic loss to the fishery through sampling costs from repeated testing and by delaying or closing harvests. In the past decade (2011-2021), about 60% of geoduck clams tested for PST failed regulatory screenings, up from a 36% failure rate in the decade prior (2001-2010). Knowledge about patterns and distributions of this harmful algal species and its toxins will help improve management of geoduck dive fisheries and provide information to reduce impacts of PSTs on this fishery. We show that geoduck clams are increasingly failing biotoxin screening tests in some areas and these patterns are most closely correlated with regional air temperatures. Additionally, we developed A. catenella cyst distribution maps for this region and found that cyst counts declined over the three-year study, but patterns were not related to geoduck PST levels or sediment characteristics. Lastly, we confirmed the ability for geoduck clams to ingest dormant cysts but revealed that neither this process, nor the age of a clam, is directly related to patterns of paralytic shellfish toxicity in this clam species.

SPEAKER: **Courtney Hart, Port Gamble S'Klallam Tribe | chart@pgst.nsn.us**

SPEAKER BIO: Courtney received her MS from Cal Poly San Luis Obispo after researching the impacts of toxins on cellular processes of Pacific oysters followed by a PhD from University of Alaska Fairbanks studying the patterns and mechanisms of paralytic shellfish toxicity in Alaska's geoduck clam fishery. She is currently the Crustacean Shellfish Program Manager at the Port Gamble S'Klallam Tribe in Washington state managing the tribe commercial crab and shrimp fisheries.

CO-AUTHORS:
Dr. Elizabeth Tobin; Dr. Cheryl Greengrove; Dr. Sherry Tamone; Dr. Ginny Eckert

IMPACTS OF A WARMING GULF OF MEXICO ON KARENIA BREVIS BLOOMS

SESSION: CLIMATE CHANGE

ABSTRACT: The Gulf of Mexico, where blooms of the toxic dinoflagellate Karenia brevis occur annually, is considered especially susceptible to climate change impacts. Climate change is predicted to have impacts on K. brevis bloom timing, frequency and magnitude due to a combination of indirect and direct impacts of warming on scales ranging from cellular to global. Long-term records of bloom severity index (BSI), based on historical counts and spatial and temporal bloom extent, are positively correlated with larger scale oceanographic phenomena and weather patterns (e.g. ENSO, NAO), likely through changing regional weather, rainfall and runoff patterns. Although no evidence of water temperature impacts on bloom overwintering success was found, changes in the timing and frequency of the passage of cold fronts may impact bloom overwintering success, while changes in seasonality and magnitude of the wet season onset in early spring have been shown to contribute to bloom longevity through the warmer summer months. Warming waters may also favor spring blooms of N2-fixing Trichodesmium, increasing nutrient supplies to initiation stages offshore. While the optimal temperature range for K. brevis blooms is 22 - 28°C, adaptation to slowly increasing water temperatures over spring months may allow cells to survive the higher temperature (>34°C) recorded during the 2021 summer bloom months. These results suggest that K. brevis blooms, while impacted in myriad ways by climate change, will continue to be a significant phenomena in the Gulf of Mexico.

SPEAKER: **Cynthia Heil, Mote Marine Laboratory | cheil@mote.org**

SPEAKER BIO: Cynthia Heil is a Senior Scientist and Director of Mote Marine Laboratories Red Tide Institute, where her research focuses on both mitigation of harmful algae and the ecology of both freshwater and marine HAB species, with an emphasis on Karenia brevis blooms in the Gulf of Mexico.

CO-AUTHORS:
Patricia Glibert, Tristen Bercel, Victoria Devillier, Sarah Klass

USING NOVEL LONG-READ METABARCODING TO ASSESS INTRASPECIFIC DIVERSITY OF TOXIN PRODUCING GAMBIERDISCUS SPP.

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Members of the benthic dinoflagellate genus Gambierdiscus are the causative agents of ciguatera poisoning worldwide. Gambierdiscus spp. are known to vary in toxicity, and multiple species are commonly present at the same site. While recent efforts have described the structure of the epiphyte communities where Gambierdiscus is found, only limited information is available about population structure of the different species, including intraspecific diversity and connectivity amongst sites. Metabarcoding techniques traditionally involve shorter sequences of a few hundred basepairs, which can limit taxonomic resolution. This is even more exacerbated for groups with low representation in databases used for taxonomic assignment, like dinoflagellates. We are using a novel long-read metabarcoding approach to amplify most of the LSU region (D1-D11, ~2,600 basepairs). In addition to capturing several regions for taxonomic assignment, longer sequences increase the chance of detecting sequence polymorphisms within species. We first determined intraindividual variability of the D1-D11 region within several Gambierdiscus spp. by sequencing multiple monoclonal strains of different species. We then used this data to inform our analysis of sequences obtained from field-collected epiphyte communities. Understanding the extent of intraspecific variability can inform the interpretation of data from complex community samples. Further, it may provide a window into the population structure of various Gambierdiscus species, and how they change in space and time.

SPEAKER: **Sabrina Heiser, University of Texas at Austin Marine Science Institute | sabrina.heiser@austin.utexas.edu**

SPEAKER BIO: I earned my PhD under Dr. Charles D. Amsler at the University of Alabama at Birmingham looking at the evolutionary ecology of the Antarctic red seaweed Plocamium. I am now a postdoctoral researcher at the University of Texas at Austin Marine Science Institute under Dr. Deana L. Erdner where I investigate community structure in benthic microalgae with a focus on ciguatera toxin producing taxa such as Gambierdiscus. I am interested in the mechanisms that structure benthic communities with a focus on the distribution of inter- and intraspecific diversity.

CO-AUTHORS:
Heiser, S., Parsons, M., Smith, T., Bennett, J., Erdner, D.L.

THE EFFECT OF HURRICANE DISTURBANCE ON BENTHIC MICROALGAL COMMUNITIES IN THE NORTHERN GULF OF MEXICO

SESSION: BENTHIC HABs

ABSTRACT: The 2021 Atlantic hurricane season was the third most active on record with 21 named storms and seven hurricanes forming, driven by La Niña and increased sea surface temperatures among other climate factors. After a prior year of significant hurricane activity in the northern Gulf of Mexico we aimed to evaluate the effect of these disturbance events on benthic microalgal (BMA) communities on petroleum structures (rigs) that form interconnected artificial reef ecosystems. Artificial tiles (n=18) were deployed for 28-42 days at rig platforms approximately 10 km southeast (nearshore) and 40 km south (offshore) of Dauphin Island, Alabama. Once retrieved, six tiles were pooled to form three replicates at each depth and site per deployment. Data loggers were maintained throughout all deployments to record continuous light, temperature, and salinity. During the second deployment (August 29-31, 2021) major Hurricane Ida moved through the field sites. Tiles were retrieved following Ida and a third deployment was conducted to capture post-hurricane BMA settlement. The epiphytic community harvested from the tiles were sieved to collect the 20-200 µm BMA fraction and partitioned for culture establishment, microscopy, and metabarcoding. Alpha diversity was comparable across deployments, locations, and depths. Community structure, however, differed between nearshore and offshore locations and pre- and post-hurricane. Interestingly, the ciguatoxin producer *Gambierdiscus* sp. was not observed before Ida at any site, but several species were identified post hurricane. These data highlight the potential of hurricane disturbance events to modify BMA communities and may allow harmful species to establish into new areas.

SPEAKER: **Sabrina Heiser, University of Texas | sabrina.heiser@austin.utexas.edu**

SPEAKER BIO: I earned my PhD under Dr. Charles D. Amsler at the University of Alabama at Birmingham looking at the evolutionary ecology of the Antarctic red seaweed Plocamium. I am now a postdoctoral researcher at the University of Texas at Austin Marine Science Institute under Dr. Deana L. Erdner where I investigate community structure in benthic microalgae with a focus on ciguatera toxin producing taxa such as Gambierdiscus. I am interested in the mechanisms that structure benthic communities with a focus on the distribution of inter- and intraspecific diversity.

CO-AUTHORS:

Sabrina Heiser[1], Elizabeth Murphy[2,3], Jennifer DeBose[2,3], Molly M. Miller[2,3] Deana L. Erdner[1], Alison Robertson[2,3]

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[2]Stokes School of Marine & Environmental Sciences, University of South Alabama, 600 Clinic Drive, 36688, Mobile, Alabama, USA.

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UNCOVERING ENVIRONMENTAL DRIVERS THAT INFLUENCE THE COLONY SIZE OF THE CYANOBACTERIA, MICROCYSTIS

SESSION: BLOOM DYNAMICS & DRIVERS II

ABSTRACT: Microcystis is the most common cyanobacterial harmful algal bloom (CHAB) and produces microcystin which is harmful to humans and wildlife. These single-celled organisms typically aggregate into colonies during CHABs. Larger colonies may benefit Microcystis by offering enhanced nutrient recycling, chemical resistance, and/or protection against grazers. Factors such as temperature, nutrient levels, zooplankton grazers, and turbulence may influence changes in the size of Microcystis colonies but precisely and accurately quantifying colony sizes has been a challenge. Here, we employed a novel, automated image capture technique to precisely and accurately quantify the size of thousands of colonies in individual samples and explored the impact of variable nutrient, temperature and zooplankton exposure on Microcystis colony size distributions. First, we found uniquely different colony size distributions across several across North American lakes, including Lake Erie. Next, we exposed Microcystis-dominated bloom water from several lakes to different temperature and nutrient treatments. Results indicated that the addition of nutrients typically led to significant increases in the abundance of smaller colonies (<4000µm2 area). Finally, we added two different species of Daphnia, D. magna and D. pulex, to Microcystis-dominated bloom water from several lakes. Results indicated that both D. magna and D. pulex were effective at grazing smaller (<6000µm2) but not larger Microcystis colonies, with D. magna displaying significantly higher grazing rates. This project presents a novel method for quantifying the size distribution of Microcystis colony sizes and demonstrates the ability of nutrients and zooplankton to shift this distribution.

SPEAKER: **Ronojoy Hem, Stony Brook University | ronojoy.hem@stonybrook.edu**

SPEAKER BIO: https://www.linkedin.com/in/ronojoy-h-203900174/

CO-AUTHORS:
Christopher J. Gobler

METHOD DEVELOPMENT OF ONSITE HARMFUL CYANOBACTERIAL DETECTION USING PORTABLE QPCR DEVICE

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Harmful Cyanobacterial Blooms (HCB's) negatively affect our nations drinking and recreational waters. HCB's have been linked to numerous concerns for public health in humans along with deaths of pets, wildlife, and livestock. This has led to ample research into identification of HCB's and improved mitigation methods. However, current research and methods are time intensive and involve shipping samples from field sites to laboratories for processing and analysis. The focus of this study was to evaluate a field deployable qPCR method that would allow more timely decision making of harmful algal blooms.
Firstly, we developed a complete field deployable qPCR procedure using the Biomeme thermocycler. For this field protocol, samples are collected, filtered, extracted using the Biomeme M1 sample prep cartridge, and then analyzed using the Biomeme thermocycler all while in the field. For the standard laboratory protocol, samples are delivered to the laboratory, filtered, extracted using a Qiagen kit which includes bead beating, and then run on a Quant studio thermocycler. Our results revealed that both protocols were comparable when analyzing samples with low biomass. A composite standard curve was also created using the Biomeme thermocycler and used to accurately quantify the samples extracted using the portable method. Samples from both protocols were comparable when analyzed with the portable Biomeme and composite standard curve or with the lab-based QuantStudio 5. Secondly, this study developed a DNA extraction protocol that is compatible with a field deployable qPCR device, the Biomeme. The preliminary results show that DNA recovery was increased by 100% with the portable method when bead beating was incorporated into the Biomeme standard protocol. The recovery of cell concentrations around 106 cells/ml was also twice as high using laboratory protocol on the QuantStudio 5 as it was to the portable bead beater method.
Our preliminary results showed that Biomeme seems to perform similarly to laboratory qPCR machines at low biomass. Additional studies are still needed to better understand the performance of the Biomeme in the field.

SPEAKER: **Aim`ee Henderson, US EPA | henderson.aimee@epa.gov**

SPEAKER BIO: Aim`ee Henderson is a emerging scientist with a background in agriculture whose studies have taken her around the world. Currently, she is enhancing her laboratory and molecular biology skills while continuing graduate education. Her current work is on Harmful Algae Blooms and opportunistic pathogens.

CO-AUTHORS:
Ian Struewing, Nathan Sienkiewicz, Jingrang Lu

DEVELOPMENT OF ANALYTICAL METHODS FOR CO-OCCURING PHYCOTOXINS IN FISH MATRICES

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Harmful algal blooms (HABs) have increased in range and severity since the 1980's and are expected to continue to worsen under changing climate conditions. In Chesapeake Bay alone there are at least 10 species of phycotoxin producing HABs. Quick and reliable methods are needed to assess toxin load in various upper trophic level fish species, both for diagnostics in fish mortality and in human poisoning events. Data are currently lacking regarding the accumulation of phycotoxins in fishes in Chesapeake Bay. In this study matrices of juvenile sandbar sharks (Carcharhinus plumbeus) were collected from ongoing surveys out of Virginia Institute of Marine Science. A method was then developed for the extraction and clean-up of these phycotoxins from these matrices using liquid chromatography- triple quadrupole mass spectrometry (LC-MS/MS). Three clean-up methods were tested and the percent recovery of each were compared across a suite of 14 different phycotoxins. The method with the best recovery was then moved forward and tested using matrices from two species of bony fishes: Atlantic striped bass (Morone saxatilis) and blue catfish (Ictalurus furcatus). Percent recoveries were compared again to validate the method in all three species of fish. This method provides a way to set a baseline of phycotoxin exposure in fish which can help guide future monitoring, management, and public health efforts.

SPEAKER: **Olivia Hernandez, Virginia Institute of Marine Science | ohernandez@vims.edu**

SPEAKER BIO: I graduated from Eckerd College with a B.S. in Marine Science with a minor in Chemistry in 2022. I am currently a graduate student at Virginia Institute of Marine Science, studying harmful algal bloom toxicology. I have interned with both Harbor Branch Oceanographic Institute, and the National Oceanic and Atmospheric Administration (NOAA). I have an interest in toxicology, environmental chemistry, and physiology.

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CO-AUTHORS:
Marta P. Sanderson, Robert J. Latour, Juliette L. Smith

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

PASSIVE HARVESTING BMP AND TARGETED REMOVAL OF MICROCYSTIS, DOLICHOSPERMUM AND EXTERNAL NUTRIENT LOADING BY TREE POLLEN FROM AN IMPAIRED WATER BODY

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: From 2021 to 2022, Microcystis and Dolichospermum (cyanoHABs) at a fresh water body (White Pond in Concord, Massachusetts), listed under the Clean Water Act Integrated List of Waters for impairments by harmful algae blooms and dissolved oxygen, were targeted and removed using a passive harvesting technology, the A-Pod (U.S. Patent No. 10,745,879). Notable improvements in cyanoHAB biomass reduction, water clarity and dissolved oxygen content were achieved in year 2022.

Improvements were sustained in year 2023 by continued use of passive harvesting as a best management practice (BMP) to target and remove tree pollen and forest particulates which were confirmed by nutrient content, loading amount and an in-water mesocosm study to be a significant external nutrient loading source (dry and wet deposition) readily usable by these cyanoHABs. Climate change is also increasing the duration, frequency and volume of tree pollen produced each year due to rising temperatures and carbon dioxide content. As such, sustainable restoration efforts should include implementation of BMPs to address this increasing loading source of nutrients to water bodies.

Importantly for shallow water adapted cyanoHAB species like Microcystis and Dolichospermum, tree pollen loading also occurs early in the otherwise clear-water, low nutrient season of many water bodies and if not mitigated, can allow these cyanoHABs to increase their biomass and dominance before other types of cyanobacteria and phytoplankton.

Targeted and passive harvesting of potentially toxic forms of cyanoHABs can improve the overall biological integrity of a water body by minimizing impacts to non-targeted, beneficial species and by improving biogeochemical conditions. Our presentation will include results and findings from our initial work with “restoration A-Pods” to remove and control health risks posed by existing cyanoHABS and our 2023 year findings for BMP use of “Sentinel A-Pods” to mitigate future cyanoHAB growth, dominance and related health risks.

SPEAKER: **Jonathan Higgins, Higgins Environmental Associates, Inc. | higginsenv@comcast.net**

SPEAKER BIO: Mr. Higgins is a consulting earth scientist. He is a Professional Geologist and Massachusetts Licensed Site Professional. He has undergraduate and graduate degrees in Geology. Mr. Higgins has been helping people solve their environmental-related issues for over 30 years now and holds four U.S. Patents for improving the health of water bodies.

WHAT ARE WE REALLY BREATHING? INVESTIGATING CYANOBACTERIA-ASSOCIATED AEROSOLS

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Concentrations of planktonic cyanobacteria (cyanoHABs) may pose health risks if contaminated water is ingested or contacted. Although endotoxin and microcystins have been detected in cyanoHAB-associated aerosols, little is known about aerosol-associated health risks. Our goal was to evaluate water and air samples representing impacted and control ponds. We report upon cyanoHAB-associated aerosols that may impact human health.
First, we screened water samples from ponds with past aquaculture use for the presence of microcystins/nodularins (MC/NOD) by the Adda-ELISA method. Among these, we selected two MC/NOD-producing ponds (Pond A and C) and a control pond (Pond B) that had no detectable MC/NOD for the study. These Eastern Alabama ponds were sampled prospectively during ten study days in October 2021. We monitored weather and water quality twice daily (AM and PM) and collected daily, cumulative air samples for microcystins and endotoxins at each pond. We measured endotoxin in air and water using the kinetic-chromogenic LAL assay. We evaluated phycology, water quality measures, other cyanotoxins, pigments, and nutrients. We evaluated Spearman correlations among variables and investigated associations between variables using linear regression.
Pond A and C maintained their rank order as lower (Pond A: 1.0-3.5 ng/mL) and higher (Pond C: 8.4-18.3 ng/mL) MC/NOD-producing ponds throughout the study. Pond B produced no detectable MC/NOD. Pond A was dominated by Planktothrix spp., total cyanobacterial counts ranged from 21,917–43,833 cells/mL. Pond C was dominated by Microcystis aeruginosa, total cyanobacterial counts ranged from 2600–4115 cells/mL. All air samples collected to evaluate MC/NOD were below the limit of detection. Maximum air endotoxin (16 EU/m3) was well below the occupational risk threshold (US) of 50 EU/m3, but higher than concentrations detected in surveys of ambient air: ~10 EU/m3*. We detected no aerosol concentrations of concern to human health.
*Rolph et al. Atmosphere 2018.

SPEAKER: **Elizabeth Hilborn, US Environmental Protection Agency | hilborn.e@epa.gov**

SPEAKER BIO: Dr. Elizabeth Hilborn is a senior health scientist/epidemiologist in the Office of Research and Development at the Environmental Protection Agency. She earned a Bachelor of Science in Biology and a Master of Public Health at the University of North Carolina at Chapel Hill. She earned her Doctorate in Veterinary Medicine at North Carolina State University. She served as a Fellow in the Centers for Disease Control and Prevention's Epidemic Intelligence Service. Dr. Hilborn is board certified with the American College of Veterinary Preventive Medicine. Her expertise is in the health effects of emerging infections, environmental and waterborne contaminants including harmful algal blooms.

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UNRAVELING ENVIRONMENTAL FACTORS CONTROLLING HARMFUL ALGAL BLOOMS IN THE CHESAPEAKE BAY USING GENERALIZED LINEAR MODELS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Forecasts of harmful algal blooms (HABs) are needed to mitigate risks associated with HAB presence. A crucial step in constructing correlative models for HAB forecasting is identifying the main environmental factors leading to HABs. The complex and often unknown reasons for their presence makes this challenging, as the interplay and collinearity between physical and biogeochemical factors driving HABs increases model parameter uncertainty. To analyze the effect of collinearity, we train correlative generalized linear models (GLMs) to predict seven (mostly harmful) algal taxa commonly observed in the Chesapeake Bay and systematically remove environmental factors in the GLM construction that surpass a specific correlation threshold (i.e., absolute value of the Pearson correlation |rho| > 0.4, 0.5, 0.6, or 0.7). We identify the controlling environmental predictors and study their association to HAB presence. Thirty-two out of the total of 165 correlations between nineteen environmental factors show strong collinearities (i.e., |rho| > 0.4). Collinearity affects the optimal set of environmental predictors, the associations between environmental factors and HAB presence, and the GLM's predictive skill. Water temperature is generally selected as an important predictor, and strong positive or negative associations between environmental factors and algal presence do not considerably change. HAB presence and blooms of some taxa (e.g., Prorocentrum minimum and Heterocapsa rotundata) are associated to similar environmental conditions, making it challenging to attribute some blooms to a specific taxon. Although removing collinearities may result in the detection of new important predictors, it may also result in a slight decrease (~ 5 %) of the GLM prediction skill, depending on the HAB taxon of interest. Our findings suggests that the main environmental predictors rely on both the HAB characteristics and level of collinearity, and highlight the challenge of interpreting the associations between environmental conditions and HABs predicted by these GLMs.

SPEAKER: **Dante Horemans, Virginia Institute of Marine Science | dmlhoremans@vims.edu**

SPEAKER BIO: Before Dr. Dante Horemans started as a Postdoctoral Research Associate at the Virginia Institute of Marine Science (VIMS), he obtained bachelor's and master's degrees in theoretical physics and a Ph.D. in biology. He has been combining theoretical work and application, including outreach to stakeholders, both in Europe and the U.S.A. Throughout this time, he has been using numerical process-based and statistical models, applied to both physical and biochemical estuarine systems. He is especially intrigued by biophysical interactions and feedback mechanisms, such as the impact of estuarine phytoplankton on suspended sediment through flocculation, which he studied during his Ph.D., as well as the effect of changes in environmental conditions on HABs, which he currently studies at VIMS.

https://www.vims.edu/about/directory/postdoc/horemans_dml.php

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A STAKEHOLDER-DRIVEN COMMUNICATION AND ENGAGEMENT STRATEGY TO FACILITATE THE FUTURE TRANSITION OF A BIOLOGICAL HAB CONTROL TECHNOLOGY TO END-USERS

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: With advancements in HAB prevention and control technology, there is an increasing need to communicate the advantages of these developed products to stakeholders, resource managers and end-users to ensure an informed understanding, successful transition, and sustained use in operational programs. For example, DinoSHIELD is a biological HAB control strategy in the field demonstration phase. The technology aims to prevent and control the growth of harmful dinoflagellates (e.g., Karenia brevis) in marine waters, thus reducing the impact of HABs on coastal communities and economically important industries. DinoSHIELD technology relies on the natural release of an algicide (IRI-160AA) isolated from an algicidal bacterium (Shewanella sp. IRI-160) commonly found in coastal waters, which is then immobilized in a non-toxic hydrogel matrix. A key component of the development of DinoSHIELD, is the multi-pronged stakeholder-driven communication and engagement strategy that helps facilitate the future transition of this HAB control technology to end-users. Stakeholder engagement activities include multiple workshops in Delaware and Southwest Florida to inform and engage the local management community on the technology and benefits of DinoSHIELD as a tool to mitigate and prevent the negative impacts of K. brevis blooms. The engagement strategy includes both pre- and post-workshop surveys that are used to assess understanding and interest in DinoSHIELD as a potential HAB control strategy, and offers an opportunity for end-users to provide feedback on the development of the technology and input on preferred communication strategies. Following feedback from stakeholders in Delaware, additional communication strategies were developed, including a factsheet and informational videos on the technology development and its future use. Workshops in Southwest Florida scheduled for August 2024 will provide additional opportunity for incorporating stakeholder feedback into the DinoSHIELD development process and serve as a critical next-step to facilitate eventual transition of this technology to the management community.

SPEAKER: **Alexandria Hounshell, NOAA / NCCOS | alexandria.hounshell@noaa.gov**

SPEAKER BIO: Hounshell works with federal, state, and local scientists, academic partners and stakeholders to understand and predict harmful algal blooms in lakes and coastal regions around the US. Specifically, she uses environmental data, satellite remote sensing, and ecological modeling to understand and identify conditions that lead to harmful algal blooms.
Hounshell currently helps to maintain NCCOS' operational HAB forecasts, develop new HAB forecasts and models, and adapt emerging HAB monitoring techniques to advance HAB forecasting and modeling. She also works with stakeholders and end-users to communicate forecast results and ensure developed products meet their needs.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ASSESSING CYANOBACTERIAL COMMUNITY DYNAMICS IN NEW JERSEY WATERBODIES OF DRINKING WATER SIGNIFICANCE USING ENVIRONMENTAL DNA APPROACHES

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Advance in molecular technologies enables to effectively assess cyanobacterial community dynamics during cyanobacterial harmful algal bloom (HAB) events in addition to conventional microscopic methods. This study employes two environmental DNA approaches, including real-time polymerase chain reactions (qPCR) as well as next generation sequencing (NGS), to investigate monthly variations in cyanobacterial abundance and diversity in two waterbodies located in the headwater of the Raritan Basin Water Supply System. Monthly water samples were collected from August 2020 to August 2021 at the outlets of Budd Lake and Spruce Run Reservoirs. Total environmental DNA from water samples were extracted and used for qPCR analysis with six DNA markers as well as 16S amplicon sequencing. Real-time PCR analysis showed at both waterbodies, the general cyanobacterial and Microcystis genes peaked in late summer and early fall in 2020, drastically dropped over the winter and early spring, and remerged from late spring to August in 2021. Higher levels of microcystin-producing genes were quantified compared to saxitoxin-producing genes, while anatoxin-a or cylindrospermopsin-producing genes were not detected. Next generation sequencing results indicated major cyanobacterial taxa, including Microcystis, Woronichinia, Dolichospermum, Aphanizomenon, and Lyngbya peaked in August 2020, reduced the percentage over fall, winter, and spring, and surged again at Budd Lake in Summer 2021. However, an opposite pattern was observed for Synechococcus, which peaked in fall, winter, and spring, and decreased the percentage in summer. The same patterns of monthly dynamics were also observed in Spruce Run Reservoir for Microcystis, Woronichinia, and Lyngbya, except for Dolichospermum, where higher percentages were observed from November 2020 to May 2021. Additional bioinformatic analysis is being conducted to further elucidate the correlations between environmental variables and cyanobacterial communities at the two waterbodies. This study demonstrates the usefulness of molecular approaches to enhance overall understanding of HAB.

SPEAKER: **David Hsu, New Jersey Center for Water Science and Technology at Montclair State University | hsut@montclair.edu**

SPEAKER BIO: Dr. Hsu has received extensive training in both life and environmental sciences. He obtained his Ph.D. in environmental sciences from the Ohio State University. He conducts water quality and environmental research from a multidisciplinary approach, with emphasis on environmental microbiology, molecular ecology, geographic information sciences, and spatial data analysis. He has been assessing HAB conditions in New Jersey waterbodies with a variety of analytical tools, including real-time PCR (qPCR), next-generation sequencing (NGS), enzyme-linked immunosorbent assay (ELISA), and liquid chromatography – tandem mass spectrometry (LC-MS/MS).

CO-AUTHORS:
Meiyin Wu

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

AN INVESTIGATION OF CYANOBACTERIA, CYANOTOXINS AND ENVIRONMENTAL VARIABLES IN SELECTED DRINKING WATER TREATMENT PLANTS IN NEW JERSEY

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: While conventional water treatments can result in the removal of unlysed cyanobacterial cells and low levels of cyanotoxins, during severe HAB events, cyanotoxins can break through and can be present in the treated water due to a lack of adequate toxin treatment. The objectives of this study were to assess the HAB conditions in drinking water sources in New Jersey and investigate relationships between environmental variables and cyanobacterial communities. Source water samples were collected monthly from May to October 2019 and analyzed for phytoplankton and cyanobacterial cell densities, microcystins, cylindrospermopsin, Microcystis 16S rRNA gene, microcystin-producing mcyB gene, Raphidiopsis raciborskii-specific rpoC1 gene, and cylindrospermopsin-producing pks gene. Water quality parameters included water temperature, pH, dissolved oxygen, specific conductance, fluorescence of phycocyanin and chlorophyll, chlorophyll-a, total suspended solids, total dissolved solids, dissolved organic carbon, total nitrogen, ammonia, and total phosphorus. In addition to source waters, microcystins and cylindrospermopsin were analyzed for treated waters. The results showed all five selected New Jersey source waters had high total phosphorus concentrations that exceeded the established New Jersey Surface Water Quality Standards for lakes and rivers. Commonly found cyanobacteria were identified, such as Microcystis and Dolichospermum. Site E was the site most susceptible to HABs with significantly greater HAB variables, such as extracted phycocyanin, fluorescence of phycocyanin, cyanobacterial cell density, microcystins, and Microcystis 16S rRNA gene. All treated waters were undetected with microcystins, indicating treatment processes were effective at removing toxins from source waters. Results also showed that phycocyanin values had a significantly positive relationship with microcystin concentration, copies of Microcystis 16S rRNA and microcystin-producing mcyB genes, suggesting phycocyanin can be used as a proxy for HAB monitoring. This study suggests that drinking water sources in New Jersey are vulnerable to forthcoming HAB. Monitoring and management of source waters is crucial to help safeguard public health.

SPEAKER: **David Hsu, New Jersey Center for Water Science and Technology at Montclair State University | hsut@montclair.edu**

SPEAKER BIO: Dr. Hsu has received extensive training in both life and environmental sciences. He obtained his Ph.D. in environmental sciences from the Ohio State University. He conducts water quality and environmental research from a multidisciplinary approach, with emphasis on environmental microbiology, molecular ecology, geographic information sciences, and spatial data analysis. He has been assessing HAB conditions in New Jersey waterbodies using a variety of analytical tools, including real-time PCR (qPCR), next-generation sequencing (NGS), enzyme-linked immunosorbent assay (ELISA), and liquid chromatography – tandem mass spectrometry (LC-MS/MS).

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

BLOSSOMING PARADIGMS FOR KARENIA BREVIS BLOOM INITIATION

SESSION: PLENARY

ABSTRACT: Devastating blooms of the dinoflagellate Karenia brevis occur regularly along Florida's Gulf Coast and can endure for over a year. Forecasting the timing and location of bloom initiation remains elusive. This is in part due to challenges with making measurements—in a large and poorly delineated offshore formative region—at the appropriate scale. To help advance questions related to bloom onset, we used historical analysis of 60+ years of bloom data along with new observing and modeling capabilities conducted in part through the Florida Fish and Wildlife Conservation Commission (FWC) Center for Red Tide Research. Florida's Gulf Coast (spanning 24°30' N to 31° N) was divided into six sub-regions to facilitate comparisons of timing, duration, and environmental conditions within and across northwest and southwest Florida. Bloom onset (based on first detection of cell thresholds from 10^2 - 10^5 K. brevis cells L^-1) varied from July to December, and occurred most often in the greater Charlotte Harbor region during fall. Northwest blooms occurred less frequently and also tended to endure for fewer months. Evaluation of subregional temperature trends highlighted latitudinal and seasonal gradients suspected to be important for growth and life history. Increased offshore monitoring revealed ephemeral pulses of nitrate in typically oligotrophic waters during the window for bloom onset. These observations highlight the importance of regional circulation, and particularly upwelling, that provides a pathway for offshore, subsurface cells and nutrients to be transported shoreward. Indeed, bloom hindcasting and forecasting exercises using the West Florida Coastal Ocean Model helped inform new sampling and testing strategies and locations for mapping benthic and pelagic stages important for K. brevis initiation, and a deeper examination of water mass and growth dynamics is underway. Overall, these interdisciplinary efforts highlight the importance of evolving paradigms regarding HAB formation with new observations and model outputs.

SPEAKER: **Katherine Hubbard, Florida Fish and Wildlife Conservation Commission-Fish and Wildlife Research Institute | katherine.hubbard@myfwc.com**

SPEAKER BIO: I am a biological oceanographer and phytoplankton ecologist leading a team focused on harmful algal bloom (HAB) and biotoxin monitoring and research for the state of Florida. I have also been a Guest Investigator at the Woods Hole Oceanographic Institution (WHOI) for a decade. This dual role provides unique opportunities to build stronger connections between managers and scientists. My research integrates a wide array of microscopic, molecular, and biochemical detection strategies for species and physiological indicators. Ongoing projects focus on HAB detection, prediction, physiology, life cycles, and toxicity. Understanding variable toxicity, and the contribution of local versus advective physical and biogeogchemical forcing over varied time scales, has been a major driver of my research and collaborations.

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ANTI-BIOFOULING STRATEGIES FOR SOLID PHASE ADSORPTION TOXIN TRACKING (SPATT)

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: Routine water quality monitoring can help identify acute and chronic risks of cyanotoxin exposure to humans and animals. However, monitoring is challenging because cyanobacteria do not always produce cyanotoxins, and concentrations of produced toxins can vary spatially and temporally. Solid phase adsorption toxin tracking (SPATT) samplers can complement discrete water sampling by concentrating varying cyanotoxin concentrations over a deployment period. SPATT samplers, which typically consist of synthetic adsorbent resin enclosed in 100 µm nylon mesh, are widely used for cyanotoxins, but there remains a need to fill knowledge gaps and improve data quality and comparability. In 2023, U.S. Geological Survey researchers convened to discuss SPATT best practices and identified seven major research and monitoring themes requiring further investigation. One theme, biofouling, or the accumulation of bacterial cells on field deployed samplers, has the potential to result in over- or underestimates of cyanotoxin concentrations derived from SPATT samplers but has not been investigated. To understand how sampler design can influence biofilm formation and toxin accumulation, experiments are planned for summer 2024 in two lakes in Central Park, New York and in one urban wetland in Nashville, Tennessee where recurrent cyanobacterial blooms occur. The experiments will test effects of (1) shading and (2) 105 µm copper mesh as two possible biofouling deterrents. The SPATT sampler deployment configuration will ensure samplers remain submerged near the surface and within approximately 6 inches of each other. Analysis will include biofilm composition, as well as the cyanotoxin concentrations present in both the biofilms and sorbed to the SPATT sampler resin for the different treatments. The results from these experiments have the potential to refine SPATT sampler design and deployment strategies, which will ultimately improve data quality and provide better estimates of ambient cyanotoxin concentrations.

SPEAKER: **Andrea Jaegge, USGS | ajaegge@usgs.gov**

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WINTER INFLOW OF TOXIGENIC PSEUDO-NITZSCHIA SPECIES FROM CONTINENTAL SHELF WATERS TO AN ESTUARY IN THE NORTHEAST U.S.

SESSION: Bloom Dynamics & Drivers I

ABSTRACT: Pseudo-nitzschia harmful algal blooms (HABs) have recently caused elevated domoic acid in coastal environments of the Northeast United States, potentially due to the introduction of toxigenic species from offshore populations. In 2017, the toxigenic species P. australis was observed in Narragansett Bay, Rhode Island, a temperate estuarine ecosystem, for the first time within a decade-long time series, and it likely contributed to toxin-related shellfish harvest closures. Little is known about offshore Pseudo-nitzschia spp. populations in the Northeast Continental Shelf marine ecosystem or how often toxigenic species enter Narragansett Bay through physical processes. To investigate the frequency and seasonality of potential Pseudo-nitzschia spp. inflow from the continental shelf to the estuary, we identified species in winter and summer from several time series in Narragansett Bay and along the Northeast U.S. Shelf Long-Term Ecological Research transect. Species were taxonomically identified using DNA sequencing of the ITS1 region and domoic acid was quantified by LC-MS/MS. During six years of sampling, connectivity between Narragansett Bay and the Northeast shelf appeared to be stronger in winter than summer, and winter Pseudo-nitzschia spp. assemblages were often accompanied by higher domoic acid. Six Pseudo-nitzschia species co-occurred most often with domoic acid and were likely responsible for toxin production in this region. Domoic acid was detected during periods of relatively low macronutrient concentrations in both seasons, warmer temperatures in winter, and colder temperatures in summer. This study represents some of the first domoic acid measurements on the offshore Northeast U.S. Continental Shelf, a region that supplies water to other coastal environments and could seed future HABs. The elevated domoic acid and frequency of potential toxigenic Pseudo-nitzschia spp. inflow to a Northeast estuary in winter indicate the need to monitor coastal and offshore environments for toxins and HAB taxa during colder months.

SPEAKER: **Bethany Jenkins, University of Rhode Island | bdjenkins@uri.edu**

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SPATIAL AND TEMPORAL VARIATION IN BENTHIC CYANOBACTERIAL ANATOXIN PRODUCTION WITHIN THE SCOTT RIVER NETWORK, CA, USA

SESSION: Poster Session, Tuesday

ABSTRACT: Proliferations of anatoxin-producing benthic cyanobacteria, notably Microcoleus, threaten aquatic ecosystems and public health. Our understanding of within-river temporal variation in anatoxin concentrations has improved, but predicting when and where anatoxin concentrations are elevated and Microcoleus is growing within a river network remains a significant challenge. To further understand the spatial scale of variation in anatoxins and their drivers across a river network, we sampled 20 mainstem and tributary locations distributed throughout the Scott River network in Northern California, USA. We chose sampling locations to span a wide range of stream sizes and watershed land use compositions to explore the relative influence of hypothesized drivers of anatoxin production, including nutrient and light availability, water temperature, specific conductance, stream discharge, and stream bed substrate size. We sampled all sites once a month from June to October of 2024 to capture the temporal variation within sites. At each site we measured environmental parameters expected to drive anatoxins, estimated percent cover of Microcoleus mats, and collected mat samples to measure anatoxin concentrations and understand community composition. Improving our understanding of anatoxin production in rivers can help inform monitoring strategies to mitigate ecological and public health risks

SPEAKER: **Andrea Garcia Jimenez, University of Nevada-Reno | agarciajimenez@unr.edu**

SPEAKER BIO: Dre is a PhD student in the Natural Resources and Environmental Science program. She graduated from the University of Texas at Austin with a BS in Environmental Science-Geology where she first became interested in cyanotoxins. She is broadly interested in the interactions between hydrological processes, water quality, and how they influence aquatic ecology. Outside of the lab, you can find Dre climbing, knitting, or hanging out with her dog Posey (who is named after the grass Poa secunda)

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE VALUE OF HARMFUL ALGAL BLOOM FORECASTS IN THE PACIFIC NORTHWEST

SESSION: PREDICTIVE MODELING - MARINE

ABSTRACT: Over the past three decades, fisheries and livelihoods on the coasts of Washington and Oregon have been severely impacted by the presence of harmful algal blooms (HABs), that produce domoic acid, a neurotoxin that accumulates in shellfish and endangers public health. Among others, recreational razor clams and commercial Dungeness crab fisheries along the Pacific Northwest (PNW) have been negatively affected, jeopardizing the economies of coastal communities that depend on tourist revenues and income generated through visits of harvesters in the region. The PNW HAB Bulletin, launched in 2008, publishes forecasts on incoming HAB events, which has enabled managers to increase toxin monitoring in high-risk locations and proceed with selected harvesting at safe beaches and delays or closures of fishing seasons, as required. In light of the value of the HAB Bulletin to local managers and communities and the occasional challenges of securing sufficient resources to ensure its continuation, this study attempts to assess the value of information (VOI) for the predictions provided by the Bulletin. Results of the study show that ongoing financial support of the Bulletin is economically justifiable based on cost-benefit criteria. The value of HAB forecast is positively related to three primary factors: the frequency of HAB events, the precision of forecast, and the number of social and economic sectors benefiting from the forecast. The expected increase in HAB frequency and intensity due to climate change, coupled with advancements in forecasting accuracy through technological development, is anticipated to enhance the value of the forecast program.

SPEAKER: **Di Jin, Woods Hole Oceanographic Institution | djin@whoi.edu**

SPEAKER BIO: Dr. Di Jin is a Senior Scientist at the Marine Policy Center of the Woods Hole Oceanographic Institution. He holds a Ph.D. in Economics-Marine Resources from the University of Rhode Island. He specializes in the economics of marine resources management and marine industries. Dr. Jin has substantial research experience with the commercial fishing and aquaculture industries, the offshore wind and oil and gas industry, the marine transportation industry, and coastal management problems. His papers have been published in Harmful Algae, Ecological Economics, Marine Resource Economics, Ocean and Coastal Management and other journals. He currently serves as specialty chief editor, Marine Affairs and Policy, Frontiers in Marine Science.
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TARGETED AND CONTROLLED RELEASE OF ALGAECIDE TO HARMFUL ALGAL BLOOMS.

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL III

ABSTRACT: Harmful Algal blooms (HABs) of the dinoflagellate Karenia brevis pose a serious threat to the marine and coastal ecosystem. These HAB species synthesize polyether brevotoxins released upon secretion and cell lysis causing significant mortality in marine life. The severe environmental concern necessitates the development of environmentally safe mitigation methods. We address the targeted and rapid destruction of Karenia brevis using the algaecide, calcium peroxide, in tandem with the flocculation and sinking of the algal species. The incorporation of the algaecide within the floc as granules or affixed to the surface of tubular clays serves to rapidly kill K. brevis minimizing escape from the floc and reentry to the water column. Calcium peroxide reacts with water to form the water-insoluble calcium hydroxide gradually releasing hydrogen peroxide which permeates cell membranes and reacts with intracellular iron to generate hydroxyl radicals toxic to the cell. Additionally, calcium peroxide also serves as a ballast. Pulse amplitude modulated fluorometry results indicate that dose levels as low as 30 mg/L are effective in suppressing photosynthesis destroying cell viability in 3-6 hours. Toxin analysis indicates a significant reduction of toxin levels attributed to Fenton processes. In further application of the technology, we have developed a method to deliver the algaecide using biodegradable surfactant-based foams. Such foams rest on the water surface and consistently deliver algaecide sequestered in the aqueous microchannels to surface algae. We show that these technologies lead to inexpensive and scalable methods to mitigate harmful algal blooms of K. brevis and freshwater HABs such as M. aeruginosa. The environmentally benign aspects of such technologies will be emphasized.

SPEAKER: **Vijay John, Tulane University | vj@tulane.edu**

SPEAKER BIO: I am a faculty member in the Department of Chemical and Biomolecular Engineering at Tulane University. My research is in the area of complex fluids and environmental nanotechnology. For the past 2-3 years, I have been working in the mitigation of Karenia brevis and Microcystis aeruginosa in collaboration with researchers at the Mote Marine Laboratory (Vincent Lovko and Richard Pierce) and at the University of Maryland (Srinivasa Raghavan). Our work is currently funded by the Red Tide Initiative and by the HAB-CTI program.

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A COUPLED PHYSICAL-BIOLOGICAL MODEL OF KARENIA BREVIS ON THE WEST FLORIDA SHELF: AN APPLICATION TO THE 2018 BLOOM EVENT

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Blooms of the toxic dinoflagellate Karenia brevis occur almost annually on the west coast of Florida, killing fish and other marine life, threatening public health and adversely impacting local economies of Florida. Mitigating such effects requires improved forecast capabilities. Based on the West Florida Coastal Ocean Model (WFCOM) that downscales from the deep ocean, across the shelf, and into the estuaries using an unstructured grid, and that provides realistic hindcast simulation of ocean circulation, we implemented a biological model using the Generalized Ecosystem Module of the Finite Volume Community Model (FVCOM, v4.4.2). The model simulates an ecosystem of two phytoplankton taxa (K. brevis and diatoms), zooplankton, bacteria, and detritus. The K. brevis dynamics include growth, grazing, remineralization and excretion processes that may change with environmental conditions, such as light, temperature and nutrients. The coupled physical-biological model was applied to simulate the K. brevis bloom event in summer-fall of 2018 on the West Florida Shelf. The modeled K. brevis cell concentration patterns were compared with in situ observations of cell abundance and satellite imagery, and the preliminary results were encouraging. The coupled modeling explored a combination of K. brevis initial concentrations and putative offshore source locations as contributing to the major bloom that manifested on the West Florida coast in 2018. These studies demonstrate the dual importance of the coastal ocean circulation and the organism biology in determining bloom evolution. Continued testing and refinement will improve the coupled physical-biological model.

SPEAKER: **Sebin John, University of South Florida | sebinjohn@usf.edu**

SPEAKER BIO: I completed my PhD, where I focused on the dynamics of Vembanad Lake, the second largest lake in India. Using the Finite-Volume Coastal Ocean Model (FVCOM), I explored the intricate hydrodynamics and associated environmental phenomena within the lake system.

Currently, I am a Postdoctoral Research Associate at the Ocean Circulation Laboratory. Here, my primary focus is on operational support for the West Florida coastal ocean model, utilizing the renowned FVCOM model. I am actively involved in developing a coupled physical biological model for West Florida shelf. Additionally, I am privileged to be part of a NOAA-funded project with the Unified Forecast System Coastal Application Team. In this role, I serve as one of the leading FVCOM testers, focusing on the implementation of a high-resolution numerical model for New York Harbor.

My work aims to enhance coastal modeling capabilities by combining oceanographic and atmospheric knowledge. Developing integrated models that incorporate both physical and biological processes is essential for comprehensive ecosystem management and accurate prediction. Through these efforts, I strive to contribute significantly to the field of coastal oceanography, helping to improve our understanding and management of coastal systems.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

EVALUATION OF SENSORS FOR CONTINUOUS MONITORING OF HARMFUL ALGAL BLOOMS IN THE FINGER LAKES REGION, NEW YORK, 2019 AND 2020

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: In response to the increasing frequency of cyanobacterial harmful algal blooms (CyanoHABs) in the Finger Lakes region of New York State, a pilot study by the U.S. Geological Survey, in collaboration with the New York State Department of Environmental Conservation, was conducted to enhance CyanoHAB monitoring and understanding. High-frequency sensors were deployed from open water monitoring-station platforms at Seneca, Owasco, and Skaneateles Lakes during 2019 and 2020. These in-place sensors were evaluated for their ability to make representative measurements of dissolved organic matter, nutrients, and algal pigments (as indicators of phytoplankton biomass) compared to bi-weekly laboratory measurements, alongside routine field parameters (water temperature, specific conductance, pH, dissolved oxygen, turbidity, weather, and light) to provide additional information about environmental conditions.

Despite challenges such as power limitations, temperature sensitivity, and biofouling, most sensors performed well, aided by targeted adjustments in operation and maintenance protocols. Notably, chlorophyll measurements from fluorescence sensors showed moderate correlation with laboratory-measured chlorophyll-a values, and simpler models relying solely on these measurements explained nearly as much variance in laboratory measures of phytoplankton biomass as more complex multivariate models. Additionally, regression analyses indicated that water temperature and turbidity were more significant predictors of cyanobacterial biovolume than phycocyanin fluorescence sensor measurements.

Correlation analysis indicated variable alignment between sensor readings of nutrients and dissolved organic matter and their respective laboratory measurements across all study lakes. Continuous monitoring of these constituents was complicated by the oligotrophic, low organic content nature of the study lakes. The challenge of detecting concentrations near the lower limit of detection for some sensors was further confounded by complexities in data interpretation resulting from their use of leading-edge technologies.

The study underscores the need for broader data collection, encompassing more CyanoHAB events, and suggests leveraging machine learning techniques to refine predictive models for enhanced CyanoHAB management. These efforts are essential for advancing sensor-based monitoring and deepening our understanding of CyanoHAB dynamics. Future research should focus on expanding the dataset and improving sensor technology to better capture the complexity of CyanoHABs in various aquatic environments.

SPEAKER: **Brett Johnston, USGS | bjohnsto@usgs.gov**

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INVESTIGATION OF BENTHIC CYANOBACTERIAL ACCUMULATIONS IN A STORMWATER POND NETWORK

SESSION: BENTHIC HABS

ABSTRACT: The occurrence of cyanobacterial harmful algal blooms (CHABs) is apparently increasing in urban areas due to various natural and anthropogenic factors, including excess nutrient input and warming waters. These events pose potential threats to human, wildlife, and ecosystem heath via the production of a variety of recognized toxins and other compounds with significant biological activities. During the late summers of 2021-2023, significant proliferations of cyanobacterial mats, were observed in a stormwater retention pond network located in northwest Florida. Weekly sampling of the pond system was conducted throughout late summer and fall to investigate water quality, nutrient loading, and the presence of cyanobacteria, associated cyanotoxins, and other potentially bioactive cyanobacterial metabolites. Diverse cyanobacterial assemblages were observed throughout the study period. Targeted and non-targeted analyses, including utilization of UPLC MS/MS, detected multiple cyanotoxin classes in whole water, passive sampler (SPATT) extracts, and mat/periphyton samples. Weather conditions fluctuated over the three-year sampling period such as oscillating rainfall in 2021 to mild and severe drought like conditions observed in 2022 and 2023 respectively. These conditions seem to have impacted the resulting cyanobacteria communities and corresponding toxins. Further, the connected pond network may serve as a vehicle for the transportation of cyanobacteria and toxins to the downstream receiving waterbodies. Results from this multi-year investigation provides valuable insights concerning the presence of HAB toxins in a model system reflecting restorative stormwater management practices in the region.

SPEAKER: **Courtney Kapczynski, University of North Carolina Wilmington | ctk6717@uncw.edu**

SPEAKER BIO: Courtney Kapczynski is a Ph.D student in the Pharmaceutical Chemistry program at the University of North Carolina Wilmington. Her work in UNCW's Drug Discovery Laboratory involves targeted and non-targeted investigation of algal metabolites via UPLC MS/MS. Courtney is evaluating the impact of storm water treatment systems on cyanobacterial harmful algal blooms and the variable toxins and bioactive compounds they produce.

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INVESTIGATING THE COMPLEX MICROBIAL COMMUNITIES ASSOCIATED WITH NITROGEN FIXING CYANOBACTERIAL MATS ON THE SUSQUEHANNA FLATS OF THE CHESAPEAKE BAY

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The Susquehanna Flats is a biodiverse and resilient submerged aquatic vegetation (SAV) bed just below the mouth of the Susquehanna River in the upper Chesapeake Bay. The site is located 16 kilometers downstream of the Conowingo Dam, which discharges ~1,100 m3 s-1 of water. This makes the Flats an important SAV bed for nutrient removal from the Susquehanna River. The Flats is also a unique part of the Chesapeake Bay as it is one of the most prolific SAV beds that makes up ~8% of SAV in the Chesapeake Bay. Therefore, the health of the Flats is crucial and can impact the overall health of the Chesapeake Bay. However, a nitrogen fixing cyanobacteria, Microseira (Lyngbya) wollei, has seasonally bloomed at the Flats since the early 2000s. Despite the consistent blooms during the summer months, the M. wollei at the Susquehanna Flats has not been thoroughly investigated and the microbial community within the M. wollei mats are not fully understood. Additionally, as new DNA sequencing technology has become more readily available, the identification and taxonomy of Oscillatoriales, of which M. wollei is a member, has become more refined and organized. Therefore, investigating the nitrogen fixing microbial community is more accessible than before. Using Illumina short-read amplicon sequencing on the nifH genes and PacBio long-read amplicon sequencing on the 16S genes of M. wollei and other cyanobacteria collected at the Susquehanna Flats, the microbial composition and diversity was investigated. The results reveal that in addition to M. wollei these communities contain also contain a myriad of other nitrogen fixing cyanobacteria and other bacteria that create a complex microbial community. Thus, to effectively investigate and manage the potentially harmful M. wollei blooms at the Flats, it is essential to consider the entire microbial community if managing prevention methods.

SPEAKER: **Shayna Keller, University of Maryland Center for Environmental Science | skeller@umces.edu**

SPEAKER BIO: Shayna is a graduate research assistant at the University of Maryland Center for Environmental Science (UMCES) at Horn Point Laboratory in Cambridge, MD. She completed her undergraduate degree at Coastal Carolina University in Marine Science where she became fascinated with plankton and harmful algal blooms. After graduating, she was a marine conservation educator at Walt Disney World in Orlando, Florida until she started working for Arundel Rivers Federation (ARF) in Edgewater, Maryland, through the Chesapeake Conservation Corps. After her year at ARF, she was a stormwater area manager until she decided to return to school and complete a master's degree in marine, estuarine, and environmental science at UMCES.
She is currently working on her Graduate research project with her advisor Judy O'Neil studying the effects of a benthic filamentous cyanobacteria, Microseira (Lyngbya) wollei (M. wollei), on a large recovering aquatic grass bed on the Susquehanna Flats, in the northern portion of the Chesapeake Bay. The project includes partners from St. Mary's College of Maryland and Maryland Department of Natural Resources. The goal is to learn what factors are driving M. wollei growth on the aquatic grasses and what the ecological effects are on the Susquehanna Flats, including toxin, that can be harmful to humans or the ecosystem.

CO-AUTHORS:
Dr. Judith O'Neil, Dr. Jacob Cram

ECOLOGICAL INSIGHTS INTO THE UNPRECEDENTED BLOOM OF LINGULODINIUM POLYEDRA IN 2020 IN SOUTHERN CALIFORNIA.

SESSION: BLOOM DYNAMICS & DRIVERS III

ABSTRACT: In 2020, a significant Lingulodinium polyedra bloom persisted for nearly three months and spanned most of the Southern California coast, though the causes of this bloom are not yet well understood. This bloom coincided with the first offshore deployment, at a mooring location 3 miles offshore from Del Mar, CA, of the Imaging FlowCytobot (IFCB), an automated submersible imaging flow cytometer that captures images of phytoplankton from 5 to 150 µm in size. The IFCB provided a high temporal resolution record of the abundance of L. polyedra, and therefore a unique record with which to study the initiation and termination of the bloom. In addition, environmental sensors deployed on the mooring offered insight into the environmental conditions during that time. The bloom's initiation was fueled by a combination of strong vertical density stratification, warm surface temperatures, and high vertical nutrient fluxes from below the pycnocline which favored the growth of vertically-migrating L. polyedra over other phytoplankton. In addition, we found that the end of the bloom of L. polyedra coincided with a rapid rise in the abundance of ciliates which are known to consume L. polyedra. Our study showed how automated imaging technology can be used to study HAB population dynamics in the remote ocean, and suggests how environmental factors and predation shape the ecology of L. polyedra, an important HAB species in California.

SPEAKER: **Kasia Kenitz, Scripps Institution of Oceanography, University of California | kkenitz@ucsd.edu**

SPEAKER BIO: Kasia earned her Ph.D. from the University of Liverpool, UK, and completed her first postdoc at the Technical University of Denmark (DTU). She then moved to the Scripps Institution of Oceanography (SIO) for her second postdoctoral position. Currently, Kasia is a project scientist jointly appointed at SIO and the Southern California Coastal Ocean Observing System (SCCOOS). Her core responsibilities include ensuring smooth operations of California Imaging FlowCytobot (IFCB) Network, image classification and generation of high-quality IFCB data products, and conducting ecological analyses to understand the drivers of harmful algal blooms (HABs) in Southern California.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

RETRIEVABLE 3D PRINTED STRUCTURES FOR ADVANCED PHOTOCATALYSIS TO DEGRADE MICROCYSTINS

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Destruction of organic contaminants by advanced oxidative processes is an expanding research topic. Photocatalytic nano-titanium dioxide (nano-TiO2) offers a sustainable treatment alternative to conventional chemical controls by generating short-lived reactive oxygen species (ROS) under solar radiation with minimal long-term impacts to non-target species. The technology is generally applicable to cyano-toxins, such as microcystins (MC), but has limitations including deployability, targeted immobilization of TiO2 in surface water, and lab-to-field scaling. Free nano-TiO2 agglomerates and settles from the photoactive zone and is unretrievable. 3D printing provides a unique opportunity to customize, immobilize, and enhance photocatalyst reactive surface area through strategic layer-by-layer design. We demonstrated submerged, printed structures reduced MC concentrations (50 □g/L) from both Microcystis aeruginosa culture and spiked MC-LR below detection at similar rates as free TiO2 under simulated solar light. Flexible printed mats also reduced MC from field-collected cyanobacteria assemblages under both artificial and natural sunlight. Subsequent work investigated better dispersion of TiO2 in the printed structures, additional light sources, new photocatalyst geometries, and modifications to the reactive TiO2 surface chemistry to enhance photodegradation rates and increase the effective treatment area. Inexpensive UV-A LED light strips yielded photocatalytic degradation rates that exceeded photolysis. These LEDs, in combination with new printed photocatalyst geometries in a reactor, demonstrated the fastest treatment rates in this study. Additional experiments with various doped-TiO2 structures with lowered band gaps were capable of absorbing more of the solar spectrum and demonstrated significant enhancements to treatment rates (greater ROS production). Experiments with a UV-C light resulted in faster degradation rates overall, but less difference between photolysis and photocatalysis. Future work investigates combination of the reactor design, deployable LEDs, and doped-TiO2 to optimize a completely customizable sustainable treatment strategy for cyanotoxins with minimal impact to the ecosystem.

SPEAKER: **Alan Kennedy, US ACE | Alan.J.Kennedy@usace.army.mil**

SPEAKER BIO: Al Kennedy is a research biologist in the Environmental Risk Branch of the U.S. Army Engineer Research and Development Center's Environmental Laboratory. He has served as a PI of both civil and military research projects since 2006, investigating novel methods for assessing the exposure and hazard of legacy and emerging environmental contaminants, including investigating novel environmental applications of 3D printing composite structures. Al has led Section 404 and 103 dredging evaluations for USACE Districts and port authorities. He has published >95 peer-reviewed journal articles and book chapters, numerous technical reports/notes innovating dredging evaluation technologies, and led development of internationally recognized testing standards. His training is in Environmental Biology (Michigan State University, B.S.), Environmental Toxicology (Virginia Tech, M.S.) and Macromolecular Science and Engineering (Virginia Tech; Ph.D.).

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REGIONAL AND SEASONAL ANALYSIS OF ALEXANDRIUM CATENELLA RDNA COPY NUMBER CONTENT FOR QPCR ASSAY QUANTIFICATION OF CYSTS

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: Accurately identifying and quantifying dinoflagellate cysts from environmental samples is challenging. This is due to the nondescript morphological similarities among cysts and their cryptic nature as they are often associated with sediment interfaces and organic detritus. Numerous studies have sought to optimize methods for identifying and quantifying cysts to improve monitoring efforts and for making bloom predictions. Alexandrium catenella is one of many Alexandrium HAB species that produce toxins responsible for causing paralytic shellfish poisoning (PSP). The work presented here includes a comprehensive investigation of rDNA copy number content in A. catenella utilizing a qPCR assay that targeted the D1-D3 region of the A. catenella LSU rDNA gene. The experimental design included analysis of vegetative cell strains and cysts collected from the Gulf of Maine, Puget Sound, and Kodiak Island, Alaska. A seasonal analysis of cyst rDNA copy number from Puget Sound was also conducted. Multiple linear regression analysis indicated that there was a very strong collective significant effect between cysts, geographic region, and rDNA copy number. Among the three regions, qPCR assay rDNA copy number estimates ranged from ~ 200–2,000 rDNA copies per cyst, while vegetative cell strain estimates ranged from ~390–650 rDNA copies per cell. Interestingly, geographic region was not significant as a predictor for vegetative cell rDNA copy numbers.

SPEAKER: **Steve Kibler, NOAA | steve.kibler@noaa.gov**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

MAPPING ALEXANDRIUM RESTING CYST DISTRIBUTION IN SOUTHCENTRAL ALASKA TO INFORM ALEXANDRIUM CATENELLA BLOOM FORECASTING.

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Alexandrium catenella, a dinoflagellate that produces toxins causing paralytic shellfish poisoning (PSP), blooms annually during the spring/summer along the southcentral Alaska coastline. Bivalve shellfish in the region show great variability in levels of PSP toxins with some of the highest levels in the Kodiak Archipelago and occasional toxicity outbreaks in adjacent lower Cook Inlet. Blooms of A. catenella are supported by a resting cyst stage that enable this species to overwinter and re-establish blooms in the spring. This study represents the first attempt to map A. catenella cyst abundance in the bays of the Kodiak Archipelago and portions of lower Cook Inlet. The project also represents the first full application of the new quantitative PCR assay developed by NOAA and its partnering institutions for large scale mapping of A. catenella cyst distribution. The objectives are to better understand the role of local cyst seed beds in promoting blooms and resulting shellfish toxicity in areas with 1) regular toxicity outbreaks each spring, 2) those with occasional outbreaks interspersed with years of low toxicity, and 3) sites largely devoid of shellfish toxicity. A. catenella cyst mapping activities for this study include winter sediment collection surveys in the Kodiak Bays, Kachemak Bay and lower Cook Inlet, as well as adjacent coastal waters. The samples will be quantified for cyst abundance using the A. catenella cyst qPCR assay, with a subset counted with the standard primulin staining method. Cyst maps will be combined with hydrographic data and numerical models to develop predictive capacity for A. catenella blooms in southcentral Alaska in support of NOAA HAB forecasting objectives.

SPEAKER: **Steve Kibler, NOAA National Ocean Service, Beaufort Laboratory | Steve.Kibler@noaa.gov**

SPEAKER BIO: Steve has been researching the ecology of harmful algal blooms and their toxins for nearly 30 years. His current work is focused on monitoring and forecasting for Alexandrium blooms in US temperate and subarctic systems and the fate of related toxins in the marine food web.

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RELATING PHYTOPLANKTON MOLECULAR PERCENT ABUNDANCES TO CHLOROPHYLL-A AND MUSSEL TOXIN CONCENTRATION IN SAN FRANCISCO BAY

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Eutrophication-related water quality goals are a key management tool to protect estuaries from the effects of harmful algal blooms (HABs). Where targets such as numerical water quality criteria exist, they have often been derived using statistical relationships between algal biotoxins, HAB species abundance, bulk algal biomass, and water column nutrient concentrations. However, phytoplankton assemblage and abundance data needed to quantify these relationships are often sparse. Molecular barcoding promises to provide a means to collect standardized phytoplankton assemblage data for a fraction of the cost of microscopic analyses, but these data have not yet routinely been used to inform development of water quality goals. Here, we investigated the basis for HAB abundance and/or chlorophyll-a water quality goals for San Francisco Bay (SFB) using seven years of qPCR and 18s/16s metabarcoding data for Alexandrium and Pseudo-nitzschia, respectively, as well as mussel toxin data (saxitoxin, domoic acid and microcystin).

We found that there are positive associations between elevated molecular abundances of Alexandrium and Pseudo-nitzschia and occurrence of toxin concentrations above preset thresholds in nearby mussels. We used the Alexandrium relative abundance associated with 50% likelihood of nearby mussels exceeding saxitoxin thresholds as a generalized abundance threshold of concern across nine known HAB taxa. Most HAB taxa increase in likelihood of exceeding that abundance threshold in the fall season (August-October) when chlorophyll-a typically ranges between 3.8-7.1 µg/L (inter-quartile range) and competition from non-harmful diatom species is lessened. Together, these analyses illustrate the value of molecular tools for establishing numerical water quality criteria and HAB toxin thresholds in SFB and other estuarine environments.

SPEAKER: **Daniel Killam, San Francisco Estuary Institute | dank@sfei.org**

SPEAKER BIO: I am an environmental scientist working with the SFEI Nutrient Management Strategy, seeking to understand the interactions between nutrient supply, production, phytoplankton ecology and biotic response. In my work I have combined direct observations of nutrient biogeochemistry with molecular data, and also have used bivalve shells as a proxy for seawater chemistry and their own physiology.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

HABSCOPE 2.0- IMPROVING THE EASE OF USE, ACCURACY, AND PROCESSING CAPABILITY OF AN AI GENERATED ‘CELL COUNT’

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: Inhaled Karenia brevis toxins are a public health concern for beachgoers, people with underlying pulmonary disease, and residents living and working in the near shore environment. Given the potential for exposure during blooms, there is a clear need for increased spatial and temporal observation of bloom intensity to better measure and forecast the likelihood of impacts from corresponding aerosols. In 2017, HABscope 1.0- was developed to improve monitoring and forecasting to an ‘Every Beach, Every Day’ resolution (https://doi.org/10.1371/journal.pone.0218489). HABscope 1.0 has been successfully used by a group of ~40 community scientists since 2017. However, the technology used by 1.0 integrated an iPod, a device no longer supported by Apple. In addition, the camera settings were limited to the presets of the iPod. To address these limitations, HABscope 2.0 was developed using the same low-cost microscope and replaces the iPod with a Raspberry Pi 4.0 and a 16MP C-mount Raspberry Pi camera. The new hardware and software capability is significantly improved from the original unit, and results in a similar cost per unit and allows for very precise control of the camera settings, on a per-taxon basis. The AI model was upgraded from a custom design to a 72 layer Xception network. Annotated training data was developed using multiple strains of K. brevis, with over 150,000 images used in the final training configuration. Rigorous validation studies are underway, and include expanding the image libraries to include other Karenia spp., testing a dynamic range of cell abundance similar to what occurs during blooms in Florida (103 to 107 cells L-1), and continuing weekly time-series. Given the promising results thus far, HABscope 2.0’s advanced capabilities are expected to help continue to meet growing demands for HAB data.

SPEAKER: **Barbara Kirkpatrick, NOAA GCOOS / TAMU | barb.kirkpatrick@gcoos.org**

SPEAKER BIO: Dr. Barbara Kirkpatrick is Senior Advisor for the Gulf of Mexico Coastal Ocean Observation System (GCOOS). She has more than 35 years of experience in human and environmental epidemiology and started her career as a Respiratory Care Supervisor at Duke University Medical Center before going on to receive a Master’s Degree in Health Occupations Education at North Carolina State University and a Doctorate in Educational Leadership from the University of Sarasota. After completing her graduate program, Kirkpatrick served as an Associate Professor at Manatee Community College in Bradenton, FL, where she continued her research interests in human respiratory health and assessing clinical teaching effectiveness. In 1999, Kirkpatrick joined Mote Marine Laboratory as a staff scientist and shifted her research focus to environmental human health, particularly the respiratory effects linked to harmful algal blooms. As a senior scientist and program manager at Mote Marine Laboratory, her continued research efforts focused on harmful algal blooms and the effects they have on humans. She was co-leader of the first major multi-institution study of Florida’s red tide on humans that was funded by the National Institutes of Health. The 11-year study was the first to scientifically document the impacts that red tide has on humans — particularly those who have chronic respiratory diseases. She was the co-chair of the National Harmful Algal Bloom steering committee for six years and co-chaired the National HAB science meeting in 2013. Kirkpatrick became Executive Director of GCOOS in 2014, where she was instrumental in broadening the scope of the ocean monitoring organization to include biological aspects of ocean monitoring — particularly monitoring for toxic algal blooms and marine animal movements. She retired as Executive Director in August 2021 and is now GCOOS Senior Advisor.

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ECONOMICS OF MITIGATION STRATEGIES FOR HARMFUL ALGAL BLOOMS IN THE U.S. WEST COAST DUNGENESS CRAB FISHERY

SESSION: SOCIOECONOMIC IMPACTS

ABSTRACT: In 2015, a severe harmful algal bloom (HAB) caused a prolonged delay to the opening of the commercial California Dungeness crab fishery, leading to tens of millions of dollars in direct economic losses. Since then, West Coast states beginning with Oregon experimented with management approaches designed to adapt to HABs. The primary strategy that emerged is an evisceration order: a requirement that crab landed in a defined spatial area during the order undergo special processing to remove contaminated parts (the viscera) so that the crab may be safely consumed. This paper introduces the economic concepts, empirical tools, and fishery context that are needed to understand the economic performance of evisceration orders. The aim is to provide an accessible introduction to the relevant economics for the interdisciplinary HAB research and policy community. Empirical illustrations are drawn from the rich data available for the West Coast Dungeness crab fishery.

SPEAKER: **David Kling, Oregon State University | klingd@oregonstate.edu**

SPEAKER BIO: David Kling is a natural resource economist at Oregon State University. His research interests include marine resource economics, natural capital pricing, and bioeconomics.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

EXPLORING CONNECTIONS BETWEEN SOCIAL CONTEXT AND CIGUATERA FISH POISONING IN KIRIBATI

SESSION: PUBLIC HEALTH

ABSTRACT: Ciguatera fish poisoning, the most common non-bacterial seafood-borne illness worldwide, is a significant threat to public health and food security for communities that rely on seafood for sustenance, livelihood, and cultural identity. The Republic of Kiribati, along with other Pacific Island Countries and Territories (PICTs), is historically among the most vulnerable places to ciguatera poisoning. In the context of Kiribati, where seafood dependency and ciguatera risk are high, there is a scarcity of information about public awareness of ciguatera and its impact on seafood consumption behaviors. This information is essential for policy makers to effectively manage ciguatera outbreaks. Using a nationally representative data set paired with a village resource survey to define village-level indicators, we provide a novel qualitative analysis of how awareness of ciguatera is related to seafood avoidance across 18 islands in Kiribati. We emphasize the need of ciguatera education and awareness, dietary access and alternatives, and Traditional Knowledge to comprehensively understand and manage the social factors influencing ciguatera risk.

SPEAKER: **Christopher Knight, Stanford University | cjknight@stanford.edu**

SPEAKER BIO: Chris (he/him) is a Biology PhD candidate, a Stanford Interdisciplinary Graduate Fellow, and a National Geographic Explorer. He employs a planetary health approach to understand the linkages between ecosystem and human health - with the goal of improving accessibility to safe and nutritious seafood. Chris investigates the social and ecological connections of ciguatera poisoning across Kiribati in collaboration with the Kiribati Government and the Pacific Planetary Health Initiative. As a US Fulbright Fellow in Italy, he explored how climate change impacts the nutritional content of seafood and the potential consequences for human nutrition. Chris is deeply interested in environmental justice issues and is drawn to working on research questions and solutions that can improve the lives of others and minimize social and economic inequalities. Furthermore, he strives to foster an inclusive and welcoming research community. Chris was a NSF Graduate Research Fellow, a Fulbright Fellow to Chile, and earned a MS in Biology from San Diego State University, as well as a BA in both Ecology and Spanish from the University of California, Davis. At Stanford, Chris is co-advised by Dr. Larry Crowder and Dr. Fiorenza Micheli.

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COMPOSITE RED TIDE VULNERABILITY INDEX (CRTVI): ASSESSING AND COMMUNICATING VULNERABILITY OF COASTAL COMMUNITIES TO RED TIDE IN FLORIDA

SESSION: SOCIOECONOMIC IMPACTS

ABSTRACT: Harmful Algal Blooms (HABs), caused by Karenia brevis, commonly known as red tide, are a recurring natural phenomenon along Florida's coastline, particularly along the southwestern peninsula. Red tide affects water quality and ecological systems and has significant impacts on human health, tourism, fisheries, marine recreational activity, and other human dimensions. While academic literature has focused on quantifying the environmental, ecological, and socio-economic impacts of red tide events, the quantification of "vulnerability" to the socio-economic impacts of red tide events, or the degree to which a community is susceptible to and struggles to cope with the adverse effects of red tide on social and economic systems has not been well studied.

A Composite Red Tide Vulnerability Index (CRTVI) for coastal Florida was developed to quantify county-level vulnerability to the socio-economic impacts of red tide events. The development of the CRTVI involved a comprehensive process for identifying indicators of tourism-related activities, fisheries- and marine-related activities, socio-economic vulnerability, human health, and red tide exposure, as well as a structured process for collecting data, constructing a composite index, selecting weights across and within domains, and assessing the CRTVI for coastal counties in Florida. An interactive web platform was also developed to visualize the different indicators as well as the composite index.

The CRTVI and related visualizations can inform local- and state-level decision-makers about county-level vulnerability to the socio-economic impacts of red tide events, and aid efforts related to red tide mitigation, management, and response. Moreover, the outcomes, insights, and lessons learned from the development of the CRTVI can inform ongoing regional-, state-, and national-level discussions related to preparing for, mitigating, or preventing the negative impacts of red tide events.

SPEAKER: **Roberto Koeneke, University of Florida | rkoeneke@ufl.edu**

SPEAKER BIO: Roberto was born and raised in Caracas, Venezuela, and spent part of his childhood in Gainesville, Florida. He graduated from Iowa State University with a bachelor's degree in 2007 and obtained a master's degree at the University of Miami in Marine Affairs and Policy in 2011. He worked for over ten years with the Center for Independent Experts (CIE), which operates the independent peer review system for NOAA Fisheries. He joined the Ph.D. program in Food and Resource Economics in August 2020 and began his research assistantship with Dr. Christa Court at the UF/IFAS Economic Impact Analysis Program. His research interests are non-market valuation systems for ecosystem services and natural resources, spatial analysis applications for valuation methods, valuation of natural disaster impacts, and economic policy analysis.

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SAXITOXIN AND DOMOIC ACID EXPOSURE RISKS TO NORTHERN FUR SEALS ON ST. PAUL ISLAND, ALASKA

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS II

ABSTRACT: As the climate has warmed over the past few decades, the Pacific sector of the Arctic Ocean has experienced dramatic changes. Although many organisms may spread into or expand within Arctic waters as a result of this warming trend, few present such significant threats to human and ecosystem health as harmful algal bloom (HAB) species, particularly the dinoflagellate Alexandrium spp. (agent for saxitoxin (STX)) and diatoms in the genus Pseudo-nitzschia (agent for domoic acid (DA)). This project aims to address the potential for these algal toxins to be present in northern fur seal (Callorhinus ursinus; NFS) populations on St. Paul Island. Over two summers (July 2022-2023), we collected sample suites (stomach, small intestine, colon, feces, liver, kidney, blubber, and muscle) from 105 individual NFS harvested for subsistence purposes. Sampling consisted of salvaging tissues from remaining NFS carcasses that were not used for subsistence. All samples were analyzed via enzyme-linked immunosorbent assays (ELISA) to determine the presence and tissue concentration of HAB toxins. In 2022, 18.4% (7/38) of fecal samples had low but detectable levels of STX, while all of the fecal samples were below detectable limits (BDL) for DA. A subset of 13 liver samples (including all livers that corresponded to animals with detectable STX in feces) were BDL for both STX and DA. In 2023, 30.2% (13/43) of fecal samples also had low but detectable levels of STX. All liver, kidney, and muscle samples were BDL for both STX and DA. Other than fecal samples, there were no other tissues that contained detectable levels of toxins, suggesting that there is low risk of harmful exposure in NFS at least at the time of harvest. These results also indicate that STX is not currently an environmental driver in the decline of NFS on the Pribilof Islands.

SPEAKER: **Chelsea Kovalcsik, University of Alaska | cmkovalcsik@alaska.edu**

SPEAKER BIO: Chelsea Kovalcsik is a second year Master’s student at the University of Alaska Fairbanks, pursing a degree in Marine Biology. She is working on transitioning into a PhD. Her research focuses on harmful algal bloom presence, tissue concentration, and microplastic contamination in northern fur seals on St. Paul Island. Chelsea is also the lead disentanglement coordinator and Island Sentinel for the Aleut Community of St. Paul Island, where in two summers, her and her team have disentangled a total of 98 seals. In her free time Chelsea loves to volunteer as a necropsy technician, mountain bike, play ultimate frisbee, play with her dog, spend time with friends and family, and travel!

CO-AUTHORS:
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SYNERGISTIC IMPACT OF CLIMATE CHANGE - INDUCED ACIDIFICATION, TEMPERATURE, AND NITROGEN ON BLOOM-FORMING CYANOBACTERIA FROM LAKE ERIE

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Lake Erie has been plagued by seasonal blooms of toxin-producing cyanobacteria, usually dominated by members of the genus Microcystis. It has been consistently demonstrated that the availability of fixed nitrogen significantly increases the biomass and microcystin levels of Lake Erie blooms dominated by Microcystis, though the type of nitrogen, nitrate (NO_3^-), ammonium (NH_4^+), and urea, can be equally important in these regards. Moreover, while elevated temperatures also significantly increase the growth Microcystis, the impact of the other major factors of climate change, such as elevated CO_2 levels, on these and other bloom-forming cyanobacterial genera, remain poorly understood. Our work subsequently investigated characterizing the impacts of all three of these factors on recently (< 6 year) isolated Lake Erie species of Microcystis as well as the diazotrophic (N_2 fixing) cyanobacterial genus Dolichospermum. Cultures were adapted to nitrogen (NO_3^-, NH_4^+, urea) types and temperature (18, 23, and 28℃) levels prior to being bubbled at pre-industrial (200 µatm), present (400 µatm), and end-of-21st century (1000 µatm) pCO_2 levels for 4 weeks. Cultures grown at 18 and 23℃ all exhibited significantly higher growth rates at 1000 µatm relative to those grown at lower pCO_2 levels, with NH_4^+ - treated cyanobacteria grown at the highest pCO_2 exhibiting the highest growth rates of all treatments. This was also the case for those cultures grown at 28℃, though NO_3^- - treated Microcystis did not exhibit any significant change in growth at 1000 µatm relative to those grown at 200 µatm. Toxin and transcriptomic data were also characterized for these experiments. Taken together, these results are instrumental in determining how continued eutrophication and climate change will impact bloom-forming cyanobacteria in Lake Erie.

SPEAKER: **Benjamin Kramer, University of Minnesota Duluth | bjkramer@umn.edu**

SPEAKER BIO: My expertise is in aquatic microbial ecology with an emphasis on toxin-producing, bloom-forming cyanobacteria. During my dissertation, I investigated the effects of eutrophication and climate change factors on these cyanobacteria, specifically on those that fix dinitrogen (N_2). As a postdoctoral researcher, my work on these topics has expanded to include the Laurentian Great Lakes. I have developed bioinformatics knowledge to understand the diversity of toxin-producing cyanobacteria within this freshwater ecosystem, as well as taking some of the first measurements of carbonate chemistry parameters within the Great Lakes to better understand how climate change - induced acidification will impact phytoplankton.

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MICROCYSTIN EXPOSURE AND LIVER LESIONS IN ESTUARINE SENTINELS IN THE INDIAN RIVER LAGOON, FLORIDA

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: Microcystin (MC) is an emerging toxin of concern in U.S. waters and is suspected to have negative health impacts on wildlife in Florida's Indian River Lagoon (IRL). We screened liver and fecal samples of IRL bottlenose dolphins (Tursiops truncatus truncatus) and North American river otters (Lontra canadensis) for MC exposure via enzyme immunoassay (ELISA) and performed confirmatory testing via high performance liquid chromatography tandem mass spectrometry methods (HPLC-MS/MS), and correlated exposure to liver histologic lesions. We also assessed non-invasive MC screening methods using respiratory swabs and vapor. Thirty-seven river otters and 156 bottlenose dolphins were evaluated. Most river otters (81%) and bottlenose dolphins (94%) were from the northern IRL. Of those with available histology, 18% of river otters and 50% of bottlenose dolphins had anomalies potentially consistent with MC exposure (e.g., inflammation, necrosis, fibrosis, and/or lipidosis). Microcystin was not detected in river otter samples. Ten bottlenose dolphins tested positive for the toxin via ELISA, but none of these were confirmed. Liver lesions could not be definitively linked to MC exposure and other differentials should be considered. Respiratory swabs could be a suitable non-invasive MC screening tool in free-ranging wildlife, but this method requires further validation. Bottlenose dolphins and river otters may not be adequate sentinels of MC exposure in the IRL. However, continued MC screening is recommended during blooms or when suggestive liver lesions are present.

SPEAKER: **Ami Krasner, Florida Institute of Technology | aekrasner@gmail.com**

SPEAKER BIO: After working for over decade as a clinical veterinarian, I decided to pursue a PhD to develop my primary interests in marine mammal health, One Health, and oceanic conservation. My graduate work focuses on the impacts of harmful algal biotoxins to marine mammal sentinels. Projects include determining the local incidence and consequences of microcystin exposure to estuarine wildlife in the Indian River Lagoon, Florida, as well as domoic acid-induced disease experienced by California sea lions on the west coast.

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MICROCYSTIN CONTAMINATION OF SHELLFISH ALONG THE FRESHWATER-TO-MARINE CONTINUUM WITHIN US NORTHEAST ESTUARIES

SESSION: Shellfish

ABSTRACT: Estuaries are dynamic ecosystems that are an important habitat for bivalves. The freshwater bodies that discharge into estuaries can introduce cyanobacteria and cyanotoxins that may accumulate within food webs. One common cyanotoxin is microcystin, a hepatotoxin, that causes adverse health effects in humans and has been linked to mortality of both terrestrial and aquatic organisms. Microcystin has been detected in marine bivalves and the rate of microcystin accumulation and depuration differs between bivalve species. No study has explored the presence or dynamics of microcystins in bivalves in the Northeast US, where bivalves represent a major fishery. In this study we quantified levels of microcystin in wild and cultured bivalves as a time series in four US Northeast estuaries which have hosted microcystin-producing CHABs within their headwaters. During the study, microcystin was rarely detected in bivalves across Chesapeake Bay, but was frequently detected in all bivalve species in the Hudson River, within two harbors of Long Island Sound, and within Mecox Bay. Microcystin was detected in clams (Mercenaria mercenaria and Corbicula fluminea), Eastern oysters (Crassostrea virginica), and mussels (Mytilus edulis and Geukensia demissa). Eastern oysters consistently had the highest levels, often exceeding 10 ng g-1, suggesting oysters are a more likely vector for hepatotoxic shellfish poisoning in estuaries than mussels or clams. Microcystins in oysters could be predicted from time-integrated measurements of pelagic microcystins and temperature. Collectively, this study demonstrates that microcystin accumulation in estuarine bivalves, particularly oysters, is a relatively common occurrence and a potential risk to human health.

SPEAKER: **Marcella Kretz Wallace, Stony Brook University | marcella.wallace@stonybrook.edu**

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12[TH] U.S. SYMPOSIUM ON HARMFUL ALGAE

INVESTIGATING SOLAR-POWERED HUMIC ACID DISPERSION EQUIPMENT (SHADE) FOR PREVENTION AND MITIGATION OF HARMFUL ALGAL BLOOMS

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL II

ABSTRACT: Harmful algal blooms (HABs) are a threat to national water resources due to their devastating environmental and economic impacts that can occur at regional scales. Many of the current HAB mitigation technologies, including oxidation and physical removal approaches, are limited in physical and economic scalability. The objective of this study is to assess the potential utility of commercial light-absorbing compounds for the suppression of HABs, with the ultimate goal of developing an ecologically-friendly system for emergency control of HABs. It is hypothesized that addition of light-absorbing compounds can temporarily reduce transmissivity of light into the water, thereby disrupting photosynthesis and resulting in starvation and death of the algae bloom. This laboratory scale study assessed the addition of natural light-absorbing compounds such as humic acid, commercially available pond dyes, and combinations thereof to block different regions of the solar spectrum. The laboratory assessment methodology compared the growth of the algae cultures, measured as total suspended solids (TSS), over the course of two weeks. The effect of increasing the light absorbing compound over a mass concentration from 0-20 ppm was assessed for various chemicals. Inhibitory effects on algal growth have been observed, and these effects vary with the type of light-absorbing compound and its concentration.

SPEAKER: **Andy Krieter, US ACE ERDC CERL | andrea.l.krieter@usace.army.mil**

SPEAKER BIO: Andy holds a B.S. in Biochemistry from Northern Michigan University and a Ph.D. in Pathiobiology from University of Illinois Urbana-Champaign. Since graduating they started a post-doctoral intern position with the U.S. Army Corp of Engineers at the Construction and Engineering Laboratory in Champaign, IL. Their research interests lie in disease mechanisms and signaling pathways. Currently, they study algae kinetics and how to inhibit the formation of harmful algal blooms.

CO-AUTHORS:
Martin Page

INTEGRATED MODELING AND MONITORING TO UNDERSTAND CYANOBACTERIAL HARMFUL ALGAL BLOOMS (HABS) IN A EUTROPHIC RESERVOIR SYSTEM

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Freshwater harmful algal blooms (HABs) occur worldwide, and in many cases are dominated by cyanobacteria. Climatic extremes and alterations to a variety of ecological conditions have accelerated cultural eutrophication and are believed to intensify cyanobacterial HABs in freshwater systems. In addition, toxin production by some HABs pose health risks to humans and animals and subsequent closures of public waters negatively impact local economies. While several factors have been linked to occurrence of HABs, identification of factors leading to the onset of the bloom or specific driver variables are still difficult to determine and can be site specific. This research aims to explore the relationships among environmental variables and bloom responses to better understand and identify indicators of the occurrence of cyanobacterial HABs in Marion Reservoir, a eutrophic reservoir waterbody in central Kansas. Collected monitoring data includes discrete, spatially distributed water quality samples and continuous, in-lake monitoring with a multiparameter sensor and meteorological and lake hydrologic data. Furthermore, collected datasets will inform the development of watershed (SWAT), lake (GLM), and cyanobacteria growth models. Model development efforts aim to better understand how watershed management effects runoff characteristics, and how the magnitude and timing of nutrients delivered from the watershed combine with internal lake processes to influence the occurrence of cyanobacterial HABs. A better understanding of the environmental and ecological drivers of cyanobacteria in Marion Reservoir informed by monitoring and modeling applications will provide additional insights for waterbody managers and contribute to improving management responses to cyanobacterial HABs.

SPEAKER: **Laura Krueger, Kansas State University | lkrueger4@ksu.edu**

SPEAKER BIO: Laura Krueger is a PhD graduate student and research assistant at Kansas State University in the Department of Biological and Agricultural Engineering. She completed her Masters in Biological and Agricultural Engineering at Kansas State in 2021. In Fall 2021, she began her PhD graduate program and is working alongside colleagues on a project focused on integrated modeling approaches (including watershed, mechanistic and machine learning models) for cyanobacterial harmful algal blooms on reservoir systems.

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THE POTENTIAL ROLE OF DISSOLVED DOMOIC ACID IN CHRONIC TOXICITY OF BIVALVES: IMPLICATIONS FOR HUMAN AND WILDLIFE HEALTH

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: While Pseudo-nitzschia and domoic acid are long-recognized problems in the California Current, much of the attention has (rightly) focused on large blooms and acute exposure events which have had significant negative impacts on fisheries and wildlife. Much less attention has been paid to the chronic presence of low levels of domoic acid in mussels and other organisms, seemingly independent of the presence of toxigenic cells. Chronic, low dose domoic acid exposure is difficult to regulate and is an emerging health risk for coastal communities. Previous work in California, using Solid Phase Adsorption Toxin Tracking (SPATT), has documented persistent levels of domoic acid in multiple ecosystems including Humboldt Bay, San Francisco Bay, and Monterey Bay, with corresponding persistent contamination of mussels. For example, at the Santa Cruz Wharf (Monterey Bay), only 1.6% of weekly samples from 2010-2022 were below detection, while about 55% of sample were at "background" concentrations. To assess whether exposure to dissolved domoic acid could explain this chronic contamination of mussels, we conducted a series of lab-based experiments exposing mussels to either toxic cells or dissolved domoic acid (with or without non-toxic food). Exposure to dissolved domoic acid was sufficient to reach the background levels seen in the various field sites, but did not result in steadily accumulating concentrations, suggesting equilibrium is reached within a few days. While the mussel domoic acid load does not reach acute levels with dissolved toxin alone, the persistent exposure to consumers is of potential concern. Based on previous human health studies, we estimate that these chronic background conditions could be high enough to cause neurological symptoms in humans. In this presentation we will provide representative timeseries from multiple coastal sites, demonstrating that this issue is probably ubiquitous, and will provide experimental results suggesting that the primary source of exposure is dissolved domoic acid and not long depuration times in mussels.

SPEAKER: **Raphael Kudela, University of California | kudela@ucsc.edu**

SPEAKER BIO: Kudela is a Distinguished Professor and Chair of the Ocean Sciences Department. Areas of expertise include ocean optics, HABs in aquatic systems, and impacts of climate change on marine ecosystems. HAB research has focused on a variety of organisms and impacts in freshwater, estuarine, and marine systems. Kudela is currently ex-officio member of the NHC, panel member for GOOS BioEco, and a member of the NHABON committee.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TRACKING OF HETEROTROPHIC FEEDING BY THE DINOFLAGELLATE, DINOPHYSIS, REVEALS THE ROLE OF DIFFERING MESODINIUM POPULATIONS IN SHAPING HARMFUL ALGAL BLOOM DYNAMICS.

SESSION: PLENARY

ABSTRACT: Dinophysis is an obligate mixotroph that relies on consumption of the ciliate, Mesodinium rubrum, to grow and form harmful algal blooms (HABs). In this study, blooms of Dinophysis acuminata in two NY, USA, estuaries were studied over the course of three years (2019-2021) using discrete samples and an Imaging FlowCytobot (IFCB) to capture images of plankton 20-150 µm. The darkness of Dinophysis images on the IFCB was used to quantify the "fullness" or feeding state of Dinophysis cells. Culture experiments performed to ground truth this approach revealed a highly significant correlation ($R=0.98$; $p<0.001$) between the darkness of Dinophysis cells and the abundance of Mesodinium. With a quantitative scale developed to track the fullness of Dinophysis cells, ecosystem observations revealed the percentage of "full" Dinophysis cells increased during blooms of a large-morphotype Mesodinium that preceded the initiation of Dinophysis blooms. A smaller morphotype Mesodinium appeared during Dinophysis bloom peaks suggesting they supported bloom maintenance. While the relative abundance of diatoms was elevated before Dinophysis blooms, other dinoflagellates and tintinnids increased in abundance during these HABs indicating they emerged within a consortium of heterotrophs and mixotrophs that may have collectively filled the same open niche as Dinophysis. This study reveals the manner in which different Mesodinium populations co-bloom with Dinophysis to support plastid acquisition, bloom initiation and bloom maintenance and contextualizes these changes within the larger plankton community succession associated with these HABs.

SPEAKER: **Megan Ladds, Stony Brook University | megan.ladds@stonybrook.edu**

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WATER LEVEL FLUCTUATIONS COULD INFLUENCE BLOOM TOXICITY VIA EFFECTS ON NEARSHORE SEDIMENT BIOGEOCHEMISTRY

SESSION: BLOOM DYNAMICS & DRIVERS I

ABSTRACT: Lake water level (WL) fluctuations are an important factor driving variation in many ecosystem processes. Relative to permanently inundated sediments in deeper waters, nearshore sediments that are periodically exposed and re-inundated develop distinct physicochemical characteristics, which we hypothesize alters nitrogen (N) and phosphorus (P) flux from sediments and influences nearshore harmful algal blooms (HABs). To test this hypothesis, we studied Lake Kabetogama (MN, USA), a northern lake where WLs are managed for multiple purposes and that experiences HABs in nearshore areas. Using intact sediment core experiments, we found that greater WL fluctuations were associated with increases in organic N and P flux from sediments into the water column. Concurrent experiments on water and phytoplankton collected from naturally occurring HABs indicate N limitation, and additions of ammonium (but not nitrate) caused decreases in the expression of a cyanotoxin gene (mcyE). The supply of organic N or P is probably only important for cyanobacteria when more labile forms are depleted, which appeared to be the case for N in our phytoplankton experiment. Possibly, increases in available organic N would prolong the persistence of cyanobacteria blooms, which in our study produced mcyE RNA when N limited. Using our data to parameterize structural equation models, we predict that, all other things being equal, WL management regimes with greater annual WL fluctuation would result in more N and P supply to the nearshore zone, and potentially prolong blooms and toxin production.

SPEAKER: **James Larson, USGS | jhlarson@usgs.gov**

SPEAKER BIO: Dr. Larson is a Research Fisheries Biologist at the U.S. Geological survey. Despite this title, Dr. Larson works relatively little on fish these days, and instead focuses on biogeochemistry and harmful algal blooms. Recent projects have been focused on sediment-water column interactions and how they promote blooms and cyanobacterial toxicity.

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INCREASING HARMFUL ALGAL BLOOM TOXIN PRESENCE IN A WARMING ARCTIC: A SYNTHESIS OF FIVE YEARS (2019-2023) OF SAMPLING

SESSION: PLENARY

ABSTRACT: Climate change-related ocean warming and reduction in sea ice extent, duration, and thickness increase the risks from harmful algal blooms (HABs) in the Alaskan Arctic. Two toxigenic species of concern include the dinoflagellate Alexandrium catenella and some diatoms in the genus Pseudo-nitzschia. These harmful algae produce the potent neurotoxins, saxitoxin and domoic acid, that impact marine wildlife health and cause the human illnesses known as paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP), respectively, when ingested in varying amounts. Domoic acid also affects animals through domoic acid poisoning (DAP). This talk presents data on algal toxin concentrations quantified in Arctic food web samples of phytoplankton, zooplankton, benthic clams, benthic worms, and pelagic fish collected during the summer months over five years (2019 – 2023) from the Beaufort, Chukchi, and Northern Bering seas. Both neurotoxins were present in all years and in all species tested, but with variable concentrations between years. Additionally, toxin concentrations differed between vector species revealing the pathways of highest exposure risk to top predators such as bowhead whales (Balaena mysticetus) and Pacific walruses (Odobenus rosmarus). Bowhead whales and walruses, as well as the marine vector species that they feed on, are critically important for Tribal communities that rely heavily on marine resources for nutritional, cultural, and economic well-being. This uniquely Arctic relationship , emphasizes the need to understand HAB toxin uptake and depuration dynamics in species used for subsistence purposes throughout the coastline of the Beaufort, Chukchi, and Northern Bering seas.

SPEAKER: **Kathi Lefebvre, NOAA/Northwest Fisheries Science Center | Kathi.Lefebvre@noaa.gov**

SPEAKER BIO: Dr. Lefebvre is a research biologist at NOAA/NWFSC. She has been studying the HAB toxins for over 25 years. Research includes trophic transfer, exposure risks, and mechanisms of toxicity for domoic acid and saxitoxins. She is currently focussing on increased HAB toxin exposure risks and impacts in a warming Arctic.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

CHARACTERIZING CYANOBACTERIAL HABS MICROBIOMES

SESSION: MICROBIAL INTERACTIONS

ABSTRACT: Cyanobacterial harmful algal blooms (cyanoHABs) are a global phenomenon, degrading water quality and aquatic ecosystems. Several genera of cyanobacteria are known to form cyanoHABs (e.g., Dolichospermum, Microcystis, Raphidiopsis). Though dominated by cyanobacteria, these cyanoHABS are a diverse collection of microbes including archaea, bacteria, fungi, and protists, including eukaryotic phytoplankton. However, these communities are more than the sum of their taxa. These organisms act in concert, relying on each other for nutrient recycling and/or auxotrophy to fill in missing genomic gaps and thus benefitting the community and potentially increasing bloom proliferation and intensity. Here we explore metagenomic data from Dolichospermum and Microcystis dominated blooms collected in various lakes across Florida, including Lake Okeechobee, to evaluate their taxonomic composition as well as their toxic and metabolic capabilities. Results indicate that there are distinct associated microbiomes between these bloom-forming taxa, primarily unknown genera belonging to Bacteroidia and Gammaproteobacteria, as well as several co-occurring protists. Furthermore, the functional roles of these taxa are explored to identify which traits are unique and shared among bloom communities to gain further insights into their relationships.

SPEAKER: **Forrest Lefler, University of Florida | flefler@ufl.edu**

SPEAKER BIO: Forrest Lefler is a postdoctoral researcher at the University of Florida in the Laughinghouse Applied Phycology lab. His research foci includes systematics, diversity, and ecology of cyanobacteria with an emphasis on cyanoHABs

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

GENOMIC INSIGHTS INTO BLOOM-FORMING CYANOBACTERIAL STRAINS FROM TEMPERATE TO TROPICAL ENVIRONMENTS

SESSION: Poster Session, Wednesday

ABSTRACT: Cyanobacteria are notorious for their ability to form harmful algal bloom (cyanoHABs) in both freshwater and marine environments. These taxa may be capable of producing various cyanotoxins (e.g., microcystins, cylindrospermopsins, anatoxins), resulting in deleterious effects to humans, wildlife and other aquatic life. To gain insights into potential toxin production, we used a combination of genomic analyses to identify toxin biosynthetic gene clusters and HPLC-MS/MS and ELISA. We investigated a diverse range of bloom-forming strains including Microcystis, Dolichospermum, Raphidiopsis, Iningainema, Dapis, Roseofilum, and Sphaerospermopsis and others from temperate to tropical freshwater, marine, and terrestrial habitats. Results indicate that microcystins and nodularins are widespread, occurring in freshwater, marine, and terrestrial environments in several taxa (e.g., Brasilonema, Roseofilum, Microcystis). Genomic analyses indicate biosynthetic gene clusters of other cyanopeptides occur (e.g., anabaenopeptins, microviridins) frequently across these strains. There is a need to better understand the occurrence and toxicity of these compounds in the environment. Overall, these data highlight the (potential) toxicity of cyanobacteria in various environments.

SPEAKER: **Forrest Lefler, University of Florida | flefler@ufl.edu**

SPEAKER BIO: Forrest Lefler is a postdoctoral researcher at the University of Florida in the Laughinghouse Applied Phycology lab. His research foci includes systematics, diversity, and ecology of cyanobacteria with an emphasis on cyanoHABs

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TROPHIC CASCADES IN THE MILL PONDS COMPLEX, BREWSTER, MA: JUVENILE RIVER HERRING (ALOSA PSEUDOHARENGUS) AND CYANOBACTERIAL POPULATIONS FORM A UNIQUE RELATIONSHIP

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Seasonal monitoring of the Mill Ponds Complex (Slough Pond, Walkers Pond, Upper Mill Pond and Lower Mill Pond) in Brewster, MA was initiated in 2024 to document the temporal patterns of cyanobacterial populations, bloom conditions and concentrations of cyanotoxins, including anatoxin-a (ATX), total microcystins (MC) and B-methyl-L-alanine (BMAA). In 2024, the field study of this freshwater resource was initiated to document the influence of biotic variables, including young-of-year (YOY) river herring and large grazing zooplankton (grazers), on cyanobacterial population structure and the trophic transfer of cyanotoxins. Within weeks of the estimated end of spawning, the grazer biomass, a preferred food source of the YOY planktivores, became absent while edible cyanobacterial biomass increased exponentially. The gut contents of YOY specimens captured during outmigration (Aug 30-Sept 27) contained detrital material suggesting a shift in feeding strategy from water column planktivory to benthic detritivory. Toxin analyses of littoral sediment, edible cyanobacteria, gut contents and muscle tissue support this hypothesis, where bioaccumulation of ATX, MC and BMAA in YOY muscle tissue were observed. The trophic cascade and trophic shift that were observed in the Mill Ponds Complex did not appear to affect the condition of the YOY specimens, however it is uncertain as to whether the bioaccumulation of cyanotoxins had any long-term effects.

SPEAKER: **Nancy Leland, Lim-Tex | nleland@lim-tex.com**

SPEAKER BIO: Nancy received her Masters in Zoology degree from the University of New Hampshire (UNH) in 2002. Since 2012, she has been developing new methods and monitoring protocols for use by citizen scientists to evaluate cyanobacterial populations in their local water resources. She has been recognized as an Affiliate Researcher with the UNH - Center for Freshwater Biology and Ecotoxicology since 2020.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

USING PLANET SATELLITE IMAGERY TO MAP AND QUANTIFY HABS IN LOWER CHESAPEAKE BAY TRIBUTARIES

SESSION: Poster Session, Tuesday

ABSTRACT: This project utilizes 8-channel Planet satellite imagery to map and quantify harmful algal blooms (HABs) within Chesapeake Bay tributaries. Satellite imagery is able to encompass a far larger area than conventional ship-based data collection, and the 3 m resolution and daily revisit time of Planet is able to resolve spatial and temporal heterogeneity in HAB distribution.

We used a ratio between the red and rededge bands to construct a Normalized Differential Chlorophyll Index (NDCI). Chlorophyll concentrations were derived from this index using a Transformed Normalized Differential Chlorophyll Index (TNDCI) specifically calibrated for shallow, turbid coastal environments.

Retrieved chlorophyll concentrations aligned with corresponding in-situ data in both the York and Lafayette Rivers in 2021-2023. We observed blooms in the Lafayette River between the months of May and September with high interannual variation. Mean bloom coverage was 0.16 km2, mean chlorophyll within the bloom was 75 mg/m3, and mean maximum chlorophyll was 672 mg/m3. Additionally, we generated seasonal maps that allow us to view spatial distributions of the bloom in the spring and summer of each year. Satellite-based mapping enables quantification of total HAB area and biomass, which is unobtainable when making point-based measurements.

Planet's high-resolution, high-frequency imagery captures the entire scope of coastal HABs and highlights areas where blooms may not be seen by traditional methods of data collection. Through the successful implementation of the TNDCI and its validation against ground-truth data, the project offers a promising framework for ongoing efforts to monitor and mitigate the impacts of HABs in coastal ecosystems. We plan to regionally calibrate and validate our algorithm in the Lafayette and York Rivers through the summer of 2024.

SPEAKER: **Mary LePere, Old Dominion University | mlepe001@odu.edu**

SPEAKER BIO: My name is Mary LePere and I am a senior undergraduate in Ocean and Earth Sciences at Old Dominion University in Norfolk, Virginia. I will graduate in December 2024, and I plan to enter a PhD program immediately following graduation. I am currently working with Dr. Victoria Hill on using remote sensing to quantify and map harmful algal blooms in lower Chesapeake Bay tributaries.

CO-AUTHORS:
Dr. Victoria Hill

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

OCEAN WEATHER IN THE COASTAL GULF OF MAINE AND ITS INFLUENCE ON HARMFUL ALGAL BLOOMS

SESSION: BLOOM DYNAMICS & DRIVERS I

ABSTRACT: In recent decades, the Gulf of Maine (GOM) has warmed significantly compared to other coastal zones around the world. In the last decade, Alexandrium catenella blooms in the GOM have been rather mild compared to a decade or more ago, thanks to low to moderate abundance in cyst seed population overwinter. With similar amounts of cysts, the interannual variability of the blooms becomes increasingly challenging to understand. We examine up-to-date variability in hydrodynamics and harmful algal blooms since 2018 (including Alexandrium, Pseudo-nitzschia, and Tripos muelleri), by combining satellite imagery, in-situ observations, and numerical models. Results show significant interannual changes in winds and hydrodynamics. 1) Overall, the interannual variability in Alexandrium in the western GOM correlates with number of quiet wind days in spring, suggesting that for years with comparable cyst seed population, interannual variability of Alexandrium bloom magnitude may be largely affected by wind-induced mixing. Further modeling sensitivity experiments confirm this hypothesis. 2) There was an anomalous Pseudo-nitzschia bloom in winter 2019-early summer 2020. Interestingly, in fall 2019- late 2020, there was significant freshening in the deep basins in the GOM, which can be traced back to anomalous freshening onshore near the Halifax line. In contrast, warmer and saltier deep water bodies were present in fall 2018, which show good to warm-core-ring activity in the Slope Sea. 3) Anomalous hydrodynamics may affect plankton composition and timing of the bloom. For example, the anomalous spring 2023 blooms of Tripos muelleri, as suggested by observations and satellite imagery, was associated with a late April river plume near western GOM, favored by simultaneous downwelling-favorable wind events. Tripos may outcompete the Alexandrium for that year during such events. Our results suggest rising challenges in forecasting ecosystems under a rapidly changing climate.

SPEAKER: **Yizhen Li, NOAA NCCOS | Yizhen.Li@noaa.gov**

SPEAKER BIO: Ph.D. in Oceanography at North Carolina State University in 2012; Postdoctoral Scholar Woods Hole Oceanographic Institution; Contractor for NOAA NCCOS since 2016.

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A CHEMICAL-FREE MAGNETOPHORETIC APPROACH FOR RECOVERING MAGNETIC PARTICLES IN MICROALGAE REMOVAL THROUGH MAGNETIC SEPARATION

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL II

ABSTRACT: Magnetic separation can swiftly remove many substances (e.g., biomolecules, cells, and viruses) from water. In algal bloom mitigation and biomass dehydration, magnetic particles (MPs) with proper surface modifications could effectively attract and remove algae from the impaired water body. It has long been expected to recover and reuse magnetic nanoparticles or particles to reduce the algal removal cost and potential adverse effects on the environment. This study evaluated the use of a tunable magnetic field to remove algae using functionalized MPs coated with polymers: polyethyleneimine (PEI), chitosan (CTS), and cetyltrimethyl ammonium bromide (CTAB), whose recovery and reuse were examined. The results show that PEI-coated MPs and CTS-coated MPs at the coating density of 2.3 g-cationic polymers·g-MPs-1 achieved higher removal efficiencies of 88.61 ± 9.12% and 73.19 ± 0.37%, respectively, toward a model algal cell (i.e., Scenedesmus obliquus) within a 5-min separation time. In contrast, CTAB-coated MPs and pristine MPs exhibited lower removal efficiencies (47.46 ± 0.3% and 52.69 ± 0.44%, respectively). Furthermore, the removal efficiency of PEI-coated MPs was further improved to over 95% under pH 7, the highest magnetic field of 40 mT, and algogenic organic matter-free conditions. Adsorption kinetics and isotherm analysis revealed that chemical and physical interactions drive the adsorption of a monolayer of algal cells on the surface of magnetic particles. Atomic force microscopy and quartz crystal microbalance confirmed a strong adhesion force and rate between functionalized MPs and algae, which affect both algal removal efficiency and MPs recovery from algae-MPs aggregates. The extended Derjaguin−Landau−Verwey−Overbeek (EDLVO) theory predicted a strong attractive force between algae and cationic polymer-coated MPs, which supported the enhanced algal removal. Finally, almost 99% of the four MPs could be recovered from separated algae-MPs aggregates within 30 s under the strong magnetic field and exhibited excellent magnetic responsiveness and reusability in further separation cycles. This study establishes a foundation for coagulant-free algae removal and enables the potential sustainable separation processes.

SPEAKER: **Lili Li, New Jersey Institute of Technology | ll64@njit.edu**

SPEAKER BIO: I'm a PhD student at the New Jersey Institute of Technology. My research area is magnetic separation for algal cells from water body.

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A SYNTHETIC AND TRANSPARENT CLAY REMOVES MICROCYSTIS AERUGINOSA EFFICIENTLY

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL III

ABSTRACT: Clay-algae flocculation is a promising method to remove harmful algal blooms (HABs) in aquatic ecosystems. Many HAB-generating species, such as Microcystis aeruginosa (M. aeruginosa), a common species in lakes, produce toxins and harm the environment, human health, and the economy. Natural clays, such as bentonite and kaolinite, have been applied to mitigate HABs. By forming large aggregates in the water column, the flocculation of algal cells and clay particles can remove toxins and cells. We investigate the effect of a synthetic, transparent, biocompatible, biodegradable, and commercially available smectite clay, laponite, on removing HAB cells. By conducting clay-algae flocculation experiments, we compare the cell removal efficiencies (RE) of laponite, bentonite, and kaolinite. Our findings indicate that laponite effectively removes M. aeruginosa cells without compromising water clarity, outperforming both bentonite and kaolinite. In order to remove 80% of M. aeruginosa cells from the water column, a mere 0.05 g/L of laponite is sufficient, which is considerably smaller compared to the 2 g/L and 4 g/L needed for kaolinite and bentonite, respectively. We demonstrate that the superior performance of laponite clay is because of its smaller particle size compared with bentonite and kaolinite, which leads to a higher encounter rate between cells and clay particles. Furthermore, the experimental data suggest that laponite demonstrates superior performance compared to polyaluminum chloride (PAC)-modified bentonite and PAC-modified kaolinite clays. Moreover, we examined the efficacy of these three clay types in water samples taken from Powderhorn Lake, and laponite displayed impressive effectiveness in controlling HABs.

SPEAKER: **Yuan Li, University of Minnesota | li002413@umn.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ENDS- MULTIPLE PERSPECTIVES IN ONE SHOT TO UNDERSTAND HAB DRIVERS

SESSION: BLOOM DYNAMICS & DRIVERS IV

ABSTRACT: Arguably the most important research in the field of harmful algal blooms is to understand what drives the formation, maintenance, and demise of the blooms. HABs emerge from a high net population growth rate of the causative species, which is influenced by a complexity of physical, chemical, and biological factors or processes. Therefore, to pinpoint which of these processes are most critical to the dynamics of specific HAB events, an integrative approach is needed to allow simultaneous characterization of the multiple processes and weigh the importance of each process. A molecular ecological approach integrating the acquisition of energy (E) and nutrients (N), defense (D), and sexual (S) as well as asexual reproduction (ENDS) has been developed. The application of the approach has shed light on the differential importance of abiotic and biotic factors in specific HAB outbreaks. The prospect of its further development into a quantitative model will be discussed.

SPEAKER: **Senjie Lin, University of Connecticut | senjie.lin@uconn.edu**

SPEAKER BIO: I study the ecology and oceanography of HABs using an integrative molecular ecological and ecological genomic approach. One focus area is dinoflagellate blooms.

BIODEGRADATION OF MICROCYSTIN BY ISOLATED BACTERIAL STRAINS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Cyanobacteria are organisms that can produce cyanotoxins, causing environmental impacts and economic losses by threatening drinking water sources and affecting recreation. Microcystin is an example of a cyanotoxin produced by cyanobacteria. This hepatotoxin can cause health effects including liver necrosis in humans and other animals. Due to its stable characteristics, normal water treatment does not mitigate microcystin. However, using bacteria with algaecidal compounds is a promising method for degrading microcystin. In this study, we isolated cyanobacterial associated bacteria and evaluated their potential to decrease microcystin. From a large bacterial culture collection, 11 bacteria isolates were grown. Each of these bacteria were used to evaluate microcystin biodegradation by treating them with 74.44 ppb of microcystin in methanol. After a 72-hour treating period, microcystin concentration in each bacterium was determined using ELISA. Among all the bacteria investigated, Chryseobacterium takoiae, Achromobacter ruhlandii, and Alcaligenes faecalis show significant potential to degrade microcystin, with an average microcystin reduction ranging from 47% to 60%. These results highlight the potential effectiveness of using these bacterial strains in degrading microcystin.

SPEAKER: **Meng Lin, University of Florida | mlin2@ufl.edu**

SPEAKER BIO: Meng Bing Lin is a graduate student in the Interdisciplinary Ecology program at the University of Florida. Meng's research is focused on the treatment of benthic harmful algal blooms using bacterial-derived algalcidal compounds.

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BUILDING A BETTER HAB MODEL PERFORMANCE METRIC

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Many methods exist for general model assessment. Application of these methods to harmful algal bloom (HAB) models is often appropriate. However, HAB events are often seasonally predictable and somewhat binary in nature. Several available methods to compare HAB model performance have been suggested. A significant shortcoming of the majority of these methods is that they assess performance based purely on a combination of fit and complexity of the model. While this may be sufficient in some cases, when the purpose of a model is to give an early warning to a potential algal bloom, the criteria for success must also include how well the model provides timely early warning.

A suite of metrics based on identifying the expected warning time provided by a given model has been developed. Here, we will detail those metrics and the rationale behind them. Examples of their application and potential shortcomings as well as opportunities for future development will also be discussed. Further development and optimization of these methodologies could provide a strong assessment metric that is agnostic of model family or design and allows for accurate quantification of model responsiveness to changing HAB conditions.

SPEAKER: **Travis Linscome-Hatfield, Neptune and Company Inc | travis@neptuneinc.org**

SPEAKER BIO: Travis Linscome-Hatfield, has been actively involved in the field of environmental statistical analysis, as a statistician, for the last decade. He has provided multiple training courses on environmental background analysis to government agencies, and helped develop and provide training resources for US EPA's ProUCL software. Additionally, he is actively involved in the R and Python communities, where he regularly utilizes those, and other languages, to provide high quality analysis and visualizations.

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GROWTH-LIMITING AMMONIUM CONCENTRATIONS IN PRODUCTIVE NORTH CAROLINA USA ESTUARIES: IMPLICATIONS FOR HAB ECOLOGY

SESSION: ECOPHYSIOLOGY & BIOGEOCHEMISTRY

ABSTRACT: Empirical measurements of ammonium (NH4+) concentrations that limit the growth rate of HABs and other phytoplankton are often orders of magnitude lower than field NH4+measurements, even in systems where there is empirical evidence for nitrogen (N) limitation of phytoplankton growth rates. Given NH4+ is often the primary limiting N-source, resolving this discrepancy between measured NH4+ concentrations which indicate no growth limitation versus empirical evidence that blooms are N-limited is critical to accurately modeling HAB bloom dynamics. One possible reason for this discrepancy is an overestimation of NH4+ concentrations by the standard colorimetric methods most often used for NH4+ analysis.
In this study, we compared the NH4+ concentrations measured in estuarine water samples using the standard autoanalzyer-indolphenol blue (IPB) colorimetric method with those determined in the field in discrete unfiltered samples using the fluorescent ortho-phthaldialdehyde (OPA) method calibrated by standard additions. Results showed that NH4+ concentrations measured by the OPA method were lower than those in duplicate samples determined by the IPB method. The largest differences were observed in samples when OPA NH4+ measurements < 1 uM. A major reason for this discrepancy is the much lower detection limit for the current OPA method (0.014 uM) compared to the IPB method (0.2-0.3 uM).
Many of the NH4+ concentrations measured with the OPA method fell within NH4+ levels that limit phytoplankton growth rates (< 0.1 uM), indicating N-limitation is more prevalent in productive estuarine waters than previously thought. The situation is analogous to that of accurately measuring iron in iron-limited ocean water samples where the extremely low, growth-limiting ambient concentrations could only be accurately measured once the analytical methodology was sufficiently refined for such low measurements.

SPEAKER: **Wayne Litaker, CSS Inc. | wayne.r.litaker@noaa.gov**

SPEAKER BIO: Wayne Litaker received his master's degree from the University of Michigan in resource ecology, a PhD in marine botany from Duke in 1986 and conducted post-doctoral research in immunology, bacteriology and molecular biology at the University of North Carolina Medical School. He subsequently did research and taught advanced molecular and biotechnology training courses for MDs and Ph.D.s before joining NOAA in 2002. At NOAA he conducted harmful algal bloom research and served as branch chief of the Harmful Algal Bloom Forecasting Branch until retiring in 2019 and then continuing his research activities as a consultant with CSS incorporated. His research interests focused on the ecology, toxicology, molecular biology and taxonomy of various species in the genera Alexandrium, Cryptoperidiniopsis, Gambierdiscus, Karlodinium, Karenia, Pfiesteria and Pseudopfiesteria. Research manuscripts and additional information can be found at https://www.researchgate.net/profile/Richard-Litaker.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

SHORT-TERM FORECAST OF KARENIA BREVIS TRAJECTORY ON THE WEST FLORIDA SHELF

SESSION: PREDICTIVE MODELING - MARINE

ABSTRACT: Blooms of the toxic dinoflagellate Karenia brevis, also known as harmful algal blooms (HABs) or red tides, occur almost annually on the west coast of Florida, killing fish and other marine life, threatening public health and adversely impacting local economies. Mitigating such effects requires improved red tide forecast capabilities on the West Florida Shelf. A short-term Lagrangian trajectory forecast tool is developed to help federal, state, and local end users monitor and manage red tides on the west coast of Florida. The automated forecast products are based on the established West Florida Coastal Ocean Model (WFCOM) and Tampa Bay Coastal Ocean Model (TBCOM) nowcast/forecast systems. Observed K. brevis cell count data are uploaded daily into the models to generate 3.5-day forecasts of the bloom trajectories both on the shelf and in the estuaries. The tracking tool displays modeled bloom trajectories at the surface and near-bottom with five categories of cell concentrations (each approximately representing an order of magnitude difference in concentration). More general and user-friendly maps are also produced to provide red tide advisories along the coast, including those integrated with satellite imagery.

SPEAKER: **Yonggang Liu, University of South Florida | yliu@usf.edu**

SPEAKER BIO: Yonggang Liu currently serves as the Director of the Ocean Circulation Lab at the College of Marine Science, University of South Florida. He is a physical oceanographer, aiming to better understand the ocean circulation on the West Florida Shelf, including the interactions/exchanges of water properties between the estuaries, the shelf, and the offshore (Loop Current) system of the Gulf of Mexico. He uses both in situ observations and numerical models in coastal ocean research, and he is interested in applying physical oceanography to marine environmental issues, such as Karenia brevis red tide predictions, storm surge forecasts, wastewater plume modeling, and oil spill tracking. He also develops and applies novel data analysis methods in meteorology and oceanography.
http://ocgweb.marine.usf.edu/
https://scholar.google.com/citations?user=j-DRSIQAAAAJ&hl=en

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U.S. National Office for Harmful Algal Blooms

CYANOBACTERIA NUTRIENT STRESSOR-RESPONSE RELATIONSHIPS IN AGRICULTURAL WATERSHEDS OF THE U.S.

SESSION: AGENCY PROGRAM APPLICATIONS

ABSTRACT: Agriculture has increased eutrophication and the potential for cyanobacteria harmful algal blooms (cyanoHABs) in freshwater systems across the United States. To help address this, USDA initiated the Conservation Effects Assessment Project and the Long-term Agroecosystem Research Network to provide information on conservation practices that will enhance agricultural sustainability and environmental integrity. From June to October 2023, 11 freshwater agricultural sub-watersheds within the Mississippi River, Ohio River, Suwannee River, Lake Erie, and Chesapeake Bay drainage basins were sampled for surface water-column cyanoHABs (monitored as phycocyanin). Laboratory bioassay (72 h) nutrient stressor-response relationships were measured to determine nitrogen and phosphorus targets for controlling cyanoHABs. CyanoHABs half-maximum effects concentrations (EC50 values) were determined from nutrient stressor-response relationships for sub-watersheds, when statistically significant ($p < 0.05$). Calculated EC50s are suggested as preliminary nutrient targets for assessing conservation practice effectiveness in watershed nutrient reductions. Nutrient stressor-response relationships were significant in 80-90% of bioassays in the Mississippi River Basin sub-watersheds, Suwannee River Basin, and Lake Erie. Only 35-50% of bioassays showed significant stressor response relationships in Chesapeake Bay and the Ohio River Basin sub-basin watersheds. CyanoHABs EC50 values indicated wide ranges in intra- and inter-basin nutrient targets. Nitrate EC50 values ranged from 0.022-0.695 mg/L above ambient concentrations and most (70%) were <0.200 mg/L. Phosphate EC50 values ranged from 0.004-0.159 mg/L and a majority (65%) were <0.050 mg/L above ambient concentrations. Understanding cyanoHABs nutrient stressor-response relationships can help provide clearer targets for agricultural watershed conservation strategies as tools to better manage non-point source nutrients in agricultural sub-watersheds.

SPEAKER: **Richard Lizotte, USDA-ARS | richard.lizotte@usda.gov**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TRANSATLANTIC IMPACTS OF CIGUATERA POISONING (CP) FROM LUTJANUS BOHAR: A TRADITIONAL CP PARADIGM SHIFT

SESSION: PUBLIC HEALTH

ABSTRACT: The international seafood trade can transport geographically localized hazards to non-endemic regions, such as ciguatoxins (CTXs) which can cause ciguatera poisoning (CP) in humans. In 2020, two commercial packages of frozen “red snapper steaks”, product of India, were collected in Germany from a large lot of product imported into the European Union (EU) in 2017, distributed to twelve countries, and responsible for an outbreak of CP. In 2017, three similar commercial packages of red snapper steaks from India, associated with one case of CP, were collected in the United States (US). Initial investigation of the US samples found CTX-like bioactivity, but the typical CTX markers used for confirmation (C-CTX-1 and P-CTX-1/CTX-1B) were not detected, leaving the case un-confirmed. From the US samples, 9 of 11 portions from the three commercial packages were positive for CTX-like toxicity, as determined by mouse neuroblastoma cytotoxicity (N2a) assay, containing 0.50-6.26 ppb CTX-1B equivalents (Eq.). All EU samples (7/7 portions from two commercial packages) were positive, containing 0.79-5.39 ppb CTX-3C Eq. LC-MS/MS analysis detected CTX analogues exclusively from the CTX-3C class in all N2a positive samples. All products (mislabeled in the US) were verified by DNA barcoding as Lutjanus bohar, a species associated with CP in the Indo-Pacific region. These findings break from several historical trends in US CP cases. First, CP outbreaks in the US are typically geographically localized and caused by only one fish in a given lot. Second, the majority of past US cases have been associated with the presence of C-CTX-1 or CTX-1B marker compounds. The finding of multiple toxic fish within a lot of frozen pre-packaged steaks/filets with a transatlantic distribution, the exclusive finding of CTX-3C analogs, and the association with L. bohar are all new occurrences in the US and will need to be monitored in the future.

SPEAKER: **Christopher Loeffler, German Federal Insitute for Risk Assessment | christopher.loeffler@bfr.bund.de**

SPEAKER BIO: Research scientist in the National Reference Laboratory for Marine Biotoxins at the German Federal Institute for Risk Assessment. Scientific SCUBA diver, experienced in field sample collections (fish, algae). Graduated from the University of Naples Federico II (summa cum laude), worked in the US at the FDA, and in the Caribbean (St. Thomas, USVI). Completed the NOAA NCMA training course on harmful algal identification.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

GROUND TO SPACE VERIFICATION OF CYAN IN SUSPENDED SEDIMENT-LADEN KANSAS RESERVOIRS

SESSION: PREDICTIVE MODELING - FRESHWATER

ABSTRACT: Optical water properties, including some kinds of suspended sediments, can affect satellite retrieval data. Select suspended sediment-laden (Secchi depth = 0.21 - 1.3 m) freshwater reservoirs in Kansas with known histories of cyanobacteria blooms and cyanotoxin production were evaluated to explore the efficacy of satellite imagery to accurately detect cyanobacteria biomass in turbid waters. Data from the Sentinel-3 Ocean Land Colour Instrument platform along with Cyanobacterial Assessment Network (CyAN) algorithms were used to resolve occurrence of cyanobacterial blooms remotely in selected reservoirs in Kansas. In situ data sets including phytoplankton and picocyanobacteria, algal pigments, and cyanotoxins in addition to typical water quality parameters were evaluated against CyAN algorithm classifications. This evaluation uses a confusion matrix approach to test true positives and true negatives relative to Kansas Department of Health and Environment cyanobacteria harmful algal bloom (cyanoHAB) thresholds. CyAN data was also compared against historical state event-response cyanoHAB warnings.

SPEAKER: **Keith Loftin, USGS | kloftin@usgs.gov**

SPEAKER BIO: Dr. Keith Loftin is a Research Chemist with the U.S. Geological Survey and has worked on cyanotoxins and associated blooms for approximately 19 of 20 years that he has been with the U.S. Geological Survey. His work has focused on analytical methods development, national occurrence, fate, and potential exposure of cyanotoxins.

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MODELLING CYANOBACTERIAL REFLECTANCE TO ESTIMATE BENTHIC CYANOBACTERIAL BIOMASS: PRELIMINARY RESULTS

SESSION: Predictive Modeling - Freshwater

ABSTRACT: Monitoring spatiotemporal distribution of cyanobacteria biomass is the first step in assessing cyanobacterial harmful algal blooms (CyanoHABs). Remote sensing of chlorophyll a and the water soluble phycobilins often utilizes band ratios tuned for estimation of these pigments based on spectral absorption features. We conducted preliminary work using linear two-band ratio algorithms to quantify cyanobacterial abundance from Unmanned Aerial System (UAS)-acquired hyperspectral imagery on the Shenandoah River, VA, yielding a strong relationship with centimeter resolution ($R2=0.94$). As these pigments have overlapping absorption spectra, linear models utilizing band ratios can result in overestimation of cyanobacteria, particularly with wide cutoff filters.

Spectrophotometric analyses of pure standards (spectral endmembers) and mixtures were used to develop optimized mathematical models for estimating pigment biomass. Samples were analyzed using a Biotek Synergy plate reader using Costar black-walled plates, and a Perkin Elmer Lambda 850+ spectrometer and integration sphere using quartz cuvettes. Data were binned to 2 nm means, then analyzed using MATLAB Eigenvector software to determine regression relationships. The model was additionally trained using both 2 nm slope intervals and reciprocals of the spectral endmembers and tested for performance. Ongoing work scheduled for summer 2024 includes model validation using mixtures of analytical pigment standards, filtered cyanobacterial monocultures, and field samples from the Shenandoah River, VA. Lastly, the limits of spatial resolution for the model will be tested using UAS-acquired hyperspectral imagery at pixel resolutions with ground truth samples from the Shenandoah River.

Technological advancements in airborne and spaceborne spectrometers will continue to improve spatial and spectral resolutions in available datasets for CyanoHAB monitoring. The advent of Planet and other publicly available satellite platforms should help in these monitoring efforts by providing coverage needed for effective CyanoHAB monitoring. This model will provide a rapid and accurate tool for assessment of CyanoHABs in freshwater inland waterbodies.

SPEAKER: **Ronaldo Lopez, Virginia Commonwealth University | lopezr5@vcu.edu**

SPEAKER BIO: I am a remote sensing specialist with a background in wetland and aquatic systems ecology. I have over seven years of experience applying emergent technologies and remote sensing methods in ecological research. My research interests include ecological applications of remote sensing, harmful algal bloom monitoring and management strategies, coastal resilience, and tidal wetland response to sea-level rise.

I am currently research faculty at the Virginia Commonwealth University (VCU) Rice Rivers Center and am involved in a broad array of studies, including serving on the Chesapeake Bay Sentinel Site Cooperative (CBSSC) SET Working Group. The CBSSC is focused on improving our understanding of coastal wetland response to sea level rise and maintaining discourse amongst stakeholders about coastal resilience in the Chesapeake Bay region. Additionally, I am involved with several remote sensing related studies, from monitoring wetland vegetation community composition and health at the Chickahominy tribal lands at Mamanahunt, to partnering with the Army Corps of Engineers in the development classification models to produce terrain mobility maps.

In addition to my faculty position, I am currently a doctoral candidate in the VCU Integrative Life Sciences program, with a focus on remote sensing applications towards the assessment and management of cyanobacterial harmful algal blooms. Specifically, I am working to develop algorithms to improve estimations of cyanobacterial pigment concentrations from hyperspectral imagery. This effort is supported by data collected through a DEQ funded project in which we are testing the efficacy of hyperspectral imaging to assess benthic cyanobacterial blooms on the Shenandoah River, Virginia.

CO-AUTHORS:
Paul V Zimba

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

FLOCCULATION AND SEDIMENTATION FOR CONTROL OF HABS USING MODIFIED BIOCHAR

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: The growing proliferation of HABs in aquatic systems results in severe impacts to natural resources, human health, and coastal economies, emphasizing the need for development of effective strategies to reduce these effects. Technologies for flocculation and sedimentation of cells are at the forefront of HAB control, with routine application in some countries. This strategy utilizes combinations of mineral clays, coagulants and other polymers, and potentially components such as algaecides and materials to sequester or degrade toxins. Although mineral clays are most commonly used, modifications are necessary to enhance flocculation, such as polyaluminum chloride (PAC) to modify the surface charge. Further, these modified clays do not sufficiently reduce toxins and do not rapidly kill cells, so additional modifications are needed. Biochar is a carbon-rich, porous functionalized solid produced by pyrolysis of biomass in an oxygen-depleted environment. Although typically used for carbon sequestration, water purification and as soil amendments, recent studies show the effectiveness for adsorption of HAB toxins. Commercial biochar removed >90% of saxitoxin (STX), microcystin-LR (MCLR) and brevetoxin (BTX) from aqueous solutions at a dose of 0.01-0.04 g/L in 30 min-2 hrs. However, our studies show that, due to slightly negative to neutral surface charge, biochar does not flocculate or remove HAB cells like PAC-modified clays can. Therefore, we have modified biochar to incorporate PAC to flocculate/remove HAB cells and adsorb their toxins. Preliminary results indicate 100% removal of K. brevis cells within 3 hours using 0.3g/L of 1:1 biochar and PAC. Here, we present the results of ongoing laboratory studies that examine cell removal of multiple HAB species (Karenia brevis and Pyrodinium bahamense) using PAC-modified biochar, including fate of cells and toxins. In continuing studies, we also consider the incorporation of algaecides, such as CaO_2 and curcumin into the PAC-modified biochar to kill HAB cells within the floc.

SPEAKER: **Vincent Lovko, Mote Marine Laboratory | vlovko@mote.org**

SPEAKER BIO: https://mote.org/staff/member/vincent-lovko1

CO-AUTHORS:
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ANATOXIN-PRODUCER DOMINATED CYANOBACTERIAL COMMUNITY STRUCTURE, SUCCESSION AND QPCR-BASED INDICATION OF CYANOTOXIN PRODUCTION

SESSION: EMERGING TOXINS & SPECIES

ABSTRACT: Annual cyanobacterial harmful algal blooms (CyanoHABs) plague Anderson Lake, WA, during the summer months. These CyanoHABs can produce excessive cyanotoxins, primarily anatoxins (ATXs), posing a significant threat to aquatic ecosystems and public health. To develop more effective strategies to prevent future CyanoHABs, we sought to unravel the cyanobacterial community structures to detect and predict CyanoHABs more accurately. Over a three year study period, we used qPCR and sequencing methods to observe that major blooms typically start before May and peak between May to June. For a typical CyanoHAB event, Dolichospermum cyanobacteria was identified as the dominant taxa. The CyanoHABs in Anderson Lake exhibited similar patterns as occurred in general freshwater HABs, specifically characterized by an initial nitrogen fixation phase (N period) dominated by Dolichospermum which then shifted to the phase dominated with Microcystis (M period). However, the N period surpassed the M period of the blooms that occurred in this lake. Our results further revealed that Dolichospermum WA102 genotype emerged as the active anatoxin producer with high level of anaC abundance and transcripts during the N period, driving anatoxin production to the level as high as 215 µg L-1. In contrast, the M period exhibited only low levels of mcy gene abundance and microcystin (~ 0.3 µg L-1), indicating a minor contribution to cyanotoxins. The high anatoxin production also correlated with elevated phosphorus (P) levels, low N/P ratios, and cooler water temperatures. By examining the relationships between total anatoxin and anaC gene abundance and transcripts, we've developed an early warning method using qPCR and RT-qPCR targeting anaC to predict short-term anatoxin production. Our data can be useful information for lake managers to protect source water and prevent tourists from exposure to excessive cyanotoxins in this coastal freshwater lake.

SPEAKER: **Jingrang Lu, US EPA | lu.jingrang@epa.gov**

SPEAKER BIO: Jingrang Lu is a Research Biologist with the U.S. Environmental Protection Agency in Cincinnati, Ohio. His research work focuses on the molecular method development and detection of pathogenic bacteria in drinking water, lake water, coastal water and biofilm, etc., using transcriptomic, metagenomic and genomic analysis and host animal model, which are applied to track bacterial pathogen contaminants, and to assess water quality and pathogenic risks. He holds a PhD in microbial ecology and a MS in zoology. His main interests are to apply molecular approaches to applied environmental microbiology and public health research.

CO-AUTHORS:
Ian Struewing, Rochelle Labiosa, Xiang Li, David Linz, Chiqian Zhang, Nathan Sienkiewicz, Stephanie Bailey, Steve Reimer, Gerald Dodo, Doug Wood, Jed Januch, Christopher Pace, Theresa McBride, Stephanie Bailey, Eunice Chern, Katie Adams, Barry Pepich; Meghan Dunn, Tim Weissman, Mike Dawson, Eric Villegas

THE MONITORING AND MANAGEMENT OF CYANOBACTERIA OVER THE WINTER AND EARLY SPRING SEASONS.

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL III

ABSTRACT: It has been recognized that many planktonic and benthic forms of cyanobacteria, the group of algae responsible for the majority of Harmful Algal Blooms (HABs) in freshwater systems, frequently originate from the sediments. Overwintering cells, either as akinetes or vegetative cells, can serve as an inoculum for HAB events over the course of the growing season. In addition, climate change has allowed these overwintering cells to initiate growth earlier in the growing season as well as persist as HABs well into the winter months. This has a substantial impact on the ecological, potable, recreational and economic value of waterbodies.

This presentation will review the annual life cycle of several types of cyanobacteria with an emphasis on the overwintering stage. This will include data on the distribution of overwintering cyanobacteria in select waterbodies in the Mid-Atlantic region of the US. The presentation will also discuss some methodology being developed to better assess and monitor for overwintering cyanobacteria. In turn, it will be demonstrated how such information can be used to better predict and manage / control the development of HABs. Finally, some recommended in-water management measures will be identified that serve as a more proactive strategy in controlling / preventing the development of HABs, particularly during the early portion of the growing season.

SPEAKER: **Fred Lubnow, Princeton Hydro, LLC | flubnow@princetonhydro.com**

SPEAKER BIO: Dr. Fred S. Lubnow is the Senior Technical Director of Ecological Services at Princeton Hydro, and the office manager of the Exton, Pennsylvania office. Dr. Lubnow received his Bachelor of Science in Biology from Susquehanna University (1988), his Master's degree in Environmental Sciences (1992) and his Ph.D. in Limnology (1994), both from the University of California Davis. Dr. Lubnow has been an environmental consultant for 30 years. His areas of expertise include the management of Harmful Algal Blooms (HABs) and their associated cyanotoxins, in-lake management strategies and the development of watershed-based management plans. Dr. Lubnow is an adjunct professor at Delaware Valley University, Doylestown, PA where he has been teaching a course and laboratory on Watershed Management since 2016. He is also an adjunct professor at Villanova University, PA where he teaches a graduate course on Freshwater Ecology.

In addition, Dr. Lubnow developed a professionally credited course on the Management and Monitoring of HABs and Cyanotoxins in Raw Water Supplies. Dr. Lubnow is also one of the members of New Jersey's HAB Expert Team who are conducting data and literature reviews on HABs in order to develop strategies on how to holistically address such conditions in freshwater systems in New Jersey.

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

UNDERSTANDING THE AFFECTS OF AMMONIUM AND PREY ON A NOVEL BLOOM OF DINOPHYSIS ACUMINATA USING ITS ISOLATES

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Dinophysis is a harmful algal bloom-forming dinoflagellate which produces toxins that cause diarrhetic shellfish poisoning (DSP) and has been linked to DSP events worldwide. Dinophysis is a mixotroph that utilizes kleptoplasty and specifically preys on the ciliate, Mesodinium rubrum to obtain functional plastids. Beyond prey, some Dinophysis blooms have been linked to eutrophication and excess nutrients such as nitrogen. A Dinophysis bloom which occurred in May 2023 in Eastport, NY on Long Island had an unprecedented density of 10^7 cells L-1 persisting for over a month, subsequently causing a shellfish closure in Little Seatuck Creek. We established isolates from this novel bloom and performed experiments, along with other strains of Dinophysis acuminata isolated from NY, MA, and VA, to understand the extent to which the growth rates and DSP content were dependent on densities of Mesodinium and concentrations of ammonium. We found that with the addition of ammonium, Dinophysis growth increased significantly, especially when it was fed prey, Mesodinium. In addition to culture experiments, field bloom experiments were conducted to compare growth rates. Alongside with ammonium amendment experiments, we conducted feeding experiments with different prey types using two strains of Mesodinium from Japan and Denmark to compare to the growth responses of clonal isolates. Assessing the responses of these strains to different bloom populations experiencing differing environmental conditions will provide insight into controls on the bloom dynamics of Dinophysis and DSP events.

SPEAKER: **Lucas Chen, Stony Brook University | lucas.chen@stonybrook.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ESTIMATING ECONOMIC DAMAGES OF WATER QUALITY WARNINGS IN THE GREAT LAKES

SESSION: Socioeconomic Impacts

ABSTRACT: Great Lakes (GL) beaches are threatened by the increasing prevalence of harmful algal blooms (HABs) and bacterial contamination. The economic limited literature on GL HABs and bacterial warnings typically proxies warnings by using beach closures, but most events have warnings without closures. We test for intra-seasonal lag effects of HAB & bacterial warnings to see if warnings cause economic losses even after they are lifted. To measure economic losses to beachgoers of HAB & bacterial warnings, we combine beach visitation and survey data. Recreation demands are modeled for all publicly-accessible sandy beaches from Lake St. Clair MI and all of the Lake Erie shore of Michigan and Ohio. The demand system captures inter-beach visitation, site substitution and seasonal participation. Survey questions capture demand behavior under environmental conditions largely unobservable during sampling. Contingent behavior response to HABs & bacterial events placed within the demand model, to utilize strengths of both approaches. Data comes from stratified random sampling of over 4,000 visitors intercepted at beaches. We find that both HAB and bacterial warnings cause significant damages and and although HABs get more headlines, bacterial warnings affect more beaches. We find that both HAB and bacterial warnings cause a loss that persists even after lifted, suggesting cost-benefit analysis that ignores effects of past warnings would underestimate damages.

SPEAKER: **Frank Lupi, Michigan State University | lupi@msu.edu**

SPEAKER BIO: Professor of Environmental & Resource Economics at Michigan State University
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CO-AUTHORS:
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EXTENSIVE AND INTENSIVE MONITORING APPROACHES TO INVESTIGATE THE DRIVERS OF HABS IN LAKE ANNA, VA

SESSION: Poster Session, Wednesday

ABSTRACT: Nutrient and sunlight are well documented drivers of harmful algal blooms (HABs) in lakes and reservoirs. However, the interactions among these drivers and other potential factors influencing HAB growth is less understood. The U.S. Geological Survey, in cooperation with the Virginia Department of Environmental Quality and in collaboration with Old Dominion University, is conducting a study to investigate the potential factors, processes, and sources driving HAB initiation, persistence, and decline at the Lake Anna reservoir in central Virginia. Lake Anna has experienced elevated cell counts of potentially toxigenic species starting in the mid-summer each year, resulting in recreational-contact advisories. Excessive algae may adversely impact the ecosystem, reduce water quality, and, if toxigenic cyanobacteria are present, produce cyanotoxins that can pose health risks to humans and wildlife.
The extensive and intensive monitoring program at Lake Anna and in the surrounding watershed evaluates the hydrology, nutrient dynamics, geochemistry, algal community, and wave action to identify potential factors and sources of a HAB event. The monitoring program also leverages multiple new technologies and approaches to better predict a HAB event.

SPEAKER: **Carly Maas, U.S. Geological Survey | cmaas@usgs.gov**

SPEAKER BIO: Carly is a hydrologist at the US Geological Survey Virginia-West Virginia Water Science Center based in Richmond, Virginia. She received her master’s degree in Geology from the University of Maryland where she studied the impacts of salinization in urban streams. Her current work at the USGS focuses on the investigating the drivers and sources of harmful algal blooms in rivers and reservoirs.

CO-AUTHORS:
Brendan M. Foster (US Geological Survey), Douglas B. Chambers (US Geological Survey), Marjorie A. M. Friedrichs (Old Dominion University), Aliyah Downing (Old Dominion University)

ADVANCEMENTS IN THE PROGRAMMABLE HYPERSPECTRAL SEAWATER SCANNER MEASUREMENT TECHNOLOGY FOR ENHANCED DETECTION OF HARMFUL ALGAL BLOOMS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The Programmable Hyperspectral Seawater Scanner (PHySS) represents a significant technological advancement in the monitoring and management of harmful algal blooms (HABs), with a specific focus on "Florida red tide" caused by Karenia brevis. This sensor introduced the use of a Fourth-Derivative Spectral Similarity Index (SI) to enhance the detection capabilities of the PHySS. The SI leverages hyperspectral imaging to identify subtle spectral features associated with K. brevis. This method provides a reliable means of detecting phytoplankton concentrations compared to traditional monitoring techniques, and the strong correlation observed between the SI and phytoplankton cell counts suggests the PHySS could serve as an effective tool for real-time monitoring, enabling timely responses to mitigate the impacts of HABs. However, while the PHySS shows great promise, it also has limitations including an inability to differentiate between various phytoplankton species solely based on spectral data in the absence of targeted species. This shortfall necessitates reimagining the sensor's capabilities to allow it to not only identify but to quantify specific species in-situ. Additionally, the PHySS is constrained by outdated electrical components and operating system which can reduce the accuracy and reliability of the sensor's data. The robust positive correlation between the SI values and K. brevis phytoplankton counts, however, underscores the potential of this technology for early detection and intervention in HAB events.

SPEAKER: **Reilly Maguire, Mote Marine Laboratory and Aquarium | rmaguire@mote.org**

SPEAKER BIO: As a Senior Engineering Technician with a diverse background, I specialize in maintaining and troubleshooting complex systems in aerospace, communication electronics, and oceanographic instruments. My expertise includes data analysis, component-level diagnostics, and system calibration in both laboratory and field settings. Currently, as the Ocean Technology Program Manager at Mote Marine Laboratory, I lead strategic initiatives in marine exploration and conservation, managing projects valued over $1.5 million and expanding operational capabilities.

Previously, as Laboratory Coordinator II at Florida Gulf Coast University, I managed seven environmental engineering labs, ensuring safety compliance and integrating advanced analytical techniques like gas chromatography into the curriculum. At the University of Western Australia, I held roles including Supervisor of the Technical and Safety Support Team, where I enhanced lab safety protocols and supported extensive research projects.

My career highlights include developing cost-saving measures, enhancing team efficiency, and driving technological innovations. I excel in project management, strategic planning, and team leadership, consistently fostering collaboration and professional growth. My ability to communicate intricate technical information effectively ensures successful project outcomes and stakeholder engagement.

ENVIRONMENTAL AND HUMAN BIOMONITORING OF MICROCYSTIN TOXIN EXPOSURE IN A FLORIDA COHORT: A CITIZEN SCIENCE APPROACH IN THE FRAMEWORK OF THE DISPEL PROJECT

SESSION: PUBLIC HEALTH

ABSTRACT: Cyanobacterial Harmful Algal Blooms (cyanoHABs) frequently raise significant concerns for public health in communities that live, work or recreate near freshwater bodies in Florida, primarily due to the presence of microcystin toxins and other toxin classes. These toxins are associated with both short-term and long-term health effects from environmental exposure. Lake Okeechobee particularly has experienced a high prevalence of HABs over the past decade. Despite this, there isn't enough information about the potential health risks linked to inhalation exposure to microcystin in the area. To cover this gap, we designed a cohort of participants in the framework of the Diversity and Innovation in the Screening and Prevention of Exposure over the Longterm (DISPEL) to HABs project. DISPEL is a "citizen science" research study where participants in different areas of Florida provide environmental water samples, along with health-related samples such as nasal swabs, oral and stool microbiome samples, lung-function tests, and health survey data. The study has been ongoing since 2019 with additional participants recruited each year and repeated samples collected from ongoing participants.
We detected microcystin via mass spectrometry in 18 out of 116 water samples collected between July 2020 and June 2023, with MC-LR and MC-LA as the most prevalent congeners. Among 32 nasal swabs analyzed, 19 contained microcystin in the form of MC-LA according to mass spectrometry analysis. In addition, we characterized participants' oral and stool microbiota and assessed the effect of microcystin exposure on microbiome structure and composition. Further studies are required to analyze the correlation between respiratory health and microcystin exposure. This is the first study to our knowledge that reports microcystin congeners in nasal swabs.

SPEAKER: **Daniela Maizel, University of Miami | dxm1457@earth.miami.edu**

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ASSESSING BLOOM CONDITIONS ALONG A NORTH-SOUTH TRANSECT IN WESTERN LAKE ERIE DURING 2021-2023

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Following improvement of the harmful algal bloom impairment in the 1970s, Lake Erie began experiencing re-eutrophication in the 1990s. Western Lake Erie (WLE) is subject to high nutrient inputs from the Maumee River from the southwest and large, nutrient-poor discharge from the Detroit River from the north. Our study explores how water quality and the phytoplankton community changed along a transect in WLE extending from the Detroit River mouth to near the Maumee River mouth. We sampled monthly from May through October in 2021-2023 at evenly spaced locations along the transect. In 2021, water quality parameters varied more spatially than monthly, particularly in August-October. During 2022, there was both spatial and monthly variation, but water nearer the Maumee River was more variable among months than water nearer the Detroit River. In the later months of both years, chlorophyll, particulate organic carbon and nitrogen, total phosphorus, and suspended solids increased and ammonia decreased along the transect. Additionally, in situ instrument-collected data revealed an increase in temperature and specific conductivity and more rapidly diminishing PAR along the transect. FluoroProbe data revealed that, in most months of both years, total algal concentration increased notably near the Maumee River. Additionally, there was a continued presence of diatoms throughout 2021 with relatively low cyanobacteria concentrations in August-October, while 2022 saw a more typical succession of algal composition for WLE, including notable cyanobacteria concentrations in July-September. These data echo differences between the two bloom years, which was more widespread but less concentrated in 2021 than 2022, possibly explained by precipitation patterns. Dynamics associated with the 2023 bloom will also be discussed to help elucidate spatial-temporal patterns of bloom conditions in WLE.

SPEAKER: **Jasmine Mancuso, Cooperative Institute for Great Lakes Research | mancusoj@umich.edu**

SPEAKER BIO: Having grown up in West Michigan just a few miles from Lake Michigan, I am very passionate about studying and maintaining the health of the Great Lakes. I received a bachelor's degree in Environmental Sustainability and Research Management with a minor in Biology from Oakland University (Rochester, Michigan) and a master's degree in Aquatic Biology from Grand Valley State University (Allendale, Michigan) where I worked with Dr. Bopi Biddanda at the Annis Water Resources Institute (Muskegon, Michigan). Currently, I am an Aquatic Ecology Research Analyst at the Cooperative Institute for Great Lakes Research, which is located at the NOAA Great Lakes Environmental Research Lab in Ann Arbor, Michigan. I work with Drs. Casey Godwin and Reagan Errera and the rest of the Harmful Algal Bloom team to understand the ecology of blooms in Western Lake Erie and to provide stakeholders with timely and important information that goes towards protecting the lake and those who enjoy it.

CO-AUTHORS:
Ashley Burtner, Andrew Camilleri, Kelly McCabe, Christine Kitchens, Duane Gossiaux, Glenn Carter, Reagan Errera, Casey Godwin

INTEGRATING TRADITIONAL POLYNESIAN VOYAGING AND MODERN SCIENCE: VIMS AND PVS COLLABORATION UTILIZING PLANKTOSCOPE TECHNOLOGY

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: The Virginia Institute of Marine Science (VIMS) has partnered with the Polynesian Voyaging Society (PVS) to combine traditional Polynesian navigation with modern scientific research on Hōkūle‘a, a traditional Polynesian voyaging canoe. This collaboration aims to inspire the next generation of "young navigators for the Earth" to respect and care for themselves, each other, and their natural and cultural environments. As an educational partner of the PVS, VIMS scientists are equipping Hōkūle‘a with scientific instruments, including a PlanktoScope, for the Moananuiākea Voyage. The PlanktoScope is a low-cost, easy-to-use, microscopic-imaging instrument featuring an open-source hardware and software platform that enables high-throughput water sample processing. This innovative tool allows for detailed examination of oceanic microbial life, making it an invaluable resource for both scientific research and educational outreach. The PlanktoScope data collected onboard will be processed by VIMS scientists and made publicly available online. Global access to data will provide material to educate the general public about plankton, including HAB species, in the various regions visited by the Hōkūle‘a. In addition, VIMS aims to distribute PlanktoScopes to coastal indigenous communities along the voyage route. By empowering these communities to peer into the microscopic world of plankton, the significance of these organisms and their critical role in marine ecosystems will be better recognized. Furthermore, PlanktoScopes will facilitate monitoring of harmful algal blooming (HAB) species and provide opportunities for educating about these organisms. This will enhance protection of the fisheries-based cultural heritage of these communities and provide additional safeguards from HAB-related illnesses.

SPEAKER: **Savannah Mapes, Virginia Institute of Marine Science | samapes@vims.edu**

SPEAKER BIO: Savannah is a Ph.D. Candidate at the Virginia Institute of Marine Science studying the dynamics of harmful algal blooming species in the lower Chesapeake Bay under the advisory of Dr. Kim Reece.

CO-AUTHORS:
Kim Reece

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

FIRST STATEWIDE ANALYSIS OF CONNECTICUT SHELLFISH FOR A SUITE OF MARINE AND FRESHWATER BIOTOXINS

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Studies around the world have demonstrated that cyanobacteria blooms and their associated toxins can be transported to estuarine environments, where shellfish can naturally accumulate and take an extended period of time to depurate the toxins. In 2022, 28 representative oyster or hard clam samples were collected from Connecticut shellfish growing areas as part of the first comprehensive analysis of marine and freshwater toxins. The main focus of the study was to assess in-situ biotoxin concentrations in the two most commercially important shellfish species in Connecticut harvest and natural seed beds. A minimum of 10 shellfish per sample were shucked, homogenized, and frozen within 24 hours of collection, in accordance with National Sanitation Shellfish Program (NSSP) Laboratory Method requirements, at the Connecticut Department of Agriculture, Bureau of Aquaculture (DoAG) laboratory. Samples were analyzed for anatoxin A, brevetoxin-2, brevetoxin-3, cylindrospermopsin, domoic acid, microcystin-LA, microcystin-LR, microcystin-RR, microcystin-YR, nodularin, okadaic acid, neosaxitoxin, saxitoxin, and teleocidin by ultra-performance liquid chromatography with tandem mass spectrometry (UPLC/MS/MS) at the University of Connecticut Center for Environmental Sciences and Engineering. Results, measured in ppb, were consistent with the DoAG's harmful algal bloom monitoring results. The most commonly detected toxin was domoic acid, but the maximum concentration was far below the NSSP regulatory limit (20 ppm). No other marine biotoxins were detected in Connecticut shellfish, and only two of the freshwater toxins were detected in one sample each. The NSSP has regulatory limits and approved testing methods for PSP, ASP, DSP, NSP, and AZP, with no current plans to adopt limits or testing methods for cyanobacteria toxins. Additional research is needed to determine acceptable consumption limits to assist NSSP programs in effectively conducting risk assessments for this emerging threat to protect public health.

SPEAKER: **Emily Marquis, Connecticut Department of Agriculture, Bureau of Aquaculture | emily.marquis@ct.gov**

SPEAKER BIO: Emily Marquis graduated Summa Cum Laude from the University of New Hampshire with a bachelor's degree in Marine, Estuarine, and Freshwater Biology, and a minor in Environmental Conservation and Sustainability. Emily has worked for the State of Connecticut, Department of Agriculture, Bureau of Aquaculture (DoAG) for 6 years. DoAG is the lead agency in charge of shellfish sanitation in the state, and operates as part of the National Shellfish Sanitation Program (NSSP). Emily is currently an Environmental Analyst II, and has overseen the DoAG's harmful algal bloom monitoring and paralytic shellfish poisoning management programs since 2019. In addition to coordinating sample collections, analyzing HAB samples, collecting and processing mussel samples for the PSP management program, and implementing biotoxin closures and reopenings, Emily assists with the routine management of statewide growing areas, report writing and other NSSP requirements.

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APPLICATION OF SOLID PHASE ADSORPTION TOXIN TRACKING (SPATT) FOR TRACKING KARENIA BREVIS-DERIVED BREVETOXINS IN SOUTHWEST FLORIDA

SESSION: APPLICATIONS OF EMERGING TECHNOLOGIES I

ABSTRACT: Blooms of the harmful marine dinoflagellate Karenia brevis occur nearly annually along southwest Florida and are hypothesized to form offshore on the West Florida Shelf. Traditional sampling consists of collecting discrete water samples at weekly to monthly resolution for evaluation of cellular abundance by light microscopy. Blooms of K. brevis are inherently patchy over space and time which can present challenges in routine monitoring. With this in mind, the time-integrated passive sampling method Solid Phase Adsorption Toxin Tracking (SPATT) was developed to detect and monitor K. brevis-derived brevetoxins and implemented as a monitoring tool from 2018 to 2024. Small 1g resin-filled mesh bags were deployed year-round at two coastal sites for 1–2-week periods and at multiple depths at one offshore site near the hypothesized initiation region for 4-week periods. At the coastal sites, brevetoxin concentrations tracked closely with cell abundance observations over multiple K. brevis events and thus marked a bloom's arrival and gradual decline, although brevetoxins remained elevated for a short period trailing the decrease in cell concentrations. In contrast, at the offshore site, brevetoxins were detected even in the absence of cell observations over multiple, at times months-long, periods. Possible explanations include resuspension of benthic sediments, spatial and/or temporal aggregation of cryptic populations of K. brevis, and/or brevetoxin in the water column from prior K. brevis bloom events. Overall, SPATT not only provides a robust time-integrated sampling method and strategy for monitoring brevetoxins and bloom events in both coastal and offshore environments, but also adds to our understanding of these dynamic events.

SPEAKER: **Kelsey Marvin, Fish and Wildlife Research Institute / FWC | Kelsey.Marvin@MyFWC.com**

SPEAKER BIO: Kelsey Marvin works in the Harmful Algal Blooms group at the Fish and Wildlife Research Institute, a division of the Florida Fish and Wildlife Conservation Commission in St. Petersburg, FL. She started at FWRI in 2017 and graduated from University of South Florida with her B.S. in Biology in 2018. Kelsey's current projects are focused primarily on the development of new monitoring tools for Karenia brevis, toxin analysis (brevetoxin), and flow cytometry for field monitoring, including immunofluorescent assays.

CO-AUTHORS:
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THE DYNAMIC INFLUENCE OF A RESERVOIR ON THE DOWNSTREAM DISTRIBUTION OF ALGAL TOXINS IN A PERENNIAL HEADWATER STREAM

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Cyanobacteria can be found in a wide range of water sources, including ponded sources (i.e. lakes and ponds) as well as in rivers and streams where the water flow can vary significantly. However, it is not well understood how upstream catchments found within in a river system can influence the overall dynamics in the distribution of both harmful cyanobacteria and their toxins. A key question is if cyanobacterial toxins produced within the catchment can propagate and ultimately migrate downstream. In addition, whether the cyanobacteria population and toxin distribution change due to other factors such as dilution or in-situ degradation. This research investigates the influence of an upstream reservoir, known to contain cyanobacteria-producing toxins, on the cyanobacteria and toxin distribution in the downstream river stretch. Discrete samples were taken over the course of a two-year study and passive samplers were deployed to monitor dissolved toxin migration.

SPEAKER: **Heath Mash, US EPA | mash.heath@epa.gov**

SPEAKER BIO: I am an analytical chemist with the USEPA. My research specializes in analytical method development and applied research focusing on the occurrence, transformation and treatment of algal toxins associated with harmful algae blooms (HABs). My research seeks to understand under what water quality conditions algal toxins are produced, in addition to the transformation, removal, and fate of these toxins downstream on a watershed scale. Research projects include partnering with USEPA regional offices, federal agencies, state agencies and academic institutions which include monitoring algal toxin migration throughout local and regional watersheds through direct water monitoring and the application of Solid Phase Adsorption Toxin Tracking (SPATT) technology.

CO-AUTHORS:
Morgan McNeely Jingrang Lu, Ian Struewing, Aimee Henderson

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

COMPARISON OF SOLID PHASE EXTRACTION METHODS FOR THE ISOLATION OF CARIBBEAN CIGUATOXIN-1 ACROSS FISH SPECIES COMMONLY IMPLICATED IN CIGUATERA POISONING

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Ciguatoxins (CTXs), produced by the marine benthic dinoflagellate, Gambierdiscus spp., bioaccumulate and undergo biotransformation as they move through food webs. The resulting ciguatoxins are among the most potent marine neurotoxins. Consumption of seafood, usually finfish from tropical and subtropical areas, contaminated with ciguatoxins can cause Ciguatera poisoning (CP). CP is the most frequently reported phycotoxin related seafood illness in the world. Although many CTX congeners may contribute to the composite toxicity of fish associated with CP, Caribbean ciguatoxin-1 (C-CTX-1) is the most abundant Caribbean form. The US Food and Drug Administration has set a guidance value of 0.1 ug/kg C-CTX-1 equivalents in finfish. However, lack of ciguatoxin reference materials continue to limit the implementation of a validated method for ciguatoxin detection/monitoring. Due to the complexity of the toxin and matrices (usually fish tissue or viscera) from which C-CTX-1 can be isolated, a multi-step extraction and clean-up method is imperative. Purification of extracts usually involves various Solid Phase Extraction (SPE) steps before analysis using LC-MS/MS. In implementation of these methods, it is important to consider not only matrix interference, but also loss of toxin. Here we show that the use of Florisil SPE followed by reverse phase C-18 SPE recovers more C-CTX-1 than other commonly used SPE sorbent beds, silica and amino-propyl. This was consistent across multiple fish species. All species tested and analyzed using LC-MS/MS had greater C-CTX-1 peak areas, by an average of roughly 50% when neither silica nor amino-propyl was used, indicating a significant loss of toxin with these methods. We anticipate the Florisil, C-18 clean-up method will be an integral step towards further isolation and purification of C-CTX-1 in the development of a reference standard. The development of which will allow for significant advances in the detection and management of CP.

SPEAKER: **Sarah May, US Food and Drug Administration | sarah.may@fda.hhs.gov**

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RESEARCH AND DEVELOPMENT OF REFERENCE MATERIALS FOR CYANOBACTERIAL TOXINS AT NRCC

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The limited availability of cyanotoxin certified reference materials (CRMs) has been a barrier to the development and validation of methods required to support cyanotoxin regulation and monitoring programs. Traceable CRMs prepared in compliance with laboratory testing quality standards (e.g. ISO 17025) ensure comparability between measurements carried out at different times or in different laboratories. A good understanding of the chemistry and stability of the toxins is required to produce CRMs that are fit-for-purpose. The large number of toxin variants within each cyanotoxin class makes this a significant challenge.

The National Research Council of Canada (NRCC) has produced a number of publicly-available cyanotoxin CRMs including microcystins (MC-LR, [Dha7]MC-LR, MC-RR, MC LA), nodularin, cylindrospermopsin, anatoxin-a, lyngbyatoxin, as well as several saxitoxins. New CRM projects are selected to expand the range of CRMs available for the analogs that are relevant in the environment. Recent efforts have been focused on the preparation of calibration solution CRMs for homoanatoxin-a (hATX-a), [Leu1]MC-LY and MC-YR. These CRMs play a vital role in the characterization of dietary supplement matrix CRMs recently prepared using the non-toxic cyanobacteria Aphanizomenon flos-aquae (Cyano A), and Aphanizomenon flos-aquae blended with a variety of cultured cyanobacterial species that produce cyanotoxins (Cyano-T).

A summary will be provided on the production of cyanotoxin CRMs at NRCC, outlining key steps in their preparation including algal culturing, toxin isolation, CRM preparation, stability testing, and accurate quantitation. Certified values for these materials are assigned providing traceability to the International System of Units (SI).

SPEAKER: **Pearse McCarron, National Research Council of Canada | 1411 Oxford St**

SPEAKER BIO: Pearse McCarron obtained a PhD from University College Dublin (Ireland) and took up a research position at the National Research Council of Canada (NRCC) in 2008. Pearse has been leading the Biotoxin Metrology group at the NRCC for almost 10 years with a primary research focus on understand the chemistry of algal and cyanobacterial toxins, development of chemical analytical methods, and production of reference materials.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THERMAL NICHE DYNAMICS OF PSEUDO-NITZSCHIA SPECIES IN MONTEREY BAY: IMPLICATIONS FOR HARMFUL ALGAL BLOOM MANAGEMENT IN A WARMING OCEAN

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: As global sea surface temperatures (SST) rise, this creates a new environment that may support harmful algae bloom (HABs) which can impact marine ecosystems and coastal communities. In the California Current System, the bloom-forming diatom genus Pseudo-nitzschia (PN) poses a significant threat due to its production of a neurotoxin called domoic acid (DA). In 2015, a massive DA event dominated by a high DA producing species P. australis occurred during anonymously warm waters and an upwelling event in Monterey Bay (MB), CA, highlighting the urgency to 1) identify the thermal niche of PN species local to MB and 2) understand how temperature influences PN community composition.
However, distinguishing PN species from each other using traditional methods like light microscopy cannot be done, requiring molecular methods like quantitative polymerase chain reaction (qPCR). This study aims to identify the thermal niche of PN species (ex. P. australis, P. multiseries, P. pungens) local to MB by conducting growth rate experiments at different temperatures (12 °C, 15 °C, 20 °C). Cultured isolates were obtained from Monterey Municipal Wharf II and subjected to controlled temperature regimes. Growth rates were calculated via cell counts, and photosynthetic health of the cells was evaluated using pulse amplitude modulated fluorometry. The next phase of this research will document how mixed communities of these species will respond to different temperatures using species-specific qPCR assays.
This research contributes valuable insights into the response of PN species to changing SSTs, which is crucial for informing HAB monitoring and forecasting systems such as the Harmful Algal Bloom Monitoring and Alert Program and the California-Harmful Algae Risk Mapping. The implications of this research extend to stakeholders including fishery managers, policymakers, environmental advocates, and public health officials, highlighting the importance of accurate PN bloom predictions for sustainable marine management and public safety.

SPEAKER: **Hannah McGrath, San Jose State University | hannah.mcgrath@sjsu.edu**

SPEAKER BIO: Hannah is a second-year graduate student in the Environmental Biotechnology Laboratory (EBL) at Moss Landing Marine Laboratories (MLML) with an interest in phytoplankton ecology, particularly harmful algae blooms (HABs). She graduated from Colby College in 2022 with a BA in Environmental Science and a minor in Managerial Economics. Her journey into marine science began during her junior year when she had the opportunity to work with Dr. Peter Countway at Bigelow Laboratory for Ocean Sciences, where she studied the abundance and duration of the harmful dinoflagellate Karenia mikimotoi using molecular techniques in Boothbay Harbor, ME.
During the summer of 2021, Hannah furthered her passion for HABs as a Research Experiences for Undergraduates (REU) intern at Mote Marine Laboratory's Red Tide Institute (RTI) under Dr. Cynthia Heil. There she investigated the co-occurrence of Karenia species responsible for red tides in Florida. Hannah continued to collaborate with Dr. Countway and Dr. Heil for her honors thesis exploring the co-occurrence of Karenia species as sea surface temperatures increase. Currently, she is co-advised by Dr. Sarah Smith and Dr. Holly Bowers at MLML, where she works on two projects: 1) weekly monitoring of water quality and phytoplankton assemblages in Monterey Bay for CenCOOS and 2) validating qPCR assays with Dr. Bowers to enhance the rapid detection of HAB species, thereby contributing to a better understanding of HAB events. For more details, please visit Hannah's LinkedIn profile [www.linkedin.com/in/hannah-mcgrath4]

CO-AUTHORS:
Sarah Smith, Raphael Kudela, Thomas Connolly, Holly Bowers

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE EFFECTS OF LONG-TERM LABORATORY CULTIVATION ON CYANOBACTERIA AND THEIR ASSOCIATED PHYCOSPHERE

SESSION: MICROBIAL INTERACTIONS

ABSTRACT: In the environment, cyanobacteria are closely associated with other organisms, forming diverse and intricate networks of ecological interactions that are collectively known as the phycosphere. In particular, the interactions between cyanobacteria and heterotrophic bacteria are thought to be mutualistic, providing each side with essential metabolic products. When cyanobacteria are isolated in the lab, they are removed from negative interactions such as predation and competition but are introduced to artificial selection depending on isolation and purification methods. These enriched communities may develop to create the stability of natural communities and fill ecological niches. To test this hypothesis, non-axenic cultures of Planktothrix agardhii and their phycosphere were sequenced for metagenomic analysis. These cultures were then split and cultivated under varied laboratory environments for a period of 15 – 30 months, being sampled infrequently to determine if there were changes in the cyanobacteria genome and/or community composition. Some of the host genomes displayed noticeable genetic rearrangements over this period, including isolates that had lost the ability to produce microcystin toxins through the deletion of most of the mcy operon, and isolates that had lost several genes required to produce an active urease. The phycosphere also displayed some interesting patterns, noting that across the tested isolates, the bacterial classes were consistent, but might vary in relative abundance depending on the state of the culture. Additionally, unique microbial classes such as archaea (Methanomicrobiales) were starting to make up a small portion of the population, allowing for future exploration of hard to study microbial interactions.

SPEAKER: **Katelyn McKindles, Baylor University | katelyn_mckindles@baylor.edu**

SPEAKER BIO: Katelyn McKindles currently serves as an Assistant Professor in the Department of Biology at Baylor University in a joint position with the Center for Reservoir and Aquatic Systems Research (CRASR). In this role, she runs a research lab that is driven by a shared mission to understand and mitigate the impacts of harmful algal blooms (HABs) including the intricate interactions between harmful algal species, microbial communities, and the surrounding environment. Prior to her appointment at Baylor University, Katelyn held positions as a Postdoctoral Researcher in Ecology and Evolutionary Biology at the University of Michigan and as a Postdoctoral Researcher at the Great Lakes Institute for Environmental Research (GLIER) at the University of Windsor. She now continues the work she started as a doctoral student at Bowling Green State University in exploring and publishing on microbial ecology and the interactions between pathogens and host cyanobacteria.

CO-AUTHORS:
D. Quynh Nguyen, Ryan Wagner

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

DESIGN AND VALIDATION OF MARKER GENES FOR A ROBUST GENOME-BASED MICROCYSTIS TAXONOMY

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Cyanobacterial harmful algal blooms (cyanoHABs) caused by members of the genus Microcystis are expected to increase in both frequency and intensity due to global climate change. As a result, blooms of this cosmopolitan, often toxigenic, cyanobacterium will increasingly reduce water quality, disrupt energy flow, and threaten human and wildlife health. Historically, Microcystis taxonomy has been inconsistent and controversial. The primary trait of colony morphology can be environmentally plastic and standard molecular-based species definitions are insensitive. A new genome-based taxonomy resolves this long-standing taxonomic uncertainty. This taxonomy is robust to novel genome additions and reveals 25 clusters of conserved genomes (genospecies) with conserved patterns of secondary metabolite gene presence/absence, including those for microcystin production. To improve access to the genome-based taxonomy, we developed and validated five novel marker genes that enable accurate identification of Microcystis genospecies without the need for whole genome sequencing, thus reducing both costs and bioinformatic burdens. Each of the five markers identified novel Microcystis genospecies with complete agreement with full genome-based analysis. Further, when used in pairs, the markers were able to resolve the phylogenetic relationships between strains. We report that these individual marker genes provide accurate identification of previously genome-defined genospecies, while concatenated pairs of marker genes can accurately reproduce the full-genome phylogeny and thereby identify new potential genospecies. This new and robust genome-based taxonomy, now accompanied by a simple and accessible marker-gene assay, will provide much-needed stability to Microcystis taxonomy and the possibility of previously unobtainable genotypic-phenotypic characterization across the gradient of environments in which Microcystis occurs globally.

SPEAKER: **Christopher McLimans, University of Oklahoma | cmclimans@ou.edu**

SPEAKER BIO: Chris McLimans is a PhD candidate at the University of Oklahoma, specializing in the study of the harmful algal bloom forming cyanobacterium Microcystis. He previously earned a Master's degree in Bioinformatics from Juniata College and is broadly interested in integrating large-scale genomic and ecological datasets to understand and tackle ecological issues. His current research employs phylogenetic and microbial macroecological approaches, as well as ecophysiological characterization, to understand Microcystis evolution and ecological success. These studies aim to resolve historical taxonomic discrepancies, investigate genome evolution, and develop accessible, cost-effective methodologies for identifying this toxic, bloom-forming organism to enable improved study. Following his PhD, he hopes to continue integrating genomics and big data approaches to address ecological problems associated with climate change through a role as a scientist with a state or federal science agency.

CO-AUTHORS:
Haiyuan Cai, Jessica Beyer, K. David Hambright (University of Oklahoma)

HAB MANAGEMENT AND CONTROL IN DREDGED MATERIAL CONTAINMENT FACILITIES AND BENEFICIAL USE ECOSYSTEM RESTORATION SITES IN THE CHESAPEAKE BAY REGION

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL III

ABSTRACT: On behalf of the Maryland Port Administration, Maryland Environmental Service (MES) manages and operates multiple Dredged Material Containment Facilities (DMCFs) and Beneficial Use ecosystem restoration sites in the Chesapeake Bay region. This presentation will focus on three sites, Cox Creek and Masonville DMCFs and the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island (Poplar Island). Nutrient rich dredged material hydraulically or mechanically placed into containment facilities may create a habitat that promotes algal growth which can lead to Harmful Algal Blooms (HAB). Algal blooms including HABs can impact site operations, human health, and wildlife due to elevated pH, turbidity, and potential toxicity.

Microcystis aeruginosa blooms impacted Poplar Island in 2012-2014, 2020, and 2022-2023 and Masonville in 2016-2022, and have produced microcystin with toxin levels that exceeded the World Health Organizations no contact threshold. During the same periods, Poplar Island experienced avian mortality events.
In 2018, MPA and MES developed a collaborative Global HAB Plan. These plans are used as a guide to reduce exposure, as well as to establish an appropriate sampling plan to ensure human safety, while protecting wildlife and the surrounding environment. This presentation will focus on the lessons learned through navigating the unique challenges of identifying and controlling for HABs within the dredged material ponds with a focus on the importance of multiagency stakeholder input, treatment, and monitoring and management to ensure impacts to human health, wildlife, and site operations are limited.

SPEAKER: **Colleen McMullen, Maryland Environmental Service | cmcmullen@menv.com**

CO-AUTHORS:
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MONITORING PLANKTOTHRIX AND MICROCYSTIS MIGRATION FROM AN UPSTREAM HARMFUL ALGAL BLOOM SOURCE INTO DOWNSTREAM WATERWAYS VIA AUTOMATED FLOW CYTOMETRY

SESSION: Poster Session, Wednesday

ABSTRACT: Cyanobacteria are a naturally occuring component of healthy aquatic ecosystems. In many instances, when there is an excessive influx of nutrients, particularly in warm stationary bodies of water, cyanobacteria may propagate leading to the production of algal toxins presenting serious health risks for humans, pets, and wildlife. Flow cytometry is one possible method for detecting and quantifying potentially dangerous cyanobacteria. Flow cytometry allows for the analysis of many particles in a heterogeneous mixture in a short period of time. Automated flow cytometers can be used to produce quantitate values by employing dozens of different parameters unique to each individual particle. By creating libraries for a targeted group of cyanobacteria composed of captured images, range values can be generated for chosen parameters of interest. This allows the user to create filters that quantify and differentiate a targeted cyanobacteria group from other particles in their water sample. This project utilizes flow cytometry to monitor levels of planktothrix and microcystis in a continuously blooming lake heavily influenced by agricultural runoff as well as various sites downstream of a canal that spills this lake water into a local river system. It aims to observe the spatial and temporal changes in cyanobacteria concentrations in contaminated water as it travels from the source of the agal bloom into the impacted waterways downstream.

SPEAKER: **Morgan McNeely, Biologist | McNeely.Morgan@epa.gov**

SPEAKER BIO: Morgan McNeely is a biologist for the Center for Environmental Solutions and Emergency Response within the US EPA who focuses on water quality issues by performing research on various biological contaminates of concern including harmful algal blooms and premise plumbing pathogens. Morgan understands the importance of scientific study in safeguarding our water resources and maintaining human health. She received a BS degree in biology from Thomas More University with a concentration in ecology and enjoys being on the water fishing any chance she gets.

CO-AUTHORS:
Heath Mash

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

NATIONAL FORECASTING OF CYANOBACTERIAL HARMFUL ALGAL BLOOM EVENTS: A BAYESIAN SPATIOTEMPORAL MODEL EVALUATION

SESSION: PREDICTIVE MODELING - FRESHWATER

ABSTRACT: The U.S. Harmful Algal Bloom and Hypoxia Research Control Act calls for robust approaches to forecasting cyanobacterial harmful algal blooms (cyanoHABs). Accurate forecasting technology could save local communities healthcare costs through the early detection of cyanoHABs and therefore faster advisory warnings. However, most existing forecasting models require time-consuming parametrization and/or are limited to well-sampled individual lake systems. An Integrated Nested Laplace Approximation hierarchical Bayesian spatiotemporal model forecasted weekly lake exceedance of 12 µg/L chlorophyll-a, the World Health Organization's recreation Alert Level 1 threshold, for 2192 satellite resolved lakes in 2021 and 2023. Model deficiencies were evaluated to improve the functionality of the forecast. We investigate the temporal and seasonal trends in false positives, that is, if reoccurring annual events are prematurely forecasted, and if there is a relationship between these false positives and their forecasted probabilities. We also consider the impacts of geographic location and seasonal ice cover on these predictions. This evaluation identifies key targets for model improvement with the goal of making the forecasts operational moving forward.

SPEAKER: **Kate Meyers, US EPA ORISE Fellow | Meyers.kate@epa.gov**

SPEAKER BIO: Kate is an ORISE Fellow working at the EPA's Office of Research and Development. Her educational background is in chemistry and coastal geochemistry, for her thesis she conducted seasonal field campaigns to understand the impacts of shallow wastewater injection on the nearshore water quality of the Florida Keys. Currently, Kate is working with Blake Schaeffer at ORD to develop remote sensing technology and methods for water quality monitoring. Her current projects include evaluating a Bayesian spatiotemporal model for forecasting cyanobacterial harmful algal bloom events and expanding the capabilities of the Cyanobacterial Assessment Network to monitor smaller inland lakes through Sentinel-2 data.
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

US ARMY CORPS OF ENGINEERS FRESHWATER HAB RESEARCH & DEVELOPMENT INITIATIVE

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Freshwater Harmful Algal Blooms (HABs) are particularly impactful to the U.S. Army Corps of Engineers (USACE), which manages vast freshwater resources and waterways that provide a variety of services including navigation, flood risk reduction, recreation, fish and wildlife management, as well as potable water supply. The U.S. Army Engineer Research Development Center (USACE-ERDC) was directed to develop and demonstrate scalable technologies that will reduce HAB impacts to our nation's freshwater resources across scales (e.g. small waterbodies to river reaches), ecoregions (e.g. subtropical to temperate), and system types (e.g. lakes/reservoirs, riverine). The USACE-ERDC Freshwater HAB Research & Development (R&D) Initiative has funded over 40 projects intended to deliver and demonstrate HAB-combatting methods, models, and technologies that may be used alone or in combination to effectively reduce HAB frequency and impacts to water resource development projects across the nation. The poster presentation will highlight new technology transfer-focused activities, learnings from the 4th Interagency Freshwater HAB Research & Development Workshop (June 2024), and will provide an opportunity to engage with federal, state, local, and university partners.

SPEAKER: **Mandy Michalsen, USACE ERDC| mandy.m.michalsen@usace.army.mil**

SPEAKER BIO: As Strategic Initiatives Program Manager, Mandy supports the Technical Director of Civil Works Environmental Engineering and Sciences in development and delivery of science-based solutions to environmental challenges that threaten USACE Civil Works mission execution, including climate change and invasive and nuisance species. Mandy's interests include innovative technologies for groundwater and sediment remediation; characterizing the hydrogeochemical processes that govern aquifer storage and recovery performance and recovered water quality; as well as development and delivery of scalable technologies for cyanobacteria harmful algal blooms. Since joining USACE in 2008, Mandy has served as Principal Investigator and lead engineer on field-scale technology demonstrations and full-scale groundwater remedy optimization projects, resulting in multiple peer-reviewed research papers. She received her bachelor's degree in Civil Engineering from University of Iowa in Iowa City, Iowa and both her master's and doctorate degrees in Civil Engineering from Oregon State University in Corvallis, Oregon. Prior to joining ERDC in November 2014, Mandy worked in consulting (Hart Crowser, Inc.) and served in multiple roles at Seattle District USACE.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

SINGLE LABORATORY VALIDATION OF A FIELD-PORTABLE DUPLEX ASSAY FOR PSP AND ASP TOXINS IN SHELLFISH

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: Toxins produced by harmful algal blooms (HABs) can cause a range of serious health effects if ingested in sufficient quantities via consumption of contaminated seafood products. Thus, accumulation of HAB toxins in shellfish and other fishery resources represents a public health threat and a concern for commercial (wild caught and farmed), recreational, and subsistence harvesting that must be addressed by careful and timely monitoring, as well as harvest closures based on established regulatory guidelines. The US requires testing of shellfish meat for saxitoxins (STX; causes paralytic shellfish poisoning (PSP)) and domoic acid (DA; causes amnesic shellfish poisoning (ASP)), and occurrence of the taxa producing these two toxin classes can overlap in time and space. Currently, individual tests for each of these toxins can be time consuming and expensive, which hinders monitoring and screening efforts. LightDeck Diagnostics has developed a transformative platform technology that will enable users in the field to perform cost-effective, multiplexed, rapid, laboratory-quality HAB toxin testing. This planar waveguide-based immunoassay provides for the simultaneous detection and quantification of both PSP and ASP toxins in a single duplexed assay, following co-extraction of these toxins from shellfish using a simple protocol that can be implemented easily in the field. This duplexed PSP/ASP detection assay and its associated extraction protocol were subjected to a Single Laboratory Validation (SLV) study for "Limited Use" applications, according to guidelines established by the Interstate Shellfish Sanitation Conference (ISSC) and National Shellfish Sanitation Program (NSSP). Here, we present the SLV results for evaluation of this portable, low-cost system for point-of-use applications. It is anticipated that this technology will enhance the safety of the nation's food supply while enabling expansion of aquaculture by reducing time and cost necessary to bring shellfish to market, as well as providing a rapid screening capability for subsistence harvesting in remote areas.

SPEAKER: **Christina Mikulski, NOAA / NOS / NCCOS | tina.mikulski@noaa.gov**

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25 YEARS OF CONTINUOUS CYANOBACTERIA BLOOM TIME SERIES FOR GREAT LAKES REGION THROUGH MULTI-SENSOR DATA FUSION AND MACHINE LEARNING

SESSION: REMOTE SENSING

ABSTRACT: Cyanobacterial harmful algal blooms (cyanoHABs) are a concern in many large lakes, including those in the Great Lakes region. A long-term bloom observation time series is needed to understand and monitor changes in bloom characteristics over time. Observations from satellite missions such as historical Envisat-MERIS and current Sentinel 3-OLCI are often used to monitor cyanoHABs due to the availability of the spectral bands required to identify cyanobacteria. However, the four-year observation gap from 2012 to 2015 between MERIS and OLCI missions has hindered the creation of long-term consistent monitoring of cyanoHABs. This study used ocean color data from MODIS-Terra and machine learning to generate a consistent cyanobacteria monitoring product that has the potential for broad applicability. As a result of a study on Lake Okeechobee, FL, we trained a fully connected deep network (CyanNet) to model the Cyanobacteria Index (CI)—a key satellite algorithm for quantifying cyanobacteria. The network was trained with Rayleigh-corrected surface reflectance at 12 MODIS-Terra bands, and results were validated with an independent dataset from 2009 and 2016. Model performance was satisfactory, with a ~17% median difference in annual bloom magnitude, with discrepancies often due to data availability, clouds, or glint variations. The same network performed well in western Lake Erie without additional training, demonstrating its versatility and robustness. The network generated MERIS-OLCI-like CI from Terra for the Great Lakes region, filling the four-year data gap and creating 25 years of continuous satellite-derived cyanobacterial bloom observations. We derived products suitable for assessing bloom phenology, which can provide valuable information about the timing, duration, and magnitude of cyanoHABs. This information can help researchers and policymakers better understand the factors contributing to bloom formation and growth to develop effective strategies for managing and mitigating their impacts.

SPEAKER: **Sachidananda Mishra, CSS Inc. | sachi.mishra@noaa.gov**

SPEAKER BIO: Sachi Mishra is a Satellite Oceanographer at the National Centers for Coastal Ocean Science (NCCOS), NOAA. His research focuses on using satellite remote sensing data, geospatial technologies, and physics-driven machine learning models to detect, monitor, and forecast cyanobacterial harmful algal blooms (cyanoHABs) in lakes, estuaries, and coastal oceans and understand their driving factors. Dr. Mishra holds a Ph.D. in Earth and Atmospheric Science from Mississippi State University and an M.S. in Ocean Engineering from the Indian Institute of Technology Madras, India.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TOWARDS A PAN-REGIONAL SARGASSUM INUNDATION FORECAST PROGRAM

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Since 2011, the CARICOOS, GCOOS and SECOORA regions, part of the IOOS coastal observing system, have been repeatedly exposed to pelagic Sargassum inundation events with major impacts on coastal recreation activities, infrastructure and ecosystem health. In response to the need for mitigating said impacts, all three regions have joined into a Pan-regional effort directed towards investing existing technical and scientific capabilities in all three regions, to develop tools required for assessing risks impacts and supporting management. We will report on progress to date, underway efforts and high priority next steps for this multi-regional collaboration.

SPEAKER: **Julio Morell, CARICOOS | julio.morell@upr.edu**

SPEAKER BIO: Professor Julio Morell: Ex. Director of the Caribbean Coastal Ocean Observing System (CARICOOS).

Trained as a M.Sc. in Chemical Oceanography,, in 1993, Morell became a research professor at the Department of Marine Sciences. Research fields pursued in his career include pollution by oil, debris and anthropogenic nutrients and the study of tropical marine ecosystems including their role as sinks or sources of atmospherically active gases. He was also a leading participant in interdisciplinary research towards identifying the expression of processes such as major river plumes and mesoscale processes on the optical, physical and biogeochemical character of Eastern Caribbean waters. Since 2007 he has focused in the development of CARICOOS through the continuous engagement of stakeholder sectors and the buildup of strategic partnerships with pertinent educational, federal, state entities as well as the private sector. Professor Morell currently serves as an advisor to the Puerto Rico Climate Change Council, the UPR Sea Grant Program, the Jobos Bay National Estuarine Research Reserve and the PR Governor's advisory team on disasters. Current research focuses on diverse expressions of climate in our oceanic and coastal areas.

CO-AUTHORS:
Debra Hernandez, Jorge Brenner

SPATIOTEMPORAL DIVERSITY OF TOXIC BLOOM-FORMING CYANOBACTERIA WITHIN THE KISSIMMEE CHAIN OF LAKES (FLORIDA, USA)

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The Kissimmee Chain of Lakes are a series of connected and primarily eutrophic subtropical lakes in central Florida which drain into Lake Okeechobee. These lakes have gained notoriety as they occasionally experience cyanobacterial harmful algal blooms (cyanoHABs). Additionally, these lakes are infested with Hydrilla, an invasive aquatic plant that is a suitable habitat for the growth of the toxic cyanobacterium, Aetokthonos hydrillicola, which produces the neurotoxin aetokthonotoxin (AETX). Cyanobacterial community structure can vary spatially and temporally due to several factors, (e.g., temperature, light, nutrients, presence of aquatic vegetation, seasons, etc.). The aim of this study was to assess cyanobacterial community structure and elucidate the environmental parameters which influence community structure and bloom-forming and/or toxic genera in the Kissimmee Chain of Lakes, Lake Istokpoga, and northern Lake Okeechobee. Sampling occurred across seven lakes over three years. The community was determined using metabarcoding of the 16S rRNA and environmental parameters (e.g., temperature, pH, conductivity, nutrients, chlorophyll-a, trace metals, etc.) were also measured. Additional targeted analyses were conducted to identify A. hydrillicola, and the aetokthonotoxin gene cluster. The bacterioplankton was dominated by Cyanobacteria, and the cyanobacterial community was dominated by toxigenic bloom-forming genera including Aphanizomenon, Cuspidothrix, Dolichospermum, Microcystis, Raphidiopsis, and Sphaerospermopsis. Moreover, many non-blooming forming taxa (e.g., Cyanobium) were also present. A. hydrillicola was only found on Hydrilla in Lake Tohopekaliga. Additionally, PCR confirmed the presence of the gene for aetokthonotoxin. There were significant differences in the cyanobacterial community structure between some of the lakes. There were distinct environmental drivers for the different bloom-forming cyanobacterial genera. For example, TN:TP is associated with Planktothrix and increasing Trophic State Index (TSI) is associated with Dolichospermum. In conclusion, this study highlights cyanobacterial diversity, revealing a high abundance and diversity of toxigenic bloom-forming cyanobacteria with distinct drivers.

SPEAKER: **Jessica Moretto, University of Florida | jessica.morettoa@ufl.edu**

SPEAKER BIO: Dr. Moretto is Ph.D. in Biosciences and Biotechnology. Her graduate works focused on the changes caused in soil bacterial communities after the selective pressure exerted by the presence of herbicides. It evaluated the genetic potential of herbicide degradation, as well as whether selective pressure would alter biological nitrogen fixation in the soil using molecular biology techniques. Also, her background includes cyanobacteria secondary metabolites, including taste and odor compounds and toxin, bioaccumulation of these secondary metabolites Currently, she is a post-doctoral researcher at Dr. Laughinghouse lab, her projects are focused on the diversity and toxicity of cyanobacteria, harmful algal blooms, microbial community characterization, and biotechnological application of cyanobacteria biomass.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

HARNESSING NANOBUBBLE TECHNOLOGY FOR EFFICIENT OZONE TREATMENT OF HARMFUL ALGAL BLOOMS IN AQUATIC ENVIRONMENTS

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: Harmful algal bloom (HAB) proliferation is a pressing environmental problem that requires immediate and effective mitigation strategies. Although conventional ozone (O3) treatment methods (i.e. regular bubbling) have proven effective in controlling HABs, they are hampered by inefficiencies in gas supply and dosing control. This study explores the integration of nanobubble (NB) technology to optimize O3 delivery and mitigate HABs in both freshwater and saline environments. Experimental results reveal that NB-assisted O3 treatment achieves rapid and substantial increases in dissolved oxygen and O3 levels compared to conventional methods. In particular, O3 NBs show superior efficacy to other green oxidants of environmental interest, such as hydrogen peroxide, in controlling two of the main HAB species in freshwater and marine environments: Microcystis aeruginosa and Karenia brevis, respectively. This increased efficiency underscores the potential of NB-assisted O3 treatment as a viable strategy for environmental water management. Our study highlights the multiple advantages of NB technology, which not only offers improved gas-liquid contact, but also enhanced dispersion and stability of O3 in aquatic matrices. By taking advantage of the unique properties of NBs, this approach allows precise control of O3 dosing and distribution, minimizing adverse effects on non-target species and reducing greenhouse gas emissions associated with conventional ozonation methods. Effective action at low concentrations of O3 assisted by NBs (<1.5 ppm of O3) holds promise for mitigating HABs, thus promoting environmental sustainability. Moreover, NBs facilitate the rapid release of oxygen, crucial for maintaining healthy oxygen levels in the water and enabling aquatic life. Overall, this study underscores the transformative potential of NB-assisted O3 treatment to address the complex challenges posed by HABs, highlighting the need for further research and implementation efforts to harness its full environmental benefits.

SPEAKER: **Jesús Morón-López, NEWT Center / Arizona State University | jmoronlo@asu.edu**

SPEAKER BIO: Dr. Jesús Morón-López is a postdoctoral researcher at Arizona State University, School of Sustainable Engineering and the Built Environment (USA). He holds a PhD in Hydrology and Water Resources Management from the University of Alcalá (Madrid, Spain), a Master's degree in Molecular Genetics and Biotechnology and a Bachelor's degree in Biology from the University of Seville (Spain). He has an international and multidisciplinary research career, having worked across four continents on issues related to water quality. Jesús has extensive experience in research projects focused on the use of nature-based solutions for the control of harmful algal blooms (HABs). In particular, he has conducted important research in the development of biofilters for microcystin contaminated waters; the use of algicidal bacteria; HAB monitoring and early warning systems. His current focus is on bio-nano interactions, such as the application of nanobubbles for harmful algae mitigation, aquaculture or hydroponic crop improvement

CO-AUTHORS:
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COMPARISON OF AI-POWERED DIGITAL MICROSCOPY AND LAB TECHNIQUES IN HAB MONITORING - LESSONS LEARNED IN CITIZEN SCIENCE AND SCREENING

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Current advances in artificial intelligence (AI), particularly machine learning and machine vision models, has given rise to efficiency gains across various use cases. Here, we developed and tested a system which combines portable, digital microscopy with AI image analysis to classify cyanobacteria to genus level and a per genus cell counting algorithm to provide cells/mL concentrations. The system aims to replace the need for manual microscopic analysis and sample shipping via the application of AI to review, classify and enumerate images automatically and on-site. The developed system was provided to 20 monitoring teams spanning 5 states. Participants collected over 170 HAB samples and 5000 images across over 35 unique lakes and shipped samples for laboratory analysis by fluoroprobe and light microscopy. We found the system to be 94% as accurate at classifying cyanobacterial colonies as human taxonomy, reviewing the same images, was overall more reliable than taxonomy when reviewing large quantities of images, and produced results in 30 seconds or less, compare to days via manual analysis. System cyanobacterial cell counts were significantly correlated with fluoroprobe total BGA concentrations with an R^2 of 0.79, in samples not subjected to shipping stresses. We noted severe colony distress and cell lysis for many samples shipped from out of state for fluorometry. In conclusion, the system developed and tested here can play a critical role in rapid HAB identification, monitoring and communication efforts, specifically in on-site applications where rapid risk assessment is critical (i.e. recreational beaches).

SPEAKER: **Igor Mrdjen, BloomOptix, LLC | imrdjen@ramboll.com**

SPEAKER BIO: Dr Mrdjen is focused on studying human and animal outcomes linked with HAB exposures and studying the driving forces related to HAB development. As part of this effort, he is currently focused on developing new monitoring tools and strategies aimed at curbing HAB exposures and advancing our understanding of HAB triggers.

CO-AUTHORS:
Abby M. Webster, Zacharias J. Smith, Danara Dormaeva, Christopher C. Nack, Gregory L. Boyer, N. Roxanna Razavi, and Stephen B. Shaw

DECIPHERING THE CHEMICAL BEHAVIOUR OF PRYMNESINS TO IMPROVE ISOLATION YIELDS FROM PRYMNESIUM PARVUM

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Golden alga, Prymnesium parvum, is associated with massive fish-kills in river and estuarine environments around the world. This species produces a class of ichthyotoxins known as prymnesins that pose a significant threat to aquatic ecosystems. Currently, there are no qualitative or quantitative reference materials for prymnesins, limiting measurement capabilities, toxin verification and toxicity evaluations. The structures of prymnesins are extremely complex with a variety of functional groups including conjugated dienes and trienes, a primary amine, polycyclic ether groups, hydroxylation, chlorination and glycosylation. Preliminary isolation of prymnesin analogues using a 5-step protocol including extraction, precipitation, SPE and semi-preparative HPLC resulted in very low yields of toxins (< 5% recovery), indicating the need to investigate handling protocols to ensure high recovery. A series of experiments were performed to identify key parameters impacting prymnesin recovery including solvent composition, pH, resin composition, drying technique, and storage conditions. The results obtained through these studies identified critical steps in the isolation protocol, which led to greatly improved recovery of prymnesins for the development of reference materials and other important applications for this class of algal toxins.

SPEAKER: **Elizabeth Mudge, National Research Council Canada | elizabeth.mudge@nrc-cnrc.gc.ca**

SPEAKER BIO: Elizabeth Mudge is an analytical chemist with expertise in food science, natural product chemistry and the development of novel analytical measurement techniques. As a Research Officer with the National Research Council's Biotoxin Metrology team, her current focus is on understanding the chemistry of globally problematic aquatic toxin classes, advancing essential analytical measurement tools for detection of these compounds, and ultimately developing a framework for management and mitigating food safety and environmental impacts. She is involved in several international collaborative projects that focus on toxin classes for which reference materials are insufficient to meet the needs of the scientific and regulatory communities.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

IMPLEMENTING IMAGING FLOWCYTOBOTS WITHIN FLORIDA'S HARMFUL ALGAL BLOOM OBSERVATION NETWORK TO EVALUATE KARENIA BREVIS BLOOM DYNAMICS AND ESTIMATE IN SITU GROWTH RATES IN HIGHLY DYNAMIC NEARSHORE ENVIRONMENTS

SESSION: BLOOM DYNAMICS & DRIVERS III

ABSTRACT: Blooms of the toxic dinoflagellate, Karenia brevis, initiate offshore on the West Florida Shelf and are transported shoreward by currents. Evaluating how growth and advection impact bloom development and progression is critical. To better understand nearshore K. brevis bloom dynamics, an interdisciplinary framework consisting of high-frequency in situ Imaging FlowCytobot (IFCB) observations, discrete sampling, remote sensing, and ocean circulation models was designed and used to examine an 8-month K. brevis bloom event from 2022-2023. An IFCB was submerged at a fixed location in Sarasota Bay, FL to examine shifts in K. brevis population abundance, cellular biovolume, and morphological variability at different bloom, tidal, and diel stages. More than 4.4 million particles were identified as K. brevis using a classifier capable of identifying four different K. brevis morphologies or orientations. Observed K. brevis populations displayed varying degrees of morphological plasticity, including changes in size and/or shape. Notably, distinct and consistent light-cued patterns in cellular biovolumes were revealed over the diel cycle and were suspected to be related to the cell cycle. This variability permitted estimation of in situ growth rates, which ranged from ~0.1 divisions day-1 to 0.9 divisions day-1. Interestingly, higher daily growth rates were typically associated with lower K. brevis abundances, while lower rates were generally observed when cell concentrations were above bloom levels (>100,000 cells L-1). Prior reported rates, generally less than 0.5 divisions day-1, suggested that K. brevis was a slow-growing dinoflagellate. These in situ rates can help provide newly developed ecological models for K. brevis with a more realistic and dynamic range of K. brevis biomass and growth, including higher growth rates than have typically been used. This also contributes to our understanding of how coastal and estuarine populations may be more influenced by population growth than previously thought.

SPEAKER: **Eric Muhlbach, Florida FWC | eric.muhlbach@myfwc.com**

SPEAKER BIO: https://myfwc.com/research/redtide/labs-people/current/muhlbach/

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

INTEGRATED SURVEILLANCE ACROSS MULTIPLE SCALES TO IMPROVE HAB MONITORING AND DETECTION: TOWARD AN EARLY WARNING SYSTEM FOR HABS IN THE LOWER CHESAPEAKE BAY

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: Destructive blooms of the ichthyotoxic harmful algal bloom (HAB) species Margalefidinium polykrikoides, have occurred nearly annually in late summer in the lower Chesapeake Bay and mid-Atlantic coastal waters for decades. Since 2007, M. polykrikoides blooms have been succeeded by blooms of Alexandrium monilatum. Blooms have been linked to eutrophication and warming temperatures and contribute to regional hypoxia/anoxia, and finfish and shellfish mortality. Through previous research, bloom initiation hotspots were identified, transport pathways from initiation sites established, and models for bloom development and transport implemented. Networks for bloom detection and monitoring that include fixed station sampling, underway "DataFlow" sampling from boats, and satellite surveillance are in place, and we are deploying low-cost, high throughput, phytoplankton imaging PlanktoScopes to expand partnerships and temporal and spatial coverage of observations. Results will advise state-of-the-art estuarine forecast models, that will be leveraged to build an operational forecast system for M. polykrikoides and A. monilatum blooms in the mid-Atlantic region and that will be accessible to stakeholder groups in near real time through the Chesapeake Bay Environmental Forecasting System (CBEFS) and MARACOOS' OceansMap portal. This presentation will describe this project, its evolution and the pathway to building monitoring and observational networks to support the national HAB observing network (NHABON).

SPEAKER: **Margaret Mulholland, Old Dominion University | mmulholl@odu.edu**

SPEAKER BIO: Has worked extensively on HABs worldwide.

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Eileen Hofmann, Peter Bernhardt, Leah Gibala-Smith, Katie Crider, Kayla Marciniak, Marjy Friederichs, Pierre St-Laurent, Kim Reece, Savannah Mapes, Willy Reay, Suanna Musick, Karen Hudson, Mary Ford, and Shelly Tomlinson

KARENIA BREVIS AND PYRODINIUM BAHAMENSE UTILIZATION OF DISSOLVED ORGANIC MATTER IN URBAN STORMWATER RUNOFF AND RAINFALL ENTERING TAMPA BAY, FLORIDA

SESSION: ECOPHYSIOLOGY & BIOGEOCHEMISTRY

ABSTRACT: This study investigated how nitrogen and dissolved organic matter (DOM) from stormwater runoff and rainfall support the growth of Karenia brevis and Pyrodinium bahamense. Excitation-emission matrix spectroscopy coupled with parallel factor analysis tracked changes in the optical properties of DOM in each bioassay, revealing greater reactivity of terrestrial humic-like DOM in stormwater runoff. Significant increases in cell yield and specific growth rates were observed upon additions of runoff for both species, with significant increases in specific growth rate upon additions of a 2 in simulated rain event for P. bahamense only. By hour 48, 100% of the dissolved organic nitrogen (DON) in each treatment was utilized by P. bahamense and by hour 72, over 50% of the DON was utilized by K. brevis. Percent bioavailable dissolved organic carbon (DOC) was greater for P. bahamense vs. K. brevis, suggesting a greater affinity for DOC compounds by P. bahamense. However, the bioavailability of DOM for each species could be owed to distinct chemical characteristics of labile DOM conveyed from each site. Autochthonous production of microbial humic- and protein-like DOM was observed upon additions of rainfall and runoff for both species, which has implications for bloom maintenance and the microbial loop. This work demonstrates that stormwater runoff and rainfall are both sources of labile DOM and DON to K. brevis and P. bahamense which has implications for blooms of these species in Tampa Bay waters.

SPEAKER: **Amanda Muni-Morgan, University of South Florida | amunimorgan@ufl.edu**

SPEAKER BIO: Amanda Muni-Morgan has a Ph.D. in Interdisciplinary Ecology from the University of Florida. Her research is centered around the effects of terrestrial dissolved organic matter on blooms of Karenia brevis and Pyrodinium bahamense in Tampa Bay, Florida.

CO-AUTHORS:
Mary G. Lusk
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PREDICTIVE MODELING OF RIVER HARMFUL ALGAL BLOOMS; A SYSTEMATIC LITERATURE REVIEW

SESSION: Predictive Modeling - Freshwater

ABSTRACT: Here we present, to our knowledge, the first systematic literature review of predictive models for harmful algal blooms (HABs) in river settings. Major scientific databases and the U.S. Geological Survey's Publications Warehouse were queried for peer-reviewed articles that presented HAB models developed for or applied in a river environment. This search returned more than 4,000 articles which were screened for relevance in three steps: first title and keywords, then abstract, and finally the full text. Fewer than 200 articles remained once the screening was complete. We only retained articles that included a predictive model, meaning the model was used for hindcasting, forecasting, making predictions between observations (temporally or spatially), or scenario analysis. Furthermore, while our focus was on HABs, we also retained articles that modeled algal blooms more generally along with models of algal dynamics. Relevant articles were reviewed by the research team and information related to site location, input and output data, model types and skill, and model application were recorded. Model type was divided into two categories: process-based and data-driven. The modeling endpoint was loosely defined during the search process to allow the opportunity to compare how different researchers leveraged monitoring data and ultimately defined a HAB for their study. We included models developed for benthic and pelagic settings as well as those used in estuarine settings where riverine processes dominated. Through the results of this literature review, we identify the common types of monitoring data used during model calibration, which types of monitoring data or physical processes show the most utility, and the range of HAB definitions (i.e., modeling endpoints) used across river models. This effort summarizes common HAB modeling strategies used in river settings while also uncovering potentially valuable though unconventional approaches.

SPEAKER: **Jennifer Murphy, USGS | jmurphy@usgs.gov**

SPEAKER BIO: Jenny Murphy is a hydrologist with the US Geological Survey. She is currently located in northern Illinois at the Central Midwest Water Science Center. Jenny completed her graduate work at Vanderbilt University in Nashville Tennessee. For over 10 years she has characterized temporal changes in water quality in rivers and streams across the Nation. Jenny currently leads two teams of USGS scientists conducting research into the distribution, occurrence, and drivers of HABs in river systems.

CO-AUTHORS:
Lisa Lucas (USGS), Rebecca Gorney (USGS)

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CYANOBACTERIAL BLOOMS: A PUBLIC HEALTH ISSUE IN WISCONSIN'S WATERS

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The Wisconsin HAB Surveillance Program (HAB Program) exists to prevent and manage HAB-related illnesses in Wisconsin with the ultimate goal to protect and promote the health of Wisconsin residents. Since its inception in 2009, our program has collected and investigated human and animal HAB-related illness complaints. This presentation will provide a deeper look into our program's history, investigation process, partnerships with other local, state and federal agencies, as well as examples of how we conduct outreach activities to improve awareness, understanding, and reporting of HABs and HAB-related illnesses.

SPEAKER: **Jordan Murray, Wisconsin Department of Health Services | jordan.murray@dhs.wisconsin.gov**

SPEAKER BIO: Jordan Murray is a Harmful Algal Bloom Epidemiologist stationed at the Wisconsin Department of Health Services, Division of Public Health, where she manages the Harmful Algal Blooms Program. Her work entails prevention and control of harmful algal bloom-related illnesses through epidemiological research, case investigation, and outreach. She holds a BA in Neuroscience and a Masters in Public Health Epidemiology.

INVESTIGATING PHYTOPLANKTON COMMUNITY DYNAMICS DURING THE AUGUST 2022 HETEROSIGMA AKASHIWO BLOOM IN SAN FRANCISCO BAY, CALIFORNIA

SESSION: BLOOM DYNAMICS & DRIVERS III

ABSTRACT: San Francisco Bay, California, is a nutrient-enriched estuary with the potential to support acute harmful algal blooms (HABs). Although HAB taxa are present in historical data, high-biomass HAB events are rare, likely due to a combination of tidal mixing, light limitation from high turbidity, and benthic grazing pressure. However, in August 2022, record-high chlorophyll concentrations (200-400 µg/L) measured in San Francisco Bay were associated with a bloom of Heterosigma akashiwo that led to widespread low dissolved oxygen and fish mortality. H. akashiwo had been detected with 18S rDNA methods in 37% of phytoplankton samples since 2015 but had never formed a bloom of this magnitude. We investigated the bloom dynamics from a community perspective, using protist community composition (18S rDNA) and environmental (light, nutrients, temperature, salinity, etc.) data collected via surveys aboard the R/V Peterson and R/V Aiken 2-3 times per month from 2015-2022. Preliminary results show that there was an anomalously large diatom bloom in June, which led to a mostly small-celled, heterotrophic community in July with an abnormally low abundance of dinoflagellates. The absence of dinoflagellates, which could include predators of H. akashiwo, plus optimal environmental conditions (high light, warm temperatures, ample nutrients, reduced flushing) may have provided opportunity for H. akashiwo to proliferate in August. The dinoflagellate Gyrodinium (predator of H. akashiwo) also increased as the bloom collapsed. Study results improve our understanding of the community drivers of the August 2022 HAB event, provide an "early warning" of conditions that could precede a bloom, help managers assess the likelihood of a HAB event of this magnitude occurring again, and provide a basis for assessing whether actions can be taken to prevent large HAB events in the future.

SPEAKER: **Schuyler Nardelli, USGS | snardelli@usgs.gov**

SPEAKER BIO: https://www.usgs.gov/staff-profiles/schuyler-nardelli

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HARMFUL ALGAE MONITORING, PREDICTION, AND CONTROL - METHODOLOGIES AND OPERATOR PERSPECTIVES

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: Harmful algae blooms (HABs) pose significant operational challenges for critical facilities managers. We describe the importance of the monitor, predict, and control framework for low-power ultrasonic water quality improvement projects. We enumerate emerging parameters of interest for HABs monitoring and corresponding sensing methods. We gain perspectives from operators in diverse sectors to learn how they defined their problems, established key performance indicators, achieved measurable success, and incorporated qualitative public feedback.

SPEAKER: **Ernest Neafsey, LG Sonic US | ej.neafsey@lgsonic.com**

SPEAKER BIO: E. J. Neafsey has 20 years of experience in water quality monitoring, analytics, and consulting. He completed his PhD at Cornell University, focusing in part on assessing infrared spectroscopy and chemometrics's usefulness to subaqueous soil survey. His research at the University of Virginia examined the linkages between hydrologic connectivity, water quality, and mangrove health in Southwest Florida. At LG Sonic US, he guides continuous improvement of its predictive analytics suite, transforms customer data into management recommendations, builds stakeholder coalitions, and advocates for environmentally sound water quality stewardship.

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THE CYANOTOXIN KNOWLEDGE GAP: ADDRESSING AN EMERGING THREAT TO MAINE PUBLIC HEALTH THROUGH MONITORING AND MESSAGING

SESSION: Poster Session, Wednesday

ABSTRACT: Cyanotoxins in Maine lakes are an emerging concern as cyanobacteria outbreaks become more frequent and more widespread. Currently, cyanobacteria blooms are tracked by the Maine Department of Environmental Protection (MEDEP) and not the Maine Center for Disease Control and Prevention, since lake cyanotoxins have not reached public health-relevant levels in the state. With cyanobacterial blooms expected to increase in the face of nutrient pollution and climate change, it will become imperative that the public, beach managers, and local and state governments are aware of the risks of cyanotoxins and that public messaging is consistent. MEDEP has surveyed for cyanotoxins (mostly microcystin) in the past, and in 2023 we collected bloom samples for microcystin, anatoxin, and BMAA analysis. Only a few samples were positive for cyanotoxins, and the sample distribution was limited due to cool and wet conditions. In order to improve our understanding of cyanobacteria and cyanotoxin production in Maine, this project has three primary statewide objectives: 1) conduct more targeted sampling on lakes with known cyanobacteria issues to better understand the species/strains that are dominant, if they have the capacity to produce toxins, and whether having the capacity to produce toxins means toxins are always produced; 2) to conduct targeted sampling in areas not sampled in 2023 for a wider cyanotoxin suite testing; and 3) to develop accessible messaging around the risks of cyanotoxins to the general public.

SPEAKER: **Patricia Nease, Midcoast Conservancy | patricia@midcoastconservancy.org**

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CYANOHAB REMEDIATION OF TWO NEW HAMPSHIRE LAKES USING ALUMINUM COMPOUNDS

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL III

ABSTRACT: Nippo Lake, an 84-acre mesotrophic lake and Lake Kanasatka, a 371-acre oligotrophic lake were recently treated with aluminum compounds to reduce internal phosphorus loads. Both lakes suffered from severe cyanobacteria blooms over several years which impacted recreation for long periods during the summer and into the fall. These were the first aluminum compound treatments performed in New Hampshire in 35 years. The New Hampshire Department of Environmental Services (NHDES) served as the permitting agency and utilized a unique regulatory framework to allow the treatments to occur. At Nippo Lake, 65% of the lake was treated and at Lake Kanasatka 41% of the lake was treated. The process used to plan, execute, and track project outcomes will be detailed from the state agency perspective. The importance of these projects in lake management in New Hampshire will also be discussed especially with respect to the state's cyanobacteria plan and available funding resources.

SPEAKER: **David Neils, New Hampshire Department of Environmental Services | david.e.neils@des.nh.gov**

SPEAKER BIO: David Neils is the Chief Aquatic Biologist at the New Hampshire Department of Environmental Services (NHDES). Dave has 30+ years experience in aquatic ecology and has worked at NHDES for 23 years. He holds a Bachelor's Degree from Cornell University and a Master's Degree from Virginia Tech.

U.S. EPA APPLIED RESEARCH ON METHODS FOR HARMFUL BENTHIC CYANOBACTERIA RISK ASSESSMENT

SESSION: PLENARY

ABSTRACT: Benthic harmful cyanobacteria blooms (HCBs) pose a significant threat to domestic animals, wildlife, and humans. State, tribal, and local agencies need a greater understanding of and guidelines for addressing the risk posed by benthic HCBs. In 2023, U.S. EPA initiated a three-year Benthic HCB Applied Research project to assess different field sampling and laboratory methods for characterizing and responding to the risks posed by proliferations of benthic cyanobacteria in streams and rivers. For the first year of the study, the objective was to focus on testing wadeable reach-scale sampling techniques and conducting multiple laboratory analyses with the goal of determining which combination could characterize risk efficiently and effectively. A transect approach for assessing relative extent of HCB at the reach scale and two disturbance methods were implemented by seven different field crews at seven sites across six states (VA, OH, KS, UT, CA, and WA). Channel sizes sampled ranged from 2 to 54 m wide. The periphyton at all seven sites were producing cyanotoxin: either anatoxin-a, microcystin, and/or saxitoxin based on enzyme-linked immunosorbent assay (ELISA), and all sites were positive for toxin producing genes per quantitative polymerase chain reaction (qPCR). Experiments were conducted at each site to test the performance of the sampling methods. These results suggested a cover estimate may be needed to inform whether composite samples over the reach or whether single point sampling is sufficient to determine the toxin loads in cyanobacteria-dominated periphyton. Risk could then be characterized based on the combination of the cover estimate and the measured toxin load. In 2024, the project will use this informed approach to assess the extent of the risk posed by benthic cyanobacteria over a larger sample population of stream and river sites.

SPEAKER: **Christopher Nietch, U.S. EPA/ORD | nietch.christopher@epa.gov**

SPEAKER BIO: I am a Research Ecologist at US EPA's ORD Center for Environmental, Measurement and Modeling in Cincinnati, OH. I hold a Ph.D. in biological and marine sciences from the University of South Carolina. My research focuses on the implementation of nutrient pollution reduction programs and practices in watersheds and harmful algal bloom ecology and risk assessment. I also direct research at the US EPA's Experimental Stream Facility where I lead ecotoxicology studies focusing on stressor impacts on small streams.

CO-AUTHORS:
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BENTHIC CYANOBACTERIA STREAM MESOCOSM STUDY

SESSION: Poster Session, Wednesday

ABSTRACT: A steam mesocosm study was conducted to examine the impact of benthic cyanobacteria on macroinvertebrates, fish, and periphyton metrics. Three strains of benthic cyanobacteria, including a species of Geitlerinema (G) and Microcoleus/Phormidium (MP) isolated from an Ohio stream periphyton community and a Phormidium species from a Florida pond (FLP), were propagated to near confluence on creek gravel. The cultured gravel was transferred to stream mesocosms such that the cyanobacteria strains would dominate the relative abundance of autotrophs in the periphyton of the mesocosms. Each mesocosm consisted of a gravel bed (0.37m2) set-up to mimic stream riffle habitat. Natural river water was used to colonize the mesocosms with a native stream periphyton community before the cultured gravel with benthic cyanobacteria were transferred. Five treatments were included, three replicate mesocosms for each of the three cyanobacteria strains, a control that received no cultured gravel transfers, and a mixed treatment of both the MP and G strains (15 mesocosms total). The mesocosms were operated in a recirculating condition but were renewed with fresh river water daily to replace evaporative losses. Transfers of the gravel substrate containing the benthic cyanobacteria occurred three times each week over 50 days. On day 22, native macroinvertebrates and grazing fish (central stoneroller, C. anomalum) were added to the mesocosm's gravel section. Also, adult fathead minnows (P. promelas) were included in a caged section downstream of the mesocosm gravel sections, and an inline ex-situ format was used to expose a cultured mayfly species (N. triangulifer). While none of the cultured isolate were producing known toxins, anatoxin-a was detected in both the G and MP+G mesocosms. Of the effects assessed, noteworthy findings included adult fish appeared stressed by food availability across all treatments, and N. triangulifer showed significant but differential sensitivity to periphyton dominated by the different strains of cyanobacteria.

SPEAKER: **Christopher Nietch, U.S. EPA/ORD | nietch.christopher@epa.gov**

SPEAKER BIO: I am a Research Ecologist at US EPA's ORD Center for Environmental, Measurement and Modeling in Cincinnati, OH. I hold a Ph.D. in biological and marine sciences from the University of South Carolina. My research focuses on the implementation of nutrient pollution reduction programs and practices in watersheds and harmful algal bloom ecology and risk assessment. I also direct research at the US EPA's Experimental Stream Facility where I lead ecotoxicology studies focusing on stressor impacts on small streams.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ASSESSING CYANOTOXIN VULNERABILITY IN VERMONT PUBLIC DRINKING WATER SYSTEMS

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Cyanotoxins produced by harmful cyanobacterial blooms (HCBs) can enter drinking water supplies and pose a risk to public health. Since 2015, the state of Vermont has provided voluntary, no-cost cyanotoxin testing for public drinking water systems on a weekly basis during the bloom season. To date, there have been no detections of cyanotoxins in treated drinking water and only one instance of an extended microcystin detection in raw water. However, as average temperatures rise in Lake Champlain and other surface waters across the state, the risk of cyanotoxin contamination in drinking water is expected to increase. To better inform future programmatic and/or regulatory decisions, this study evaluates the relative vulnerability of Vermont's public surface water systems to cyanotoxin contamination. Vulnerability is characterized by multiple qualitative and quantitative parameters along three axes: 1) source water bloom risk, 2) intake and water treatment barriers, and 3) response preparedness. This analysis integrates data from public water systems, state agencies, and non-profit partners to evaluate risk across water systems and identify opportunities for increased system resilience to future cyanotoxin events. The assessment is intended to contribute to the development of a more targeted, efficient, and public health protective cyanotoxin management program.

SPEAKER: **Chase Novello, Vermont Department of Environmental Conservation (Drinking Water and Groundwater Protection Division) | chase.novello@vermont.gov**

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TARGETED TOXIN ANALYSIS IN RECREATIONAL WATER SOURCES... THE MORE YOU LOOK, THE MORE YOU MAY FIND

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: Cyanotoxin analysis of various water sources (recreational and intake for drinking) is critical from a safety standpoint. Targeted LC/MS/MS analysis is a particularly useful technique to monitor for algal toxins. These analyses are generally guided by commercial standards, which are available for a suite of common toxins. However, hundreds of toxin variants exist and most, including toxins that have been seen regularly in blooms, do not have established, standards or reference material. Backward (precursor) monitoring can provide a useful screening tool for the detection of any unusual toxins, especially ones in which other detection techniques, ELISA for example, may not detect their presence. This talk will discuss specific examples, including results from of a benthic bloom in the summer of 2023 in Utah that resulted in several dog deaths. Many "uncommon" compounds were detected in samples collected from this bloom, including homoanatoxin and possible dihydroanatoxin. Results from other interesting blooms throughout the US will also be discussed. Backward monitoring can expand the understanding of toxin production in harmful algal blooms and inform and guide future monitoring focus.

SPEAKER: **Stuart Oehrle, Northern Kentucky University | oehrle@nku.edu**

SPEAKER BIO: Stuart Oehrle is a senior field chemist with 30 years of tenure at Waters. In addition, he is an adjunct instructor for 25+ years at Northern Kentucky University, teaching such classes as freshman chemistry lab and instrumental analysis lab. Stuart obtained his chemistry degree from Northern Kentucky University and did his graduate work at the University of Alabama-Huntsville and University of Cincinnati. Stuart's primary area of focus is in the development and application of LC and LC-MS/MS for both preparative and analytical work. He has been involved in a wide variety of research projects including extensive work in the identification and analysis of toxins from cyanobacteria using LC and LC-MS/MS as well as the development of the Porapak RDX solid phase extraction cartridge for groundwater analysis of explosives, and the use of LC-MS/MS for the analysis of chemical warfare agents to name a few. He has published or presented over 70 papers during his tenure as well as been awarded several patents

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

CYANOTOXIN MIXTURES AND PHYTOPLANKTON COMMUNITY INTERACTIONS IN RIVERS, LAKES, AND RESERVOIRS ACROSS THE UPPER MIDWEST

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Complex relationships and interactions exist between cyanobacteria communities that produce toxins, which is an often understudied aspect of harmful algal bloom (HAB) dynamics. There may be numerous symbiotic or antagonistic relations between different cyanobacteria as they share or compete for resources, such as nutrients or sunlight. During the summers of 2019 and 2020, the U.S. Geological Survey and collaborators at the National Park Service, NEW Water, and North Dakota State University collected phytoplankton community and cyanotoxin concentration data at lakes, rivers, and impoundments across Wisconsin, Minnesota, and North Dakota. Cyanotoxin samples were analyzed for up to 32 toxins, including many lesser studied neurotoxins and hepatotoxins. Non-metric multidimensional scaling was used to identify relations between or among different cyanobacterial species and the cyanotoxins produced. This study highlights the interaction between cyanobacteria and multiple cyanotoxins across the region, as well as presents methods for discovering additional patterns in cyanobacteria communities in other water bodies. This information may lead to enhanced understanding of how these interactions result in an algal bloom producing toxins.

SPEAKER: **Hayley Olds, U.S. Geological Survey | htolds@usgs.gov**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

LAKE OKEECHOBEE CYANOHAB FORECAST MODEL AND EVALUATION

SESSION: PREDICTIVE MODELING - FRESHWATER

ABSTRACT: Lake Okeechobee water levels are managed by the US Army Corps of Engineers (USACE) to avoid flood risks, and to support water supplies and other ecosystem services in Central and South Florida. In summer, the shallow and nutrient-rich lake experiences cyanobacterial harmful algal blooms (cyanoHABs) that pose hazards to the lake and surrounding waters. Water releases by USACE need to be timed around blooms to avoid sending excess cyanobacteria into the Caloosahatchee and St. Lucie estuaries. To support this effort, the NOAA National Centers for Coastal Ocean Science HAB-Forecasting Branch (HAB-F) has provided guidance on bloom location since 2017 using a satellite monitoring system. However, to appropriately plan for and implement management activities, the USACE is in need of short-term forecasts for future bloom location and intensity.
We developed forecast capabilities for an existing numerical model of Lake Okeechobee (Lake Okeechobee Environment Model, or LOEM, originally developed by South Florida Water Management District). This bloom forecast provides information on the location, movement, and density of cyanoHABs in Lake Okeechobee three and a half days out. We adapted tools from numerical weather prediction to evaluate the performance of our bloom forecast. We then applied these tools to actual forecasts from years with varied bloom conditions, allowing us to evaluate adjustments to our forecast model.
The resulting performance metrics may help in assessing the importance of physical transport as a driver of overall HAB intensity in Lake Okeechobee. They also highlight the sensitivity of bloom forecasting to environmental drivers, quantify the performance of the LOEM forecast model under different conditions, and provide a potential avenue to evaluate similar numerical forecasts within the HAB-F branch, such as the HABtracker used to predict bloom movement in Lake Erie.

SPEAKER: **Caroline Owens, CSS Inc. | caroline.owens@noaa.gov**

SPEAKER BIO: Caroline Owens is an ecosystem ecologist and data scientist. She currently works with the NCCOS HAB-Forecasting Branch to develop and maintain operational bloom forecasts. https://www.linkedin.com/in/caroline-owens-a214b098/

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

PST VS. BIOLUMINESCENCE: SKEWED EXPRESSION OF MULTIPLE DEFENSE STRATEGIES

AGAINST GRAZERS IN ALEXANDRIUM CATENELLA

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The dinoflagellate Alexandrium catenella displays multiple chemical defense traits such as PST, bioluminescence, bioactive extracellular compounds (BECs), and ROS production. If defense is costly, the expression of multiple defense traits may be compromised. Most anti-grazing defense studies, however, are designed to measure a single defensive trait at a time; potentially biasing costs/benefits considerations of such trait. Here, we quantified the change of grazer-induced PST and bioluminescence simultaneously using relative gene expression (RGE) of sxtA4 (initiating the steps to STX synthesis) and lbp (luciferin-binding protein). Treatments where the cells were exposed to copepod grazers significantly increased in RGE of sxtA4 relative to the control (without grazers), whereas RGE of lbp decreased with grazing pressure. This indicates that defense in A. catenella in response to grazers may upregulate expression of one trait (PST production) at the expense of another (bioluminescence) because of the high direct fitness cost of grazer-induced PST production. Documenting and quantifying skewed expressions of defense traits is necessary for mechanistic and holistic understanding of prey defense strategies against grazers.

SPEAKER: **Gihong Park, University of Connecticut | gihong.park@uconn.edu**

SPEAKER BIO: I am a marine plankton ecologist. I have been studying relationships of predator-toxic prey, Copepod-Alexandrium species, at the Dr. Dam lab.

CO-AUTHORS:
Hans G. Dam

A "BENTHIC BLOOM" OF GAMBIERDISCUS: POTENTIAL CAUSES AND POSSIBLE CONSEQUENCES.

SESSION: PLENARY

ABSTRACT: Fish exhibiting erratic behavior (e.g., spinning) have been observed in the lower Florida Keys since October 2023. An examination of water samples did not reveal the presence of any likely stressors (i.e., red tide, low oxygen, pollutants) and red tide toxins (brevetoxins) were not detected in fish tissue samples. The toxigenic benthic dinoflagellate, Gambierdiscus, was reported at concentrations of 1,000 cells L-1, far above baseline levels measured by the authors over the previous ten years sampling in the Florida Keys (averaging 39 cells L-1). As more than 50 taxa of fish have now been affected, the lack of other potential stressors coupled with the potentially elevated levels of Gambierdiscus led to a more extensive survey in the lower Keys to determine if a "benthic bloom" of Gambierdiscus was occurring in the region. Over 150 seagrass (Thalassia testudinum), macroalgae (Dictyota, Halimeda, and Laurencia), and water samples were collected and examined to quantify Gambierdiscus cell densities in addition to other, co-occurring benthic dinoflagellates. A comparison of samples collected in spring 2024 with baseline samples (2011 – 2023) collected elsewhere in the Keys indicated that Gambierdiscus cell densities were up to 7 times higher on average at sites exhibiting erratic behavior versus baseline levels. A snapshot of Gambierdiscus distributions across the Florida Keys in February 2024 indicated that Gambierdiscus cell densities were significantly greater on Thalassia blades in the lower Keys versus farther up the Keys. Working in tandem with toxin analyses of algae, water, and fish samples, the leading hypothesis is that the erratic fish behavior is due (in part) to exposure to toxins produced by elevated densities of Gambierdiscus, indicating that a threshold may have been breached, suggesting that a "benthic bloom" of Gambierdiscus was achieved, in which acute exposure to the produced toxins elicited the deleterious effects exhibited in the fish.

SPEAKER: **Michael Parsons, The Water School, Florida Gulf Coast University | mparsons@fgcu.edu**

SPEAKER BIO: Michael Parsons is a Professor of Marine Science in the Water School at Florida Gulf Coast University and Director of FGCU's Vester Field Station. In addition to his teaching duties focused on marine ecology, Parsons has built a successful research career, receiving over $20 million of extramural funding to study harmful algal blooms and ecosystem health. His work has been cited over 4,000 times in the scientific literature, demonstrating the quality of his work. In addition to working with other researchers around the state to find solutions to our algal bloom problems, he was appointed to the Blue-Green Algae Task Force by Florida Governor Ron DeSantis in 2019 to work to reduce the impacts of harmful algae in our region.

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Adam Catasus (Florida Gulf Coast University)

NUTRIENT UPTAKE AND ENCYSTMENT BY THE TOXIC DINOFLAGELLATE ALEXANDRIUM CATENELLA IN NAUSET MARSH ESTUARY

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Blooms of the toxic dinoflagellate Alexandrium catenella have been recorded in the Nauset Marsh (NM) since the 1970's. Through deployments of an Imaging FlowCytobot (IFCB), it's been shown that bloom declines are driven by sexual induction and encystment. A longstanding hypothesis has been that these transitions are triggered by nutrient limitation, but dissolved nutrient concentrations remain high through declines. Cell division rates also increase leading up to sexual transitions and are much greater than is observed in culture. In this study, nutrient dynamics and carbon, nitrogen, and phosphorus cell quotas were measured during bloom development and decline of a bloom to determine whether and how nutrient uptake may change through sexual transitions in situ. An IFCB provided real-time data about Alexandrium bloom progression, and images were used to identify the phases when vegetative cells, gametes, or planozygotes were dominant. The depth of migrating thin layers was provided by profiling CTD. By targeting these thin layers for particulate sampling, samples could be enriched so that they were greater than 90% Alexandrium by biovolume. Similar measurements were also made from batch cultures of an A. catenella strain isolated from NM for comparison to in situ measurements. Our findings indicate that nutrient limitation does not play a role in the sexual induction of NM Alexandrium blooms. Instead, other density-dependent, cell signaling, or environmental factors are the proximate cause of these transitions. Through this study, we have also developed and optimized sampling approaches for further detailed study of Alexandrium cell physiology in situ.

SPEAKER: **Mrunmayee Pathare, WHOI | mpathare@whoi.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

APPLYING PARADIGMS TO PARADOXES: PHYTOPLANKTON COMMUNITY ANALYSIS TO IMPROVE PREDICTION OF CYANOBACTERIAL DYNAMICS

SESSION: PREDICTIVE MODELING - FRESHWATER

ABSTRACT: Predicting the growth and toxicity of cyanobacterial harmful algal blooms (cHABs) is a pressing national need. However, our predictive ability may be hampered by the constraints of available data and technology, especially with respect to routine monitoring data. In a recent paper by Bramburger et al. 2022 in Freshwater Biology, titled Paradox versus paradigm: a disconnect between understanding and management of freshwater cyanobacterial harmful algae blooms, the authors posit that traditional morphospecies identification is a constraint on predicting cHABs due to the high degree of cryptic functional specialization, taxonomic ambiguity, incongruence between genomic capability and phylogeny, and genomic flexibility among cyanobacteria. These authors recommend that cHAB management consider competition between generalist cyanobacteria and more specialized eukaryotes, as well as the response dynamics of co-occuring eukaryotes, for insights into cHABs dynamics that could more readily inform management. Here we use water quality and phytoplankton composition data from the USEPA National Aquatic Resource Survey, National Lakes Assessment to test the ideas recommended in this paper. Specifically, we examined the dynamics of eukaryotic algae relative to 1) cyanobacterial taxa, 2) known toxin forming taxa and 3) toxin concentrations. We identified eukaryotic taxa strongly associated with cyanobacterial response and extracted the traits for those eukaryotes to explore patterns that emerged which could provide insights into both temperature and nutrient gradients associated with cyanobacteria dominance and toxin production. We share the results of this analysis in this talk, evaluate the hypotheses generated by the Bramburger et al. 2022 paper, and offer recommendations for next steps to improve the application of this concept to future analysis and management.

SPEAKER: **Michael Paul, US EPA | paul.michael@epa.gov**

SPEAKER BIO: Dr. Michael J. Paul is an aquatic ecologist with 30 years of experience in the research and management of aquatic ecosystems. His work has focused on the ecology of freshwater ecosystems, including 20 years' experience in water quality criteria development across the nation. He has provided technical support in assessment and criteria development for more than 42 states, tribes, and federal government agencies and has led instructional workshops on assessment, analysis, and criteria development across the nation, supported development of targets for and predictive models of harmful algal blooms and cyanotoxins, and coauthored EPA guidance on analytical methods for bioassessment and nutrient criteria development. Mike has authored more than 40 peer reviewed scientific papers, including several recent reviews of climate and wildfire impacts on aquatic ecosystems. He received his B.A. in Biology from Colgate University, and M.Sc. in Zoology and Ph.D. in Ecology both from the University of Georgia. Mike is now the USEPA National HAB Program Lead.

CO-AUTHORS:
Brenna Friday

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE EFFECT OF TEMPERATURE AND SALINITY ON MARGALEFIDIUM POLYKRIKOIDES GROUP III VA, USA STRAIN GROWTH

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: M.polykrikoides is a cosmopolitan dinoflagellate that blooms in coastal waters worldwide. Despite genomic evidence that it is in Group III and so closely related to isolates from tropical regions and New England, USA, M. polykrikoides group III VA, isolated from the lower Chesapeake Bay, bloom at warmer temperatures and lower salinities than in coastal ecosystems occupied by its closest relatives. In this study, the effect of temperature and salinity on the growth rate and total cell yield of an M. polykrikoides VA culture isolate were studied. Growth rates were calculated from cultures in exponential phase growth to determine growth kinetics with respect to temperature and salinity. M. polykrikoides group III VA strain grew at temperatures and salinities ranging from 18-32˚C and 15-30 respectively. M. polykrikoides group III VA strain grew optimally at warmer temperatures and lower salinities than other M. polykrikoides strains from related groups, but did not grow at 34˚C, 32˚C (when exposed to 15 salinity), 16˚C, and 10 salinity. Low salinity and excessively warm temperature interacted and inhibited M. polykrikoides group III VA strain growth. Temperature and salinity likely interact in estuarine waters to inhibit or promote M. polykrikoides bloom initiation and development.

SPEAKER: **Eduardo Perez Vega, Old Dominion University Ocean and Earth Sciences Department | epere002@odu.edu**

SPEAKER BIO: My name is Eduardo Pérez Vega and I am a PhD candidate from Old Dominion University Ocean and Earth Sciences department. I have a master's degree in Ocean and Earth Sciences from Old Dominion University. My research interests are harmful algal blooms, dinoflagellate ecology, dinoflagellate ecophysiology, and dinoflagellate cysts.

CO-AUTHORS:
Margaret R. Mulholland, Katherine C. Crider, Kimberly E. Powell, Dreux Chappell, and Alexander Bochdansky

ISOLATION AND CHARACTERIZATION OF CYANOPHAGES FROM FRESHWATER ENVIRONMENTAL SAMPLES FOR MITIGATION OF HARMFUL CYANOBACTERIAL BLOOMS

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: Freshwater harmful cyanobacteria blooms (HCBs) are caused by toxin-producing cyanobacteria. The interplay of human activities, eutrophication, and climate change has led to an increase in HCB frequency, scale, and severity. Current efforts to prevent and mitigate HCBs tend to be expensive and time-consuming, and often cause unintended side effects on non-target organisms. We propose the use of cyanophage, an abundant yet underutilized natural resource, as the biocontrol agent to mitigate HCBs in a target-specific manner. Cyanophages tend to be very host-specific, some infecting only a single species of cyanobacteria, which would limit the impact on non-target organisms. To develop and understand the workflow for isolating, purifying, enriching, and characterizing environmental cyanophages we tested the protocols on previously identified cyanophages Ma-LMM01, CL131, and B16. Next, these protocols were applied to freshwater samples by filtering and enrichment, plaque assay, liquid infection assay, DNA isolation and library preparation, metagenomic shotgun sequencing, bioinformatic analysis, and SEM (Scanning Electron Microscopy) imaging. Our metagenomic sequencing data suggested the presence of both characterized and uncharacterized cyanophages. Further research will focus on morphologically and genetically characterizing the isolated cyanophages and identifying and validating their host cyanobacteria in preparation for genetically engineering the cyanophages to bypass lysogeny and/or expand their host range to the genus level of host cyanobacteria for field scale application in HCB mitigation.

SPEAKER: **Erin Peters, USACE ERDC | erin.e.peters@usace.army.mil**

SPEAKER BIO: Ms. Erin Peters is a Research Biologist with the Environmental Laboratory of U.S. Army Engineer Research and Development Center in Vicksburg, Mississippi. She earned a B.S. in Biology at King University in 2023 and was a recipient of the Department of Defense (DoD) Science, Mathematics, and Research for Transformation (SMART) Scholarship with the 2022-2023 cohort.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

A DINOFLAGELLATE EXPLOITS TOXINS TO ACCUMULATE GUANINE

SESSION: ECOPHYSIOLOGY & BIOGEOCHEMISTRY

ABSTRACT: A large group of polyhydroxy polyene compounds that we call sterolysins have been isolated from dinoflagellates (Amphidinium and Karlodinium, currently) that have been implicated in numerous fish kills worldwide. The sterolysin (karlotoxin) from Karlodinium has been shown to be involved in prey capture when it transitions to mixotrophic growth in the presence of cryptophytes. The transition to mixotrophy permits bloom formation. The mode of toxicity for sterolysins has been shown to be membrane pore formation when interacting with desmethyl sterols in the membranes of the prey. The dinoflagellates producing sterolysins do not have desmethyl sterols and thus avoid self-intoxication.

Amphidinium carterae which produces the sterolysin amphidinol has been shown to accumulate guanine from the media when starved for nitrogen. Using surface plasma resonance with bound sterolysins to SPR chip, we find that nitrogen containing compounds (guanine, xanthine, and cytosine) would bind to the sterolysins while the nitrogen-containing compound, caffeine did not bind.

Using confocal Raman microscopy we have been able locate amphidinol in the cell as discrete droplets from lipid vesicles and near guanine crystals. Using scanning electron microscopy, we find the amphidinol vesciles are in close proximity to the guanine crystallization sites. We would like to propose another evolutionary reason for making sterolysins, purine binding prior to crystal formation in dinoflagellates.

SPEAKER: **Allen Place, UMCES@IMET | place@umces.edu**

SPEAKER BIO: Allen R. Place is Professor and Associate Director of Research at the Institute of Marine and Environmental Technology, UMCES. He organized and hosted the 9th US Symposium on Harmful Agae in 2017, in Baltimore, MD. He has spent the last twenty years researching the microscopic algal cell at Institute of Marine and Environmental Technology (formerly COMB) in Baltimore. Every year since then, blooms of Karlodinium have been implicated in fish kills along the Atlantic coast as well as worldwide. The nature of fish kills can be traced to production of a unique polyketide toxin similar in structure to amphidinol. The toxin is made to assist in prey capture (i.e. cryptophytes) through formation of a nonspecific pore upon complexation with prey's sterol brassicasterol.

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HYPERSPECTRAL DISCRIMINATION OF CYANOBACTERIA: MOVING TOWARDS RELEVANT FIELD SCALES

SESSION: REMOTE SENSING

ABSTRACT: Traditional multispectral sensors measuring reflected light at only a handful of broad spectral bands are effective for monitoring HABs by measuring biomass proxies, but are unable to distinguish HAB community composition. Emerging technologies like hyperspectral imagers (HSIs) onboard suitable platforms offer the potential to monitor cyanobacteria blooms at higher spectral, spatial, and temporal resolution, enabling the capturing of subtle differences in the reflectance of phytoplankton types at different taxonomic levels. Thus, HSIs may offer increased capabilities to monitor phytoplankton community composition. As HSIs transition into the field on various platforms, from unmanned aircraft systems (UAS) to satellites, it's important to understand spectral features at various taxonomic levels that can be used to differentiate between phytoplankton groups. This study was conducted in two parts. First, a hyperspectral reference library of relevant cyanobacteria was compiled, having over 17 unique strains imaged across several cell densities. Second, a UAS-based HSI survey was conducted in Milford Lake, KS, USA, to demonstrate the capability of HSIs to discriminate cyanobacteria functional groups at relevant field scales. A novel spectral classifier pipeline was developed and validated using this reference library to differentiate cyanobacteria with remarkable accuracy. Collectively, this instills confidence in the method's effectiveness and transferability of the spectral library for routine monitoring. This study will allow the community to take advantage of the technology while also understanding its limitations, thereby increasing the likelihood of successful adoption into monitoring programs. HSIs have the potential to quickly assess the spatial extent of cyanoHABs and associated risk, allowing resource managers to make timely informed decisions to protect their communities and resources.

SPEAKER: **Kaytee Pokrzywinski, NOAA / NCCOS | kaytee.pokrzywinski@noaa.gov**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ATMOSPHERIC OXIDATION OF MICROCYSTIN REVEALED DURING AMBIENT HIGH VOLUME AEROSOL SAMPLING

SESSION: Poster Session, Wednesday

ABSTRACT: Historically, health concerns surrounding cyanotoxins including microcystin are based in waterborne exposure, but recent work has investigated their aerosolization as a source of potential respiratory irritation. Despite dedicated studies, the characteristics of microcystin in aerosol are still largely unclear. This is partially because meeting limits of detection when studying airborne cyanotoxins is a challenge; this work evaluated high-volume (>1000 L min-1) impaction onto quartz fiber as one possible solution/monitoring approach. In summers 2022 and 2023, aerosol was collected using high-volume samplers (Tisch Environmental) during cyanobacterial blooms occurring in the San Francisco Bay Delta, CA, USA. However, following several failures to detect and quantify cyanotoxins (microcystins, anatoxins, and cylindrospermopsins) in aerosol, our focus shifted to better understand how microcystin might be chemically transformed (i.e., oxidized, degraded) during the sampling process and in the atmosphere. Therefore, we 1) examined the degradation of microcystin-leucine alanine (MC-LA) during high-volume sampling, 2) simulated the suspected atmospheric oxidation chemistry in laboratory-based experiments, and 3) chemically-characterized the aerosol using targeted liquid chromatography-mass spectrometry. Experimental additions of MC-LA standard were not observed on aerosol filters after 72 hour sampling periods in field, nor following 24 hour hydroxyl radical/ozone exposures in the lab, suggesting that oxidative processes can effectively diminish airborne cyanotoxins during high-volume sampling. Findings suggest that high-volume sampling approaches are ultimately not suitable to monitor aerosolized cyanotoxins, especially when samples are integrated over time periods exceeding 24 hours. Accordingly, we recommend that medium-flow sampling instruments supplied with inline carbon- and ozone-strip denuders (to remove atmospheric oxidants) are utilized to monitor cyanotoxins in aerosol. Future work should also aim to characterize the terminal atmospheric oxidation products of microcystin and other cyanotoxins because these compounds may be relevant for inhalation toxicology.

SPEAKER: **Kimberly Popendorf, University of Miami | kpopendorf@earth.miami.edu**

SPEAKER BIO: I am an Associate Professor at RSMAES at the University of Miami studying marine microbial biogeochemistry and harmful algal blooms, focusing on the rates of microbial chemical fluxes and the intersection of HABs and human health particularly through aerosolization of HAB toxins.

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PARTICIPANT RECRUITMENT AND ENGAGEMENT IN THE DISPEL TO HABS STUDY: A FLORIDA CYANOBACTERIAL HAB HEALTH IMPACTS STUDY

SESSION: Poster Session, Tuesday

ABSTRACT: Harmful algal blooms (HABs) are increasingly occurring across the U.S., with new research indicating exposure to some HABs may lead to serious lifelong health issues. Cyanobacterial HABs are prevalent in freshwater (lakes, ponds, rivers, and streams) and produce a range of toxins including. While microcystin has been identified as a hepatotoxin, causing liver damage, there are still many uncertainties about the long-term human health impacts of exposure to cyanobacteria toxins including microcystin. In 2019, the Diversity and Innovation in Screening and Prevention of Exposure over the Long-term (DISPEL) to HABs cohort study was launched with the primary goal of recruiting Florida workers, residents and visitors to examine the short- and long-term health effects of exposure to cyanobacterial HABs. A key feature of this epidemiologic cohort is its community-engaged research (CEnR) approach that fosters collaboration between the cohort's scientists and Florida communities affected by cyanoHABs. In this presentation, the strengths, weaknesses and lessons learned of the CEnR approach in conducting blue-green algae research with the community are characterized, and our participant recruitment process is described. Engagement and participation of community members in data collection, monitoring, and dissemination of findings greatly supports the cohort scientists by leveraging local knowledge and observations that may otherwise be overlooked. This participatory method by the community within the cohort enhances the accuracy and timeliness of HAB detection and response, promotes environmental stewardship, and empowers communities with the tools and information needed to mitigate and adapt to the effects of cyanoHAB toxins. To date, 135 cohort participants have been actively self-collecting biological and environmental samples that inform how acute and chronic exposure to cyanoHAB toxins are associated with human health effects. Ultimately, findings from the DISPEL to HABs cohort study are strengthened by CEnR that bridges the gap between scientific investigation and real-world application.

SPEAKER: **Kimberly Popendorf, University of Miami Rosenstiel School of Marine, Atmospheric & Earth Science | kpopendorf@earth.miami.edu**

SPEAKER BIO: I am an Associate Professor at RSMAES at the University of Miami studying marine microbial biogeochemistry and harmful algal blooms, focusing on the rates of microbial chemical fluxes and the intersection of HABs and human health particularly through aerosolization of HAB toxins.

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SHELLFISH AS SENTINEL ORGANISMS FOR MONITORING MICROCYSTINS ACROSS THE FRESHWATER TO MARINE CONTINUUM

SESSION: Shellfish

ABSTRACT: Harmful cyanobacteria blooms are a growing threat in estuarine waters as upstream blooms are exported into coastal environments. The cyanotoxin microcystin (MC) can persist and accumulate within the food web. Filter-feeding invertebrates may biomagnify toxins up to 100X ambient concentrations. As such, bivalves can be used as an environmentally relevant and highly sensitive sentinel for MC monitoring. To date there has been little research on cyanotoxin bioaccumulation in estuaries. The Sacramento-San Joaquin Delta (Delta) aquatic food web has undergone a profound change in response to widespread colonization of aquatic invasive species such as Asian clams (Corbicula fluminea) in the freshwater portion of the Delta. These clams are prolific—blanketing areas of the Delta at densities up to 1000 clams/m2, and are directly implicated in the pelagic organism decline of threatened and endangered fishes. We studied MCs accumulation in Delta Asian clams and signal crayfish (Pacifastacus leniusculus) over a two-year period. We found MCs accumulate in Asian clams across all months and at all study sites, with seasonal maxima occurring during the summer. Although MC concentrations rarely exceeded public health advisory levels, the persistence of MCs year-round still poses a chronic risk to consumers. We found crayfish at times also accumulated high concentrations of MCs. ELISA and LC-MS analytical methods were used to measure free and protein-bound MCs in clam and crayfish tissues. We expanded our study to also measure MCs further along freshwater to marine continuum, by collecting crabs (Rhithropanopeus harrisii and Metacarcinus magister) and shrimp (Crangon franciscorum) in more saline waters. Preliminary data shows these organisms also accumulate MCs that likely originated in upstream Delta waters. Our results highlight the utility of shellfish as sentinel organisms for monitoring in estuarine areas.

SPEAKER: **Ellen Preece, California Department of Water Resources | ellen.preece@water.ca.gov**

SPEAKER BIO: Ellen received her B.S. from University of New Hampshire and M.S. and Ph.D from Washington State University. She has worked on cyanobacteria and cyanotoxins in freshwater and estuarine ecosystems for over 15 years. Much of Ellen's research has focused on the connection between freshwater and marine ecosystems to better understand cyanobacteria dynamics across the freshwater to marine continuum.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ENVIRONMENTAL DRIVERS OF CYANOTOXIN ACCUMULATION IN LOUISIANA ESTUARIES AND OYSTERS

SESSION: SHELLFISH

ABSTRACT: The food supply for filter feeders is shifting in Louisiana estuaries, with toxigenic cyanobacteria more likely to appear with drainage from the Mississippi-Atchafalaya River Basin (MARB). The large volume of enriched freshwater delivered to Louisiana estuaries via the MARB can physically alter receiving waters by lowering salinities and increasing nutrients which may lead to the advective transport of upstream cyanobacteria and recruitment of cyanobacteria seedstock in coastal ecosystems. Previous studies in Louisiana estuaries directly impacted by river flood control structures found year-round presence of cyanobacteria and microcystins (MCs), a suite of hepatotoxic cyanotoxins. MCs have also been detected in Louisiana shellfish which may pose a health risk to consumers. Therefore, it is important to understand environmental drivers of toxigenic cyanobacteria into estuaries where filter-feeding shellfish co-exist with these species. In this study, we monitored water quality from October 2022 to June 2024 to identify drivers of microcystins in two distinct oyster grow-out sites in estuaries not directly influenced by river control structures – mesohaline LUMCON (LU) and polyhaline Grand Isle (GI). Preliminary results indicate differences in river influence between sites with decreased salinity and increased PO_4, NH_4, and Si observed at LU. Extra- and intracellular MC were detected at both sites with similar intracellular MC between sites but higher extracellular MC concentrations at GI than LU ($p < 0.01$) suggesting that toxigenic cyanobacteria may be experiencing cell leakage and/or lysis due to increased salinities and releasing microcystin into the environment. Also discussed are the relationships between water column MCs and those measured in solid phase adsorption toxin tracking (SPATT) resin and oyster tissue, as well as pigment-based characterizations of community structure.

SPEAKER: **Jennifer Raabe, University of Louisiana at Lafayette | jennifer.raabe@louisiana.edu**

SPEAKER BIO: Jen Raabe (she/her) received her BSc in Biology with an emphasis in Environmental Biology in 2009 from the University of Southern Mississippi. In 2018 she received her MSc from the University of North Florida after studying the vertical distribution of meroplankton and bivalve settlement in a shallow estuary in northeast Florida under the guidance of Matthew Gilg. As a Research Associate at the University of Louisiana at Lafayette she served as the technical lead on the northern Gulf of Mexico nutrient sensor project (NOAA) led by Beth Stauffer (UL Lafayette). In 2021 she joined the UL Lafayette Department of Biology as a PhD student, remaining in the Stauffer Lab, where she is currently studying environmental drivers of cyanobacteria and cyanotoxins and their effects on benthic filter feeders like the Eastern oyster. You can learn more about her previous and current work here: https://www.researchgate.net/profile/Jennifer_Raabe2

CO-AUTHORS:
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EFFECTS OF NUTRIENT MANIPULATIONS ON LAKE ERIE MICROBIAL COMMUNITY COMPOSITION AND CYANOBACTERIAL TOXIGENICITY

SESSION: BLOOM DYNAMICS & DRIVERS II

ABSTRACT: Freshwater cyanobacterial harmful algal blooms (cHABs) are a major threat in the western basin of Lake Erie due to their associated risks to humans and wildlife through toxin contamination of recreational and drinking waters. Anthropogenic nutrient (N & P) pollution is the primary culprit in facilitating cHAB blooms, warranting recommendations for a 40% reduction in nutrient loading into Lake Erie by 2025. Positive correlations between lakewater nutrient concentrations and cyanotoxin production have been documented, justifying further research on the efficacy of the suggested 40% reduction in Lake Erie nutrient loading in decreasing cyanotoxin production. Using a microcosm setup to manipulate nutrient levels in Lake Erie water samples over 3-day incubation periods in June and July 2022/23, we produced water samples representative of Lake Erie with various dilution rates of N and/or P. DNA extracted from vacuum-filtered water samples was used for 16S rDNA microbial community sequencing and quantitative PCR (qPCR) for detecting and quantifying gene copy numbers of cyanobacteria-specific 16S rDNA, and gene targets responsible for the production of microcystins (mcyE), saxitoxins (sxtA), and cylindrospermopsins (cyrA). We present on our community sequencing and qPCR results to elucidate how various nutrient dilution scenarios may affect Lake Erie microbial community composition and cyanobacterial toxigenicity.

SPEAKER: **Riley Ralph, Bowling Green State University | rralph@bgsu.edu**

SPEAKER BIO: Riley Ralph is a Master's student at Bowling Green State University in Bowling Green, OH. Riley's research interests include HABs, aquatic prokaryotic communities, and fisheries within the Laurentian Great Lakes. He has worked as a technician, monitoring effects of constructed reefs on Lake Erie coregonine and walleye spawning, as well as electrofishing for invasive grass carp in Lake Erie tributaries. Riley is currently studying the effects of nutrient manipulations on Lake Erie prokaryotic community structure and cyanobacterial toxigenicity.

CO-AUTHORS:
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CONTROLS ON ALEXANDRIUM CATENELLA VARIABILITY IN THE GULF OF MAINE FROM A 25-YEAR HINDCAST

SESSION: PREDICTIVE MODELING - MARINE

ABSTRACT: The Gulf of Maine (GOM) is a region with recurrent harmful algal blooms of the dinoflagellate Alexandrium catenella that cause closures of shellfish beds in coastal and offshore waters. To quantitatively investigate the sources of variability in bloom distribution and intensity, we coupled a dynamically downscaled climate model with a regional model of circulation and A. catenella dynamics. A. catenella cell concentrations from the 3-d model are converted to toxicity in terms of saxitoxin equivalents (STX) based on a submodel with first-order uptake and depuration kinetics calibrated to observed shellfish toxicity. Simulations run for a recent hindcast period (1994-2018) are used to compare modeled STX at the coast with toxicity observations from state shellfish monitoring stations. We find that the model provides skill at seasonal and interannual time scales, including the distribution of toxicity along the coastline. Analysis of the model shows strong spatial gradients in bloom timing that depend primarily on the seasonal climatology of nutrient availability. Interannual variability in A. catenella cell concentrations in the Western GOM correlates with the cumulative sea surface temperature (SST) anomaly, which affects growth rates, and the SST anomaly during the bloom period varies primarily with the downwelling solar radiation. However, cell concentrations along the coast of the Western GOM depend more on the interannual variability in the winds and freshwater inputs than on the temperature anomaly. The years with the most extensive shellfish toxicity, as found in both the observations and the model results, have strong downwelling winds and high river discharge that cause increased cell concentrations along the coast relative to waters offshore. Interestingly, interannual variability in the cyst abundance prior to blooms does not significantly affect bloom intensity or extent relative to forcing with the climatological cyst distribution, in contrast to observations over shorter periods.

SPEAKER: **David Ralston, Woods Hole Oceanographic Institution | dralston@whoi.edu**

SPEAKER BIO: Senior Scientist in Applied Ocean Physics and Engineering at WHOI

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

UNLOCKING THE POTENTIAL FOR OZONE NANOBUBBLE TECHNOLOGY TO CONTROL HARMFUL ALGAL BLOOMS

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: Effective Cyanobacterial Harmful Algal Bloom (CHAB) control strategies are needed to address CHAB impacts to recreation, drinking water, fisheries, and natural resources. Existing control strategies are limited and may have negative impacts to non-target organisms. Nanobubble ozone treatment (NBOT) is an innovative CHAB control strategy that consists of ozone encapsulated within nanobubbles, unlocking ozone's potential for use in natural waters. NBOT was evaluated at the lab, mesocosm, and full field scale. Nanobubble production was measured with a nanosight at high concentrations (2.56 × 108 ± 2.05 x 107 particles/ml) and new methods to measure ozone in nanobubbles, a critical step for understanding ozone fate and dose response, were developed. Lab experiments demonstrated that hydroxyl radical production through nanobubble collapse alone was minimal, indicating that ozone is a critical treatment component. Triplicate mesocosm experiments compared high (11.8 mg O3/L, O3:DOC=1.64), medium (9.4 mg O3/L, O3:DOC=1.31), and low (5.2 mg O3/L, O3:DOC=0.73) ozone doses with oxygen-only nanobubbles, and control tanks. Within 24 hours after treatment, medium and high ozone nanobubble doses eliminated cyanobacteria, while low doses substantially reduced cyanobacteria. NBOT treated tanks also showed significant release of AOC and dissolved nitrogen and, after 3 days, non-cyanobacterial algal populations rebounded. This suggests that effectiveness of treatment can be related to both dosage and biogeochemical response of the system. At Lake Sylvan, following increased NBOT dose, cyanobacteria concentrations decreased, the community shifted, and recreational advisories were avoided. Grand Lake Saint Marys field trials showed some treatment, but low ozone:DOC ratios measured during the severe bloom, combined with large lake volume, overwhelmed treatment capacity of the available units. Our findings reveal the importance of three design components critical for effective CHAB treatment:1) applied ozone:DOC in the water body, 2) water body volume to treated volume per time, and 3) spatial coverage of treatment.

SPEAKER: **Heather Raymond, The Ohio State Univeristy | raymond.54@osu.edu**

SPEAKER BIO: Heather Raymond is the Water Quality Initiative Director for The Ohio State University's College of Food Agricultural and Environmental Sciences. In this role she helps coordinate applied interdisciplinary water quality research that addresses the needs of local, state, and federal partners and integrates research findings into extension outreach. Prior to accepting her position at OSU, Heather served as the State of Ohio Harmful Algal Bloom (HAB) Coordinator where she led development of the nation's first public water supply HAB monitoring and reporting rules, assisted lake managers and water systems respond to HABs, conducted applied research on HAB treatment in coordination with U.S. EPA and University partners, and taught webinars and workshops on HAB response. She serves on the GlobalHAB Committee, National HAB Committee, and Great Lakes HABs Collaborative Steering Committee and is a contributing author to state, federal, and international HAB guidance. She has over twenty years of water quality related government experience and earned master's degrees in science and public administration from Ohio University.

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BIOMARKER DISCOVERY IN RED TIDE (KARENIA BREVIS) EXPOSED FLORIDA MANATEES (TRICHECHUS MANATUS LATIROSTRIS) FOR DEFINITIVE DIAGNOSES BY BOTTOM UP, QUANTITATIVE, MS BASED PROTEOMICS

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: In the Gulf of Mexico (GOM), recurring, nearly annual blooms of the dinoflagellate Karenia brevis, known as the Florida red tide) can persist for weeks, months, or even years leading to significant fish kills and marine wildlife mortality. These adverse impacts are attributed to brevetoxins, a group of neurotoxins produced by K. brevis. The Florida manatee (Trichechus manatus latirostris), a subspecies of the West Indian manatee listed as threatened by the US Fish and Wildlife Service, inhabits areas where Florida red tide blooms are prevalent. Prolonged red tide blooms in the GOM have been associated with significant manatee die-offs and strandings. Animals exposed to sublethal levels of brevetoxins can undergo successful treatment at local rehabilitation centers, with the goal of reintroducing healthy animals to the wild. Typically, manatee deaths and strandings coincide with or shortly follow K. brevis blooms. In some instances, however, a lag effect has been observed. Manatees displaying signs of brevetoxicosis have been recovered up to 4 weeks after the dissipation of a red tide episode posing a challenge for a definitive diagnosis. We characterized alterations in protein abundance in 70 plasma samples of manatees either naturally exposed to the Florida red tide or healthy free ranging manatees, by mass spectrometry (MS)-based, bottom-up, quantitative proteome profiling. Plasma proteomics can identify specific protein expression patterns, and post-translational modifications associated with toxic responses, providing insights into the underlying mechanisms of toxicity, and establishing a baseline for healthy animals and revealing biomarkers for red tide exposure.

SPEAKER: **Kelly Rein, Florida Gulf Coast University | krein@fgcu.edu**

SPEAKER BIO: Dr. Kathleen Rein is a professor in the Department of Marine and Earth Science at Florida Gulf Coast University. Dr. Rein is an organic and natural products chemist whose research focuses on toxins produced by algae and cyanobacteria that pose an environmental or public health risk. For over 30 years Dr. Rein has studied the toxicology/pharmacology, biosynthesis, detection, isolation and structure elucidation and degradation of algal toxins. These include the brevetoxins produced by the Florida red tide dinoflagellate Karenia brevis as well as okadaic acid and the dinophysis toxins and microcystins. Dr. Rein received her BSc in chemistry from the University of Central Florida and her PhD in organic chemistry from the University of Miami. She was an NIH post-doctoral fellow at the Rosenstiel School for Marine and Atmospheric Sciences. Prior to joining FGCU, she spent 25 years in the Department of Chemistry at Florida International University. Dr. Rein's current work is focused on proteomic approaches for biomarker discovery in marine wildlife poisoned by red tide and for the study of toxin biosynthesis.

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Catherine Walsh, Celina Ceballos

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ASSESSING THE IMPACT OF CYANOBACTERIAL COMMUNITY COMPOSITION AND SEDIMENT CONCENTRATION ON THE EFFICACY OF A PEROXIDE-BASED ALGAECIDES

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL II

ABSTRACT: Cyanobacterial harmful algal blooms (cyanoHABs) are predicted to grow in frequency and severity across the globe as waters warm, anthropogenic nutrient inputs increase, and growing periods lengthen. Hydrogen peroxide (H_2O_2) can selectively kill cyanobacteria and is increasingly being used to treat cyanobacterial blooms. While previous studies provide evidence for the efficacy of H_2O_2-based algaecides against scum-forming cyanobacteria (e.g. Microcystis) much less is known about its effect on non-scum-forming groups. Additionally, many studies suggest that high DOM content reduces the efficacy of these algaecides, but preliminary data from our study site, Lake Mattamuskeet, showed no effect of high DOC concentration on H_2O_2 efficacy. Lake Mattamuskeet is a eutrophic, sediment-rich, shallow lake with high phytoplankton biomass (~100 µg Chl a L^{-1}) dominated year-round by small, filamentous cyanobacteria (Raphidiopsis and Komvophoron). To determine the practicality of applying LakeGuard® Oxy in such an environment, we will conduct a series of mesocosm experiments beginning August 2024. Using water and sediments from Lake Mattamuskeet, we will test four concentrations of the algaecide in 60L mesocosms, both with and without sediment. Impacts will be assessed by comparing H2O2 residence time, total cyanobacteria biomass, eukaryotic phytoplankton populations, and dominance by specific cyanobacterial strains in control versus treated mesocosms. More than a year's worth of monitoring data has been collected from the lake and will help to put the results of our mesocosm experiments into context. By characterizing the lake water's physical, chemical, and biological properties throughout the experiment, we will increase our understanding of the role that H2O2 dosage, cyanobacterial community composition, and sediment concentration plays in the efficacy of H2O2-based algaecides. Results of this study will broaden the scope of expected outcomes of H_2O_2-based algaecides in nonideal systems and inform future management decisions on the most effective methods to combat cyanoHABs in various lake environments.

SPEAKER: **Mary Kate Rinderle, University of North Carolina | rinderle@unc.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

DETECTION OF BENTHIC ALGAL TOXINS IN WATER, ALGAE, AND FISH ASSOCIATED WITH UNUSUAL FISH BEHAVIORAL ANOMALIES IN THE FLORIDA KEYS

SESSION: PLENARY

ABSTRACT: The Florida Keys host a diverse ecosystem vital for subsistence, recreational, and commercial fisheries, contributing significantly to the local economy. However, climate-driven and human-induced disturbances have impacted these resources in the last few decades. Adding to these impacts, in Fall 2023, flats fishing guides reported observations of fish "spinning" in the lower Keys, initiating a response effort to determine the cause. A myriad of behavioral effects were documented in >50 fish species crossing many trophic and migratory guilds. These effects included erratic swimming (spiral and circular), loss of equilibrium, vertical breaching, impaired gill movement, and reduced fight or flight response. Based on our long-term monitoring of benthic algae and their toxins in the Florida Keys, we hypothesized algal neurotoxins as a possible cause. Subsequent sampling (see abstract by Parsons et al.) revealed elevated levels of Gambierdiscus and the presence of other potentially toxigenic dinoflagellate genera. While fish necropsy results showed no macroscopic effects in fish, subsequent toxin testing by in vitro assay, targeted liquid chromatography-tandem mass spectrometry (LC-MS/MS), and untargeted LC-high resolution mass spectrometry (LC-HRMS) revealed the bioactivity and presence of a variety of benthic algal toxins in whole water, epiphytic microalgae (20-200 µm), and in tissues of symptomatic fish. Subsequent chemical partitioning and assay-guided fractionation aided in identifying ciguatoxins, gambierones, and okadaic acid in water samples, and a complex suite of these toxins were also identified in fractionated microalgal extracts. Increased toxin diversity was identified from sites in the lower Keys where fish were most affected, including the identification of portimines in algae and fish (though no known source was identified in preserved samples). Preliminary water-borne exposure to algal extracts containing toxin mixtures resulted in fish behaviors akin to those observed in the field so further efforts are underway to examine the components and mechanisms involved.

SPEAKER: **Alison Robertson, Stokes School of Marine and Environmental Sciences, University of South Alabama and the Dauphin Island Sea Lab | arobertson@disl.org**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

SPATIOTEMPORAL DISTRIBUTION OF CIGUATOXINS FROM LONG-TERM MONITORING IN THE FLORIDA KEYS MARINE SANCTUARY

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Ciguatera poisoning (CP) is an emerging issue for Florida, with a long history of sporadic cases from the Florida Keys, South Florida, and from residents traveling to the Bahamas. Due to climate change causing an increase in seawater temperature, it is hypothesized that this could cause an increase in CP incidence and range. In this study we aimed to evaluate spatiotemporal trends and environmental drivers in ciguatoxin (CTX) levels in the epiphytic dinoflagellate community using samples collected from 6 distinct long-term monitoring sites in the Florida Keys National Marine Sanctuary that vary in depth and benthic cover. Replicate samples of dominant macroalgal genera were collected monthly over a six-year period, 2012 - 2018. A sodium channel-specific mouse neuroblastoma assay was used to screen extracted algal samples for the presence of CTX-like and palytoxin (PLTX)-like activity, and overall neurotoxicity. Liquid chromatography-mass spectrometry was then employed to further investigate the toxin profiles in positive samples. Spatiotemporal data on algal abundance and toxicity identified site specific trends that were related to habitat type. These data will be explored to evaluate trends and to contribute to predictive models that further incorporate temperature, wind/wave, and other environmental parameters. These data not only provide a solid baseline in CTX and other benthic algal toxin trends but will further our understanding of changes over time and space to improve our predictive capacity for ciguatera in vector organisms.

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DRIVERS OF TOXIN-PRODUCING MARINE HAB SPECIES ACROSS ESTUARINE GRADIENTS IN LOUISIANA OYSTER-GROWING HABITATS

SESSION: BLOOM DYNAMICS & DRIVERS III

ABSTRACT: Louisiana estuaries experience variable abiotic conditions including large fluctuations in salinity and nutrients, conditions that may support harmful algal blooms (HABs). There is a need for more research on the presence and toxin-production of HAB species in Louisiana estuaries and their impacts on oysters given the ecosystem and human health implications. This study seeks to aid in closing that knowledge gap by identifying toxic marine HAB species found in oyster growing estuarine basins, their environmental drivers, and correlations with oyster fitness. Starting in October 2022, water quality at five estuaries along a hydrodynamic gradient has been continuously monitored and paired with discrete and time-integrative sampling for phytoplankton community composition and the toxins domoic acid (DA) and Brevetoxin (PbTx). Preliminary results show that the most saline site (mean salinity: 19.5) has the highest amount of HAB taxa observed, five of which were toxin producers. A putative Chattonella spp. bloom (91 cells mL-1) was observed at one of the sites and molecular analysis is being utilized to verify the species. Toxin analyses are also being conducted for particulate & dissolved toxins as well as toxins collected via SPATT bags and potential toxins accumulated in oyster tissue. Results will be discussed further into what HAB taxa are in these estuaries, potential drivers, if they are producing toxins, if oysters are accumulating these toxins, and what possible effects this could have on the oysters.

SPEAKER: **Tessa Rock, University of Louisiana | tessa.rock1@louisiana.edu**

SPEAKER BIO: I am a masters candidate at the University of Louisiana at Lafayette in the Stauffer lab. I research phytoplankton taxa with an emphasis on toxic HAB species and their impacts on estuaries and oysters. I received my bachelors degree in marine science from the University of New England in 2018 where I worked on phytoplankton taxonomy and crustacean physiology.

CO-AUTHORS:
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TRACKING CYANOTOXIN OCCURRENCE AND VARIABILITY IN NEW JERSEY'S SALEM RIVER: A COMPARISON OF DISCRETE AND PASSIVE SAMPLING APPROACHES

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The Salem River is a small tributary of the Delaware River, flowing through a rural, predominantly agricultural area of southern New Jersey, with its upper reaches alternating between free-flowing sections and small impoundments. Since 2019, the river has been affected by severe cyanotoxin-producing cyanobacterial blooms. To assess cyanotoxin occurrence and variability in the watershed, discrete water samples were collected at 11 sites (both free-flowing and impounded) on a weekly basis from July to October 2020. In addition, discrete water samples were collected daily at three of the sites (Memorial Lake, Fox Mill/Daretown Lake, and Salem River Reservoir) over the course of one week in mid-July 2020. Samples were analyzed for four cyanotoxins (microcystins, cylindospermopsin, anatoxin-a, saxitoxin) by Enzyme-Linked Immunosorbent Assay (ELISA). Discrete sampling was complemented by Solid Phase Adsorption Toxin Tracking (SPATT) samplers, which are passive sampling devices designed to adsorb dissolved cyanotoxins from the water column. These samplers were deployed from 1-15 days at field sites to assess temporal variability of cyanotoxins, evaluate optimal deployment times, and assess sampler efficacy under a range of field conditions. SPATT sampler extracts were analyzed by ELISA for the same four cyanotoxins as the discrete samples. Three of the four toxins (microcystins, anatoxin-a, and saxitioxin) were detected in both discrete and SPATT samples. This presentation will discuss the results of the discrete and SPATT sampling efforts, the relation between the two data sets, as well as lessons learned regarding SPATT deployment times, field logistics, and extraction and analysis procedures.

SPEAKER: **Joshua Rosen, U.S. Geological Survey | jrosen@usgs.gov**

SPEAKER BIO: Joshua Rosen is a hydrologist with the USGS New York Water Science Center (NYWSC) in Troy, NY. He works on a variety of water quality projects across New York and the broader northeastern US, with a focus on harmful algal blooms (HABs) and cyanotoxins. As part of the NYWSC's Soil and Low Ionic Strength Water Quality Laboratory, he is responsible for the preparation, analysis, and data compilation for cyanotoxin analyses (Microcystin, Cylindrospermopsin, Anatoxin-a, Saxitoxin) by ELISA. He has over a decade of experience in water quality field work and laboratory analysis in both the public and private sectors.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

EXTRACELLULAR POLYMERIC SUBSTANCES: A PHYSIOLOGICAL RESPONSE TO A VARIETY OF STRESS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Cyanobacterial colonies and filaments secrete extracellular polymeric substances (EPS), composed of polysaccharides, proteins, DNA and lipids, which serves a variety of purposes supporting the growth and proliferation of cyanobacterial blooms (cyanoHABs). Colony integrity of colonial cyanobacteria, such as Microcystis, is an important function in flotation, reduced herbivory, physical dispersion in a water body. Using laboratory cultures of Microcystis aeruginosa co-cultured with the green alga Haematococcus, the proliferation of EPS by Microcystis was observed in response to glyphosate exposure, a stress response, while Haematococcus was unaffected and remained motile. The shunting of photosynthate in the polysaccharide component increased colony integrity, making it difficult to enumerate samples using standard disruption techniques. Over a period of a week, colonies became “exhausted” physiologically, losing the ability to effectively transfer electrons between photosystem I and II (PhytoPam) and became chlorotic, although there was less of an effect on the increase in cell numbers. In other experiments with natural cyanobacterial blooms, EPS proliferation was observed when colonies of Microcystis or filaments of Dolichospermum were exposed to higher salinities. A sudden increase in salinity caused massive amounts of clumping of the cyanobacteria and sinking from the water column. As long as individual cells remain viable, they will shunt photosynthate into the EPS as a protective mechanism. Cyanobacteria commonly survive desiccation by this same mechanism. Methods for disrupting colonial cyanobacteria for counting purposes have been explored using heat, boiling and sonication, however, a standard approach for a natural bloom remains elusive because prior growth conditions complicate their EPS history. Filamentous forms add another kind of complexity when it comes to enumeration as they are, in general, more delicate.

SPEAKER: **Barry Rosen, Florida Gulf Coast University | brosen@fgcu.edu**

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IMMUNOAFFINITY MAGNETIC BEADS FOR MICROCYSTINS CAPTURE AND CONCENTRATION IN BIOLOGICAL SAMPLES

SESSION: Poster Session, Wednesday

ABSTRACT: Cyanotoxins are a category of toxins produced by cyanobacteria (blue-green algae) that are prevalent in certain bodies of water, where they can reproduce exponentially into harmful algal blooms (HABs), posing a significant health risk. Microcystins are the most commonly found cyanotoxins, and have hepatotoxic effects. The US EPA has issued health advisories in drinking and recreational water, but government agencies, public health labs, and academic researchers also have an interest in detecting Microcystins in biological samples, primarily urine and blood serum to assess exposure.

Due to the complex nature of urine and blood serum, and possibly low levels of Microcystins, sample clean-up and concentration is needed to prepare samples for downstream detection with sensitive analytical techniques such as LC-MS and ELISA. Immunoaffinity Magnetic Beads (IMB) have emerged as an effective clean-up method. IMB, synthesized by conjugating antibodies onto magnetic nanoparticles, mix with a biological sample whereby the antibody binds the target of interest. The IMB-target complex is separated from the matrix using a strong magnet. The IMB clean-up method possesses high affinity for the target of interest, and by varying the elution volume, can result in a 10-fold concentration of the target to detectable levels.

Gold Standard Diagnostics Horsham (GSDH) developed a novel Microcystins in urine and blood serum IMB clean-up kit for sample pre-treatment and concentration prior to downstream analysis. Matrix-matched Microcystins standard curves of known concentrations of 0.025 to 0.4 ppb in synthetic urine and blood serum are extracted alongside unknown biological samples.

Results obtained during the development and validation of the IMB clean-up kit are presented, including a novel LC-MS downstream analytical method developed in collaboration with Waters Corporation that optimizes the detection of Microcystins following the sample clean-up, and GSDH evaluation of the method using commercially available ELISA and phosphatase enzyme-inhibition (PP2A) kits for Microcystins.

SPEAKER: **Leah Ruth, Gold Standard Diagnostics Horsham | Leah.Ruth@us.goldstandarddiagnostics.com**

SPEAKER BIO: Senior Scientist - Research & Development, Gold Standard Diagnostics Horsham

CO-AUTHORS:
Stuart Oehrle, Boris Polyak, and Fernando Rubio

U.S. National Office for Harmful Algal Blooms

OXYLIPINS, BIOACTIVE BYPRODUCTS OF PHYTOPLANKTON, ARE AN EMERGING CONCERN FOR THE SHELLFISH AQUACULTURE INDUSTRY.

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS I

ABSTRACT: Successful hatchery production is the foundation of much of the shellfish aquaculture production of the US East Coast. In recent years, however, hatcheries throughout the region have struggled to move shellfish through the hatchery phase, slowing industry growth and cutting into profits. Understanding the cause of hatchery failures is critical to identify solutions and ensure shellfish aquaculture sustainability. In 2020, a troublesome new syndrome presented in young oyster larvae at a hatchery in Maine, resulting in production failures which decreased seed output. Delayed in development and often moribund, affected larvae displayed pale digestive glands suggesting failure of digestion despite a stomach full of microalgal food. The disease reappeared in 2021, 2023 and 2024, demonstrating the syndrome's persistence. Similar symptoms were observed in hatcheries across a wider geography of the East Coast. Preliminary larval bioassays, coupled with lipidomic analyses, demonstrated a link between the pathological signs and bioactive phytoplankton byproducts (oxylipins) in hatchery water. Oxylipins, an oxidative byproduct of polyunsaturated fatty acids, are produced by some phytoplankton in response to stress such as grazing. New research on oxylipin presence and abundance from three commercial shellfish hatcheries in Maine, New York, and Virginia, along with oyster larval pathology and lipidomics will be presented. Through partnerships between industry and academia, this research strives to understand this new but persistent disease, increase awareness along the East Coast, and identify mitigation technology to avoid or minimize symptoms with the overall goal of improving hatchery production.

SPEAKER: **Marta Sanderson, Virginia Institute of Marine Science | mps@vims.edu**

SPEAKER BIO: I am interested in drivers of harmful algal blooms (HABs) and algal toxin production, as well as the persistence and fate of algal toxins. In addition, my research interests include the trophic transfer of toxins through the food web as well as the effects of the toxins on different life stages of aquatic organisms. More recently I have focused on the breakthrough of HAB cells and algal toxins, as well as other byproducts, into shellfish hatchery facilities, as they maybe a contributing factor to intermittent production issues at hatcheries. I am interested in further research on the potential effects of toxins and byproducts on the different life stages of shellfish raised in hatcheries.

CO-AUTHORS:
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LINKING SPATIOTEMPORAL BIOLOGICAL DATA TO PREDICT HARMFUL ALGAL BLOOMS

SESSION: Applications of Emerging Technologies I

ABSTRACT: Cyanobacterial Harmful Algal Blooms (cHABs) have significant impacts on an affected region's economy, ecology, and human health. The blooms can release toxins that kill fish and poison water for people and animals. The global adverse effects of cHABs are exacerbated by the consequences of climate change and increased pollution. Though the phenomena are well documented, scientists' efforts to mitigate the damage are hampered by insufficient predictive models and incomplete granular knowledge of cHAB community structure. With a goal of leveraging bioinformatics and machine learning tools to better understand and predict cHABs, we are first exploring water sample data sets. Using more than two thousand samples from the National Center for Biotechnology Information Sequence Read Archive (NCBI-SRA) across 16 years with latitude and longitude embedded in the metadata, we mapped the location of the samples onto a Lake Erie shape file. We combined information about location, date, and community taxa in the NCBI samples to discover factors that determine cHAB features. The data are separated into three distinct zones, with the majority pooled at the southwest end of the lake and occurring in 2017. The samples are rich in biological data; our next steps are to carry out whole genome sequence analysis and use the community profiles as part of our predictive machine learning model.

SPEAKER: **William Sanderson, Los Alamos National Laboratory | ikes@lanl.gov**

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FACTORS DRIVING DOMOIC ACID PRODUCTION IN THE SOUTHERN CALIFORNIA BIGHT: INSIGHTS FROM A 3D OCEAN BIOGEOCHEMICAL MODEL

SESSION: PREDICTIVE MODELING - MARINE

ABSTRACT: The toxigenic harmful algal diatom genus Pseudo-nitzschia, and its neurotoxin domoic acid (DA) are a leading cause of Harmful Algal Blooms (HABs) along the U.S. West Coast, with severe consequences to aquatic and human life. Connections between HABs and anthropogenic nutrient enrichment, upwelling, and climate have been highlighted, yet the relative importance of these drivers has not been systematically evaluated. Parsing these interactions requires an integrated modeling approach, validated against available observations. Here, we embed a mechanistic model of DA production that leverages previous culture experiments into a realistic, three-dimensional ocean biogeochemical model of the Southern California Bight. The model is based on the hypothesis that nutrient ratios (Si:N) and temperature modulate the timing and magnitude of DA production. We show results from simulations for the 2006-2017 period, run under two different scenarios. A simulation that includes terrestrial nutrient inputs (ANTH) better captures in situ particulate DA (pDA) magnitudes and patterns than a simulation that only includes natural nutrient sources (CTRL). Anthropogenic inputs increase HAB occurrence and strength in urbanized coastal waters, where particulate DA concentrations nearly double. Our results suggest that external nitrogen sources not only boost phytoplankton primary production, favoring diatoms but also shift nutrient limitation from nitrogen to silica, enhancing toxin production by Pseudo-nitzschia. Our study sheds light on the complex drivers of DA production in the Southern California Bight, advancing our ability to link HAB occurrence to natural and human drivers.

SPEAKER: **Marco Sandoval Belmar, UCLA | marcsandovalb@g.ucla.edu**

SPEAKER BIO: Geophysicist from Universidad de Concepción, Chile. Masters Degree: Atmospheric and Oceanic Sciences M.S. Atmospheric and Oceanic Sciences Ph.D Candidate

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MONITORING MICROCYSTIN TOXIN PRODUCTION IN LAKE ERIE

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Microcystin toxins created by cyanobacteria are a major threat to both the environment and to human health in Lake Erie's western basin. Many researchers use grab samples to detect microcystins in the lake, however, it is difficult to predict future microcystin concentrations by solely using data from grab samples. Understanding cyanobacterial growth rates, microcystin production rates, and what drives them will be crucial to creating a Lake Erie microcystin forecast to minimize our exposure to the toxins and understand how management actions may affect future blooms' biomass and toxicity. In 2023 and 2024, we sampled several sites throughout Lake Erie's western basin and Maumee Bay and monitored the microcystin production rates and cyanobacteria growth rates using laboratory experiments with ambient conditions and elevated phosphorus and nitrogen (P&N). Production and growth rates in the P&N enrichment were greater than the ambient nutrient controls indicating nutrient limitations throughout the 2023 growing season. The highest microcystin production rates were measured during July (average across all sites 0.16±0.04/d), and decreased throughout the season (0.12±0.09/d in August; 0.07±0.07/d in September). We observed this temporal pattern in previous years (2018 and 2019). The summer 2024 results will be presented during this presentation. The only spatial pattern observed was the ambient nutrient controls had the highest production rates at sites closest to the Maumee River. We will continue monitoring microcystin production and growth rates for the 2024 and 2025 growing seasons.

SPEAKER: **Alessia Saul, The Ohio State University Stone Lab | saul.48@osu.edu**

SPEAKER BIO: My name is Alessia Saul and I am the Ohio State University Stone Lab's Research Senior Technician. I received my bachelor's degree in zoology and environmental science at Miami University in Oxford, OH and my master's degree in biological sciences at Bowling Green State University in Bowling Green, OH. My scientific background is in algal taxonomy and aquatic ecotoxicology.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE EFFECTS OF TIDAL FLOODING ON HABS IN THE LAFAYETTE RIVER

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Harmful algal blooms (HABs) threaten the health of Virginia's coastal ecosystems and the occurrence of HABs is increasing. Increases in the incidence, magnitude, and proliferation of HABs has been linked to excess nutrients entering waterways from wastewater, industrial operations, and synthetic fertilizers. These excess nutrients can stimulate phytoplankton growth and overproduction. In the Lower Chesapeake Bay, storm events and regular precipitation can introduce significant amounts of land-derived nutrients into waterways, stimulating algal blooms. In the Lafayette River, a sub-tributary to the Elizabeth River, tidal flooding events, independent of rain or storms, regularly introduce nitrogen loads that exceed the total maximum daily load (TMDL) allocation, which is the allowance established by the U.S. Environmental Protection Agency. Since local HABs are linked with nitrogen inputs and the Hampton Roads region experiences one of the highest rates of relative sea level rise globally, tidal flooding has the potential to stimulate and sustain HABs in the region. The number of hours that water levels exceed mean higher high water (MHHW) have increased in recent years because of sea level rise, especially in the days before, during and after perigean spring tides. To understand the relationship between tidal flooding and algal bloom formation, daily chlorophyll measurements from two estuarine stations on the Lafayette River were compared to the daily water level measurements and other physical parameters during lunar months of frequent flooding from 2017 to 2023. We analyzed 55 lunar months between both sampling locations, with observations spanning all four seasons. There were 10 lunar months when water level alone (precipitation was non-significant) was positively correlated with total chlorophyll in reverse time, indicating that tidal flooding has a significant impact on algal blooms in the Lafayette River.

SPEAKER: **Ben Schelling, Old Dominion University | bsche004@odu.edu**

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MICROCYSTIN AND DOMOIC ACID PRESENCE IN CRASSOSTREA VIRGINICA IN NORTH CAROLINA COASTAL WATERS

SESSION: Shellfish

ABSTRACT: Harmful algal blooms adversely affect estuaries and coastal sounds, where excess biomass and produced toxins can lead to numerous impacts, including surface water discoloration, odor issues, decreased oxygen levels, and at times dramatic fish kills. Concerns about human exposure to those produced toxins through contaminated seafood have risen dramatically, especially in coastal sounds of the southeastern United States, where coastal development and eutrophication intersect with these ecosystems' distinct sensitivity to global change. Here we report on the presence of the freshwater hepatotoxin microcystin (MC) and the marine algal neurotoxin domoic acid (DA) in farmed oysters during the summer and fall of 2021 and 2023. MC is known to cause Hepatotoxic Shellfish Poisoning (HSP) and the marine toxin DA is the cause of Amnesic Shellfish Poisoning (ASP). Our preliminary data suggest that both toxins are prevalent with 15-86% and 11-29% of the animals testing positive for MC and DA, respectively. The prevalence of both phycotoxins in the tested oysters, albeit at relatively low levels not exceeding World Health Organization guidelines, indicated the potential for chronic exposure risks via shellfish consumption. Our sampling sites were all fully marine environments suggesting freshwater toxin transport along the land-sea interface may be common within these coastal systems. Findings from this study have guided a recently award Oceans and Human Health Center, the North Carolina Center of Coastal Algae, People and Environment (NC C-CAPE) for a state where aquaculture industries contribute nearly $300 million in value and over 5,000 jobs to the economy.

SPEAKER: **Astrid Schnetzer, North Carolina State University | aschnet@ncsu.edu**

SPEAKER BIO: Astrid Schnetzer is a biological oceanographer and plankton ecologist in the department of Marine, Earth and Atmospheric Sciences at North Carolina State University who received her MS in Zoology/Ecology and PhD in Marine Biology from the University of Vienna, Austria. Her research interests focus on how natural and anthropogenic processes, such as eutrophication, impact plankton assemblages and how changes in community structure and diversity impact matter and energy flux through aquatic systems (e.g., harmful algal blooms). She investigates these topics in freshwater, coastal and oceanic environments using molecular techniques in combination with traditional approaches (i.e. microscopy and culture) in the field and in laboratory settings. She serves as the director of a recently funded Ocean and Human Health Center, the NC Center for Coastal Algae, People and Environment (NC C-CAPE) to understand, predict, and reduce risks to human health from cyanobacterial Harmful Algal Blooms in NC's coastal waters.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TOXICITY OF NEWLY MANUFACTURED VS. WEATHERED SYNTHETIC RUBBERS ON THE HEALTH AND SURVIVAL OF KARENIA BREVIS

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: When constructing laboratory assay systems for testing the response of phytoplankton to algicides, potential control compounds, or environmental stressors, it is critical to consider the types of materials that comprise various components. There is limited published literature on the effects of some commonly used plastics, rubbers, and other materials on phytoplankton, and specifically K. brevis. We observed consistent declines of K. brevis cultures in an 80L tank system constructed to test the efficacy of HAB mitigation compounds. To determine if materials used in the construction of this assay system contributed to the decline of cultures, we tested various plastic and rubber components used in the construction of this system on K. brevis physiology and survival. Preliminary tests in small volume assays (250-500mL) with different used plastics from our 80L system (polypropylene, PVC, and nylon) showed no effect on cell abundance after >96hrs. Tests. Using new/unused synthetic rubbers (Neoprene, silicone, and EDPM) initially showed no significant effect on photophysiological response or cell growth and survival after >96hrs. However, when tests were conducted with Neoprene that had prolonged use in the system and demonstrated visible degradation resulted in 100% cell death of K. brevis within 24 hours. Here, we will present the results of ongoing controlled laboratory studies comparing the response of K. brevis growth, survival and photophysiological response to new and artificially "weathered" synthetic rubbers, including Neoprene, silicone, Buna-n, and EDPM, which are common components in commercially available valves, sampling ports, and bulkhead fittings. These results will help inform the construction of similar assay systems to ensure success and repeatability of results.

SPEAKER: **William Scott, Mote Marine Laboratory & Aquarium | Wscott@mote.org**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

PACE SATELLITE PRODUCTS FOR HAB AND WATER QUALITY MONITORING

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: NASA launched the PACE (Plankton, Aerosol, Cloud, ocean Ecosystem) Earth observing satellite in February. PACE's unique hyperspectral data allows for novel and insightful observations of inland and coastal waters. With near daily coverage and 1 km spatial resolution PACE products can provide more information for water quality managers and researchers interested in large inland water systems. The presentation will feature a mixture of new PACE inland water products that could assist in monitoring for harmful algal blooms and other water quality variables. It is an exciting time to have incomparable hyperspectral data for inland waters. PACE inland water products are under development and a goal of the presentation includes creating discussion and gathering feedback from the HABs community.

SPEAKER: **Bridget Seegers, NASA GSFC Ocean Ecology Lab | bridget.n.seegers@nasa.gov**

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AN INTENSIVE MONITORING PROGRAM TO UNDERSTAND AND FORECAST TOXIGENIC CYANOBACTERIAL BLOOMS AND NON-TOXIGENIC, NUISANCE ALGAL BLOOMS IN THE UPPER SHENANDOAH RIVER BASIN, VIRGINIA. (PART B. LONGITUDINAL SURVEYS AND RESPONSE BASED SAMPLING)

SESSION: BENTHIC HABS

ABSTRACT: Toxigenic cyanobacterial blooms (HABs) and excessive non-toxigenic algal blooms (nuisance algae) have proliferated in benthos in the rivers of the upper Shenandoah River basin, the South Fork of the Shenandoah River basin and the North Fork of the Shenandoah River basin, in recent years. The toxins produced by these HABs, and abundance of nuisance algae can affect ecosystems, drinking water sources, and recreational access. These algal and cyanobacterial communities can also produce unpleasant smells, further impacting the public's opportunities to interact with these rivers and creating disruption to the daily lives of residents within the basin. The U.S Geological Survey, in cooperation with Virginia Department of Environmental Quality and in collaboration with the Interstate Commission on the Potomac River Basin, is conducting an intensive monitoring program to understand the environmental factors, processes, and interactions causing HABs and nuisance algae, identify the sources of environment factors that trigger HABs and nuisance algae, and assess multiple novel approaches and technologies to predict HAB and nuisance algae events. Preliminary results from this study will be presented and discussed.

SPEAKER: **Gordon Selckmann, River Basin Commission | GMSelckmann@icprb.org**

SPEAKER BIO: As Associate Director of Aquatic Habitats, Gordon “Mike” Selckmann is responsible for evaluating and interpreting the habitat quality and biological health of aquatic communities within Potomac Basin. His work coordinates the cooperation of federal, state, academic, and local partners to find and implement solutions to environmental issues within the Potomac Basin. Prior to joining ICPRB, Mr. Selckmann worked for University of Maryland Chesapeake Biological Lab, Round River Conservation, and the Okavango Research Institute. At ICPRB he is currently leading investigations pertaining to large river assessments, Harmful Algae Blooms (HABs), North Branch Potomac tailwater optimization, and western basin ground water studies. In his free time you'll likely find him floating around somewhere, either sailing the Chesapeake Bay, canoeing the Potomac Basin, or diving any place there happens to be water.

CO-AUTHORS:
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PROGRESSION AND IMPACTS OF A 2022 HAB EVENT IN SAN FRANCISCO BAY

SESSION: PLENARY

ABSTRACT: Nutrient-enriched San Francisco Bay hosts multiple phytoplankton taxa known to form harmful algal blooms (HABs), yet has rarely experienced severe HAB events. However, in August 2022, a Heterosigma akashiwo bloom spread throughout South Bay and other subembayments of San Francisco Bay, profoundly impacting water quality and causing unprecedented fish kills. To investigate factors that shaped the bloom's evolution and characterize its water quality impacts, we tracked the bloom's progression in South Bay over five weeks through a rapid-response field program, including measurements from weekly high-resolution biogeochemical mapping surveys (underway chlorophyll (chl), nitrate, turbidity, temperature, salinity) and five continuous water quality moored stations, along with remote-sensed estimates of chl and turbidity (Sentinel 3). Reports in late-July of discolored water in sheltered areas around Alameda and Oakland (South Bay, eastern shore) served as early indications of the developing event. Remote-sensed chl estimates (Sentinel-3, Sentinel-2) in early August registered the bloom's expansion into open-water regions of South Bay, and triggered the first mapping survey (August 10), during which underway chlorophyll measurements frequently exceeded 200 ug/L and H. akashiwo densities reached 10 x 106 cells/L. The bloom expanded throughout South Bay over the subsequent 2.5 weeks, growing to unprecedented biomass levels for South Bay while fully utilizing ambient dissolved inorganic nitrogen (pre-bloom concentrations of 25-40 uM), and resulting in low dissolved oxygen (2-4 mg/L) over a >200 km2 area. This presentation will describe the bloom's progression and impacts, and use observational data along with numerical simulations to explore hypothesized factors that contributed to the bloom's initiation, spread, and termination.

SPEAKER: David Senn, San Francisco Estuary Institute | davids@sfei.org

SPEAKER BIO: David Senn is a Senior Scientist at the San Francisco Estuary Institute, and Lead Scientist of the San Francisco Bay Nutrient Management Strategy.

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HARMFUL ALGAL BLOOM EVENTS: TRANSITIONING THE BERING STRAIT REGION WITH TEAMWORK

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: The comprehensive use of marine resources is essential to the nutritional, cultural, and economic well-being of remote coastal communities of the Bering Strait region in western Alaska. During 2022, a novel, massive, and toxic harmful algal bloom (HAB) of Alexandrium catenella occurred from the northern Bering Sea to the Southern Chukchi Sea. Offshore ship-based academic researchers investigating harmful algae documented this event. This event was a very hazardous situation for coastal communities that 1) primarily rely on the consumption and use of diverse marine wildlife for food and 2) had no experience with this type of, or scale of, event. The severity of this HAB event was unexpected and presented immediate food safety, food security, and human health concerns. The immediate regional response to protect public health was based on teamwork as well as regional support from a variety of stakeholders. We will provide an overview on the immediate response from a rural regional perspective that include the concerns for marine resources traditionally harvested for subsistence purposes to feed families. We will highlight the continuing and expanding teamwork that includes ship-based researchers, tribal governments, federal and state agencies, as well as regional academic institutions, tribal consortiums, and the Bering Strait regional public. Results include how the offshore research is transitioning to improved project research to understand this new marine-based threat to coastal communities. Coastal communities received comprehensive educational outreach of the nearshore monitoring and surveillance needs to protect human health in the Bering Strait region. Learning together, transitory offshore ship-based research efforts, combined with regional nearshore community-based surveillance efforts adapted communications and science efforts for the safety of future generations as the northern Bering Sea warms.

SPEAKER: **Gay Sheffield, UAF Marine Advisory Program / Alaska Sea Grant | gay.sheffield@alaska.edu**

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CYANOTOXINS IN UPPER KLAMATH LAKE, OR

SESSION: PUBLIC HEALTH

ABSTRACT: Upper Klamath Lake (UKL) is a large, shallow, and hypereutrophic freshwater lake in southern Oregon, USA. Although there is evidence that UKL was historically eutrophic, changes in numerous water quality parameters indicate a shift to hypereutrophy during the early 20th century. Simultaneously, cyanobacteria were observed in UKL for the first time. By the 1960s, annual phytoplankton blooms were described as an Aphanizomenon flos-aquae (AFA) “monoculture.” Cyanobacterial blooms typically begin in UKL in late spring or early summer and persist through the fall. The cyanotoxin microcystin (MC) has been detected as early as mid-May in shallow areas and bays of UKL, with recreational advisories following shortly after. Despite the presence of cyanobacteria genera capable of producing a wide range of cyanotoxins, UKL is currently only routinely monitored for MC. In 2021, MC, cylindrospermopsin, anatoxin-a, and saxitoxin were detected in nearby waterbodies receiving UKL water for irrigation purposes. Additionally, a 2023 synoptic Solid Phase Adsorption Toxin Tracking (SPATT) monitoring effort resulted in the first consistent detections of anatoxin-a in UKL. In 2024, U.S. Fish and Wildlife Service and the Oregon Department of Environmental Quality will collaborate on a simultaneous SPATT and water sample monitoring effort for multiple cyanotoxins in UKL. This oral presentation reports the findings of this collaborative monitoring effort, which will inform conservation efforts to benefit numerous natural, cultural, subsistence, and economic resources associated with UKL.

SPEAKER: **Megan Skinner, US FWS | megan_skinner@fws.gov**

SPEAKER BIO: Dr. Megan Skinner works for U.S. Fish and Wildlife Service as a water quality specialist informing and implementing restoration actions to improve water quality in Oregon’s Klamath Basin. Megan has been working on natural resource issues and water quality and management in the Klamath since 2015, and is an aquatic ecologist and limnologist by training.

ALL HANDS ON DECK: COLLABORATIVE SOLUTIONS TO RECURRING CYANOBACTERIA BLOOMS ON DAMARISCOTTA LAKE

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: Damariscotta Lake is one of midcoast Maine's most popular attractions. The lake draws visitors from across the state and country to its miles of shoreline, excellent fishing, and vibrant wildlife. Recurring blooms of cyanobacteria threaten the lake and the local economy. Spurred by a large bloom in 2020, Midcoast Conservancy and Bigelow Laboratory for Ocean Sciences have collaborated to identify and track the species responsible for blooms in an effort to better understand the drivers and impacts of the phenomenon. We conducted bi-weekly sampling in 2022, 2023, and 2024 for eDNA, toxins, nutrients, and environmental parameters across the lake. Our approach combines genomic investigations to determine toxic potential, eDNA based quantification using digital PCR, and ELISA tests to measure toxin concentrations. We find that multiple species of Planktothrix and Dolichospermum are abundant at predictable times during the summer, but that these abundant species lack any of the known toxin biosynthesis genes. Together this work seeks to understand the genetic and environmental factors that combine to produce recurring cyanobacteria blooms. This collaboration has advanced the capabilities of a community-based environmental organization and enhanced public awareness of water quality issues in the region.

SPEAKER: **Robin Sleith, Bigelow Laboratory for Ocean Sciences | rsleith@bigelow.org**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE SPATIOTEMPORAL VARIABILITY OF MICROCYSTIN CONCENTRATIONS AND CYANOBACTERIA COMMUNITY COMPOSITION IN TWO AGRICULTURAL PONDS IN GEORGIA, USA

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Cyanobacteria and their toxins can have multiple effects on agricultural productivity and waterbodies. Cyanotoxins can be transported to crops during irrigation and may pose a risk to livestock health through drinking water sources. Of particular concern is microcystin due to its persistence in crop plant roots, stems, and leaves and the hepatocellular damage it can cause in mammalian liver tissues. Spatial and temporal variations of cyanotoxin concentrations have been reported for large freshwater sources such as lakes and reservoirs, but studies on smaller agricultural surface waterbodies are lacking. To address this research gap, surface water microcystin concentration and phytoplankton community composition at an irrigation pond (8 acres) and a livestock watering pond (4 acres) on two working farms in Georgia were monitored monthly across a fixed sampling grid of 16-18 stations for 17 months. In both ponds, the cyanobacteria community was dominated year-round by Microcystis, though different species dominated in winter versus summer. Consistent spatial patterns of microcystin were observed in both ponds. Discrete locations, often associated with the pond shoreline or along bathymetric features, exhibited consistently higher or lower microcystin concentrations compared to pond-wide averages, indicating that microcystin assessments can be substantially different depending on where sampling occurs. Elevated microcystin concentrations occurred October through March in the livestock pond and September through January in the irrigation pond. Both ponds had detectable, but decreased, microcystin concentrations thereafter. Another peak in microcystin concentration occurred in both ponds in July, indicating that year-round monitoring in these agricultural waters is necessary to safeguard agriculture operations. The use of this type of spatially robust data to develop effective monitoring programs in small waterbodies will be discussed.

SPEAKER: **Jaclyn Smith, USDA-ARS Environmental Microbial Food Safety Laboratory | Jackie.Smith@usda.gov**

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A ONEHEALTH REGIONAL RESPONSE PLAN FOR WILDLIFE STRANDING EVENTS ASSOCIATED WITH HARMFUL ALGAL BLOOMS: A CALIFORNIA PILOT

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Harmful algal blooms (HABs) are an emerging health threat in many coastal ecosystems, potentially causing widespread impacts on marine wildlife health. Developing quantitative linkages between blooms and related ecosystem impacts has been challenging. Clearly defining these linkages is important for developing bloom management targets and forecasting models. Event response and documentation is difficult because events can occur suddenly, impacting hundreds of animals over large areas. Wildlife stranding networks, rehabilitation centers, and natural resource management agencies often lack sufficient resources to properly respond to large numbers of impacted animals. Concurrent impacts on aquaculture and shellfish sanitation, which are relatively common during larger scale HAB events, also cause significant constraints on human and financial resources. Documenting the extent and magnitude of HABs is also often difficult, since blooms are heterogenous, toxin depuration by invertebrates can be slow, vertebrate species forage at multiple different trophic levels, and routine monitoring efforts are limited in scope. In California, domoic acid producing blooms of Pseudo-nitzschia occur regularly, impacting thousands of marine animals. In 2022 and 2023, two major events occurred that impacted hundreds of pinnipeds and cetaceans. These events highlighted the need for the development of a pilot response plan. This plan prioritizes interdisciplinary collaboration and includes clear event definitions for the regional HAB-related syndromes that pose potential human and wildlife health risks. Communication needs, before, during, and after each HAB event are also defined. Priority sample types, sample collection, and analytical protocols from wildlife and the environment were also identified to ensure comparability. Finally, collaborative priorities were identified for research and funding needs related to HAB impacts, monitoring, and modeling to guide future response efforts. This California pilot can serve as a model for other areas that experience frequent HABs, in an effort to coordinate response and optimize use of available resources.

SPEAKER: **Jayme Smith, Southern California Coastal Water Research Project | jaymes@sccwrp.org**

SPEAKER BIO: Jayme Smith is a Senior Scientist at the Southern California Coastal Water Research Project (SCCWRP) in Costa Mesa, CA where she runs the HABs research thematic area. Her current research efforts range from assessing the factors linked to increased risk of cyanobacterial HABs and their associated toxins in California freshwater systems, examining the environmental drivers and impacts caused by toxigenic Pseudo-nitzschia blooms in coastal southern California, and developing HAB monitoring tools and approaches in marine and freshwater systems. She serves on several committees focused on HAB monitoring and research including the National Harmful Algal Blooms Committee (NHC), California Harmful Algal Blooms Monitoring and Alert Program (Cal-HABMAP) steering committee and is a co-chair of the California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network. Staff profile: https://www.sccwrp.org/about/staff/jayme-smith/

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE APPLICATION OF A NOVEL NITROGEN TRACER, METOLACHLOR-ESA, TO LAKE ERIE AND SEVERAL ASSOCIATED TRIBUTARIES

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Nitrogen plays a critical role in the production and types of cyanobacteria and toxins identified in lakes. While phosphorus was identified to be crucial as a limiting nutrient since the 1970's in the Canadian Experimental Lakes Area, our understanding of nitrogen's role in freshwater systems has been more limited, although it has become better established in the last decade. However, while nitrogen's importance has been established, tracing nitrogen movement through environmental systems has remained challenging. Novel work has been performed by the Agricultural Research Service to trace nitrate and groundwater movement using a metolachlor degradation byproduct, metolachlor-ESA (MESA), that shares similar chemical and solubility features with nitrate. Being a highly stable and conserved compound due to its application alongside fertilizer in agricultural settings, it can be used as a tracer for agricultural nitrate. This compound remains in the dissolved phase of the water column, and therefore can also be used to trace nitrate uptake/removal/loss in aqueous environments. Samples were collected from Lake Erie and surrounding tributaries and analyzed for MESA to evaluate the potential for using MESA as a nitrogen tracer. We believe that MESA can be used to trace agricultural inputs on nitrogen to Lake Erie and other important waterbodies. This can help reduce the impact of harmful algal blooms on the surrounding urban environment, as well as evaluating the potential for measuring nitrate uptake or removal within an active bloom.

SPEAKER: **Zacharias J Smith, USDA Agricultural Research Service | zach.smith@usda.gov**

SPEAKER BIO: Cyanobacterial neurotoxin expert with 10 years of expertise in HABs, toxin analysis and detection, and HAB remediation. Current interests include HAB mitigation and harm reduction, HAB drivers and nutrient tracers.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

MARINE MAMMAL STRANDING EVENTS CAUSED BY DOMOIC ACID: THE ROLE OF BLOOM TIMING, LONGEVITY, AND GEOGRAPHIC EXTENT ON ECOSYSTEM IMPACTS IN SOUTHERN CALIFORNIA

SESSION: CLIMATE CHANGE

ABSTRACT: Southern California experienced expansive domoic acid producing blooms of Pseudo-nitzschia in 2022 and 2023, resulting in significant, but variable ecosystem impacts. The timing of each of these bloom events was atypical for the region, occurring in May-July and August-September in 2023 and 2022, respectively. These blooms were large but spatially heterogeneous throughout the region, with routine shore-based monitoring stations missing much of the event, particularly in 2022. The effects on marine mammal populations were significant with upwards of 1,400 animals stranding on local beaches with domoic acid intoxication symptoms across both events. More than twice the number of marine mammals stranded in 2023 compared to 2022. In 2022, the most impacted species were California sea lions (Zalophus californianus). In 2023, a large number of common dolphins (Delphinus spp.) stranded in addition to high numbers of California sea lions. Interestingly, the concentrations of domoic acid present in tested California sea lions were higher in 2022 compared to 2023, despite the larger number animals that stranded in 2023. Similarly, the observed toxin levels in the environment were higher in 2022 compared to 2023. The duration and timing of the bloom events may be related to the differences in the numbers and demographics of mammals impacted by the bloom. Notably, the bloom event in 2023 occurred at the beginning of the breeding season for California sea lions and towards the end of the breeding season in 2022. These findings point to the importance of better understanding how the timing, provenance, and magnitude of harmful algal bloom events may shift in the future due to climate change and anthropogenic influences as these shifts may also results in changes to the ecosystem impacts caused by these events.

SPEAKER: **Jayme Smith, Southern California Coastal Water Research Project | jaymes@sccwrp.org**

SPEAKER BIO: Jayme Smith is a Senior Scientist at the Southern California Coastal Water Research Project (SCCWRP) in Costa Mesa, CA where she runs the HABs research thematic area. Her current research efforts range from assessing the factors linked to increased risk of cyanobacterial HABs and their associated toxins in California freshwater systems, examining the environmental drivers and impacts caused by toxigenic Pseudo-nitzschia blooms in coastal southern California, and developing HAB monitoring tools and approaches in marine and freshwater systems. She serves on several committees focused on HAB monitoring and research including the National Harmful Algal Blooms Committee (NHC), California Harmful Algal Blooms Monitoring and Alert Program (Cal-HABMAP) steering committee and is a co-chair of the California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network. Staff profile: https://www.sccwrp.org/about/staff/jayme-smith/

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MICROCOLEUS AS TOXIC BENTHIC MATS ON DIFFERENT BOTTOM SUBSTRATES: ECOPHYSIOLOGY AND DISTRIBUTION

SESSION: BENTHIC HABS

ABSTRACT: Benthic cyanobacteria, notably Microcoleus, contribute to harmful algal blooms globally due to their toxin production. Their thriving in nutrient-poor freshwater environments presents significant environmental and public health challenges. In May 2023, we observed Microcoleus growing in a small tributary of the Virgin River near the Temple of Sinawava. Benthic mats were collected from six sampling points, three each, from rocks and sand substrates and collected rock and sand samples, along with downstream water samples. We aim to understand how these organisms survive in low-nutrient environments, explore interactions between toxic and non-toxic cyanobacteria and other bacteria, and analyze benthic community diversity and growth facilitators using metagenomics. Additionally, we aim to understand the influence of various substrate types on benthic mat composition and growth. An LCMS/MS toxin measurement analysis revealed that all the benthic samples contained anatoxin-a (ATX) (377.13 ±18.05 µg/g) and dihydro anatoxin-a (5.15±0.3 µg/g). In contrast, homoanatoxin-a and its dihydro derivatives were notably absent. ATX (0.377 µg/L) was also present in water samples. Low chlorophyll-a levels and microscopy results suggest the toxin in the water comes from benthic sources, not pelagic algae. The initial metagenomic analysis found that cyanobacteria constituted the majority (>60%) of all benthic mat samples, predominantly belonging to the Microcoleus genus, with <5% attributed to eukaryotic algae. Upon resampling in the fall (October), we observed a complete shift in benthic algae composition, with no presence of Microcoleus. Additionally, no ATX was detected in the algal mats or water samples. Distinct Microcoleus monoclonal strains isolated from the same location in April 2023 are under study for comparative analysis of Microcoleus genotype variations between laboratory-cultured and environmental samples. Our future work involves employing metagenomics and utilizing gene expression analysis to explain the mechanisms underlying Microcoleus growth, toxin production, and the roles of other organisms in facilitating the proliferation of toxic cyanobacteria.

SPEAKER: **Abeer Sohrab, The University of Utah | u1370694@utah.edu**

SPEAKER BIO: Abeer Sohrab is a graduate student at University of Utah, Salt Lake City, UT, USA, pursuing PhD in the field of Environmental Engineering. Her research focuses on studying the impact of harmful algal blooms on the environment, concentrating on genomic studies: the genetic mechanisms that govern the ecological successes of toxic and nontoxic benthic cyanobacteria. Her other work includes studying surrogate pathogens in wastewater specifically bacteriophages.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TOXIC CYANOBACTERIAL BENTHIC MATS GROW IN THE VIRGIN RIVER IN ZION'S NATIONAL PARK UNDER LOW NUTRIENTS CONDITIONS

SESSION: Poster Session, Wednesday

ABSTRACT: The toxin production and resilience of benthic cyanobacteria have driven extensive genomic and evolutionary research. In 2020 summer, A dog's death in the Virgin River at Zions National Park, USA by ingesting cyanobacterial mats highlighted the dangers of toxin-producing cyanobacteria. In 2021 summer, benthic mats were collected several times from two sites (visitor center and north creek) in the Virgin River at Zion's National Park for genomic and transcriptomic analyses. The primary focus was on understanding the diversity and ecology of cyanobacteria and bacterioplankton present in benthic mats, with an emphasis on Microcoleus species. Cyanobacteria were more abundant at the Visitors Center than at North Creek, with potentially toxic genera like Microcoleus, Oscillatoria, and Pseudoanabaena present at both sites, particularly Microcoleus, which accounted for up to 23% of total cyanobacteria abundance at the Visitors Center in May. The metagenomic assembled genome (MAG), named Microcoleus_ZNC_2 from North Creek was phylogenetically identified as species M. anatoxicus (isolated from Russian River, USA), while the Microcoleus MAG from the Visitor Center exhibited genetic similarity to a Canadian strain, indicating genotype diversity. Interestingly, this toxic Microcoleus_ZNC_2 displayed thiamine synthesis genes and a CAMP metabolic pathway but lacked anaHIK genes for dihydroanatoxin-a production. This strain of Microcoleus was found to use pho regulon by expressing pstS gene and alkaline phosphatase to cope with low or depleted concentrations of dissolved phosphorus. Although cyanobacteria do not perform denitrification, Microcoleus_ZNC_2 was found to harvest and express nosZ gene (176.13 TPM). The study also explored gene expression related to P and N metabolism in other organisms residing within the benthic mats. This study helps in understanding cyanobacterial mat ecology in shallow river ecosystems, marking a significant contribution as one of the few studies in the United States and the first for Zion's National Park to explore toxic benthic cyanobacterial mats.

SPEAKER: **Abeer Sohrab, The University of Utah | u1370694@utah.edu**

SPEAKER BIO: Abeer Sohrab is a graduate student at the University of Utah, Salt Lake City, UT, USA, pursuing PhD in the field of Environmental Engineering. Her research focuses on studying the impact of harmful algal blooms on the environment, concentrating on genomic studies: the genetic mechanisms that govern the ecological successes of toxic and nontoxic benthic cyanobacteria. Her other work includes studying surrogate pathogens in wastewater specifically bacteriophages

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CHILLING DEPENDENT INDUCTION OF QUIESCENCE IN NEWLY FORMED ALEXANDRIUM CATENELLA CYSTS

SESSION: Poster Session, Wednesday

ABSTRACT: Alexandrium catenella is a cyst-forming dinoflagellate that causes paralytic shellfish poisoning (PSP). Diploid resting cysts can remain viable in sediment for decades and oscillate between states of quiescence when they will germinate in response to favorable conditions and dormancy when they will not. In mature cysts, passage through these states is temperature dependent; quiescence is shortened by warming and dormancy by chilling. Newly formed cysts experience an alternate form of dormancy that prevents germination immediately after their formation. In this study, we investigated whether passage through immature cyst dormancy is similarly temperature dependent. Several liters of surficial sediment containing high concentrations of newly formed cysts were collected from Salt Pond (Eastham, MA) after a massive new cyst production event that occurred in 2023. This material was then packed into 2 cc amber vials and stored in anoxic mud for distribution between 4 different temperature treatments (4, 10, 15, and 20 □C). Periodically, vials were retrieved for completion of germination assays to characterize cyst appearance, fluorescence, and dormancy status. For all treatments, it took 7 weeks for the new cysts to transition from starch-filled to polar (mature) morphology. Similar to mature cysts, dormancy was shortened by incubation at colder temperatures as assessed by time to reach 50% quiescence. In the colder two of these temperature treatments, the amount of chilling required for dormancy passage, measured in chilling units, was similar to that required for mature cysts. However, unlike mature cysts, new cysts still achieved quiescence when incubated at 20 ˚C. These results help explain the development of late fall and wintertime blooms in Cape Cod embayments and suggest that new cysts may contribute to bloom renewal and prolongation when they are formed during winter months. They may also have helped promote early initiation of Nauset blooms in 2023 and 2024.

SPEAKER: **Nathaniel Spada, Woods Hole Oceanographic Insitution | nathaniel.spada@whoi.edu**

SPEAKER BIO: I am a research technician in the Don Anderson Lab at Woods Hole Oceanographic Institution. I study the ecology of harmful algal blooms (HABs) as well as their impacts and ways to mitigate bloom events. Through both research and outreach, I look to elevate the knowledge of HABs and how to exist in a world where they are becoming more prevalent.

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DYNAMICS AND DRIVERS OF TWO CYANOTOXIN-PRODUCING BLOOMS IN THE LARGEST DRINKING WATER RESERVOIR IN SOUTHERN CALIFORNIA

SESSION: Bloom Dynamics & Drivers II

ABSTRACT: Diamond Valley Lake is the largest reservoir in Southern California with a capacity of 800,000 acre-feet of water. It is also the newest, with construction completed in 1999 and initial filling completed in 2002. Two significant cyanotoxin-producing cyanobacterial blooms occurred in the reservoir during a ten-year period (2013-2023), leading to voluntary recreational advisories in 2018 and 2023. Microcystin concentrations were elevated from June through July and from July to November in 2018 and 2023, respectively. Drinking water was not impacted due to lake operations during the impacted periods. The cyanobacteria attributed to the production of microcystin were Microcystis spp. and Gloeotrichia echinulata. Biomass for these cyanobacteria was significantly greater in 2018 and 2023 compared to other years during the ten-year period evaluated. The trophic status of the reservoir changed from eutrophic to hypereutrophic during the ten-year period, with the highest trophic indices in 2018 and 2023. Total phosphorous was greater in 2018 and 2023 than in other years and total nitrogen was higher in these two years compared to their respective two preceding years. The water in the reservoir has a five-year detention time with variable inflow and outflow rates, which have a significant impact on nutrients, phytoplankton assemblages, and cyanotoxin production. Cyanotoxin-producing blooms and changes in the phytoplankton assemblages in 2018 and 2023 were preceded by refilling of the reservoir with the only available source water (nutrient-rich) after extended drought years, during which the lake was continuously discharging water, experiencing severe hypolimnetic hypoxia and episodes of nutrient release from the sediment. Therefore, the likely drivers of the cyanotoxin-producing blooms in 2018 and 2023 were increased nutrient input during essential refilling and sediment phosphorous releases during dry years, switching the trophic state of the lake from eutrophic to hypereutrophic.

SPEAKER: **Margaret Spoo-Chupka, Metropolitan Water District of Southern California | MSpoo-Chupka@mwdh2o.com**

SPEAKER BIO: Margaret Spoo-Chupka is a senior biologist with an emphasis in phycology at the Metropolitan Water District of Southern California (MWD-SC). She holds two B.S degrees in marine biology and plant cellular/molecular biology at the University of North Carolina-Wilmington and the Ohio State University, respectively. She also holds a M.S degree in microbiology from Texas A&M University-Corpus Christi . She has 20 years of experience in freshwater phytoplankton taxonomy, getting started in her work at the limnology laboratory at the Ohio State University. She is also experienced in the culture, isolation, and characterization of algae and cyanobacteria having previously worked at an algae biofuel company. Her work there earned her a patent, Methods for improved mixed trophic state algal culture. Margaret's current work at MWD-SC focuses on the monitoring and management of problem algae and cyanobacteria in seven different source water reservoirs and an aqueduct. Margaret has aided in the development of guidance documents for the management and treatment strategies of benthic cyanobacteria with the Interstate Regulatory Council (ITRC). She also helps organize an international collaborative discussion group on benthic cyanobacteria, hosted by the EPA, by organizing webinars. https://www.linkedin.com/in/margaret-spoo-chupka-99099953/

HARMFUL ALGAL BLOOM FORECASTING AT NOAA'S NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE: A RESEARCH TO OPERATIONS TO RESEARCH (R2O2R) APPROACH

SESSION: PREDICTIVE MODELING - MARINE

ABSTRACT: Harmful algal blooms (HABs) cause significant economic, social, and ecological impacts to coastal and Great Lakes communities around the United States. As such, coastal managers, industry leaders, and community members need robust HAB early-warning and forecasting capabilities to anticipate and prepare for potential bloom events, and in the event of a bloom, tools to track the HAB location, trajectory, and magnitude. The National Centers for Coastal Ocean Science (NCCOS) within the National Oceanic and Atmospheric Administration (NOAA) is a leader in conducting applied coastal science that provides information to better understand and respond to complex coastal issues. The NCCOS Harmful Algal Bloom Forecasting Branch (HAB-F) in particular uses novel approaches in remote sensing, numerical modeling, and in situ data collection/integration to develop and deliver HAB early-warning and forecasting products. This work is combined with diverse dissemination and communication methods to provide stakeholders with advanced warning of bloom impacts. To date, HAB-F produces routine HAB forecasts for western Lake Erie, the Gulf of Mexico, the east coast of Florida, and the Gulf of Maine, and is collaboratively conducting innovative research to expand the geospatial footprint of these forecasts (e.g., Chesapeake Bay, Gulf of Alaska, Lake Okeechobee, etc). Ongoing research includes assessing new technologies to incorporate into operational HAB forecast systems, such as new hyperspectral ocean color sensors; and to implement new forecasting capabilities such as the probability of toxin exceedance. This presentation will focus on the programmatic approach that NCCOS HAB-F is taking to develop a sustained operational framework for HAB forecasting to establish a robust research to operations to research (R2O2R) lifecycle for accessible, decision-making coastal products.

SPEAKER: **Kari St.Laurent, NOAA / NOS / NCCOS | kari.stlaurent@noaa.gov**

SPEAKER BIO: Kari St.Laurent is the Chief of the Harmful Algal Forecasting Branch within NOAA's National Centers for Coastal Ocean Science. She received a Ph.D. in Oceanography from the Graduate School of Oceanography at the University of Rhode Island studying black carbon fluxes in the Subtropical Atlantic Ocean. Previously, St.Laurent has been the Research Coordinator for the Delaware National Estuarine Research Reserve and was the Ocean Biology Product Portfolio Manager for NOAA's National Environmental Satellite, Data, and Information Service.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

NEW APPLICATIONS FOR PHYTO-ARM, A ROS-BASED TOOLKIT FOR INTEGRATION OF IFCB WITH OTHER OCEANOGRAPHIC SENSORS AND OBSERVING PLATFORMS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: PhytO-Arm is a free and open-source software and hardware design toolkit for the creation of automated ocean observing systems that leverage the capabilities of the Imaging FlowCytobot (IFCB) particle imaging sensor. Software is built using the Robot Operating System (ROS) and is highly modular, making reconfiguration of system components to suit particular observing applications and objectives straightforward. In this work, several recently deployed PhytO-ARM configurations are described. These include: (1) a profiling 'arm' configuration that collects and interprets hydrographic profiles and targets fluorescence thin layers for IFCB sampling; (2) a modified two-arm version that coordinates the CTD profiling and IFCB thin layer sampling with carbonate system profiling using a CHANOS pH/DIC sensor (Wang Lab, WHOI) and an in situ multichannel analyzer for dissolved nutrients (Wiz probe, Systea Analytical Technologies); and (3) a USV-focused configuration that enables real-time image classification using convolutional neural network (CNN) models. These systems have been deployed in the Nauset Marsh on Cape Cod and at various locations along the coast of Maine. The winch component of arm-based systems has been developed with the goal making it both affordable and easy to maintain. Its main components are a repurposed deep-sea fishing reel, a servo motor, and a worm gear reducer. The winch can profile instrument packages up to 100 lbs water weight and costs less than $7500 to build. Instructions for assembly and configuration of the base arm system are available online and required software is available through GitHub.

SPEAKER: **Michael Staiger, Woods Hole Oceanographic | michael.staiger@whoi.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

USING MULTIPLE MONITORING TECHNIQUES TO UNDERSTAND HARMFUL ALGAL BLOOM POTENTIAL IN A SMALL PUBLIC WATER SUPPLY RESERVOIR IN SOUTHEAST PENNSYLVANIA, USA.

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The Susquehanna River Basin Commission (Commission) has been using a combination of in-situ continuous monitoring, routine discrete sampling and remote satellite imagery to evaluate harmful algal bloom potential and in-lake conditions in a public water supply reservoir in southeast Pennsylvania, USA since 2022. The land use in the surrounding watershed is largely agricultural with more than 1,200 individual farms and thus of high concentrations of nutrients, particularly nitrate, into the reservoir is well documented. Harmful algal blooms are fairly uncommon within the reservoir but have wide ranging repercussions due to the multi-use nature of the waterbody for public water supply as well as secondary recreation. The Commission deploys a buoy housing a data sonde for continuous monitoring of general water quality parameters as well as the algal pigments chlorophyll and phycocyanin. Additionally, air temperature and light intensity are also both monitored continuously. Monthly sampling events are times to coincide with the crossing of the Sentinel-2 satellite. Literature suggests a relationship between observed chlorophyll concentrations across a lake and multi-spectral imagery based algorithms from the same day. Here we attempt to correlate chlorophyll concentrations at one point in the lake across satellite imagery from multiple passes throughout the field season. Initial result how marginal correlation at the one point over multiple months of remote sensing returns so an attempt was made to pivot to the more traditional multiple points in a lake correlated to one satellite image. Another facet of this research if linking cyanobacteria colony counts and any detected toxins with observed in-situ conditions. Multiple sensor types have been compared and two years of data reveals fascinating results which may impact lake management. Lessons learned include improved data sonde calibration with multiple replicates of pigment analysis in addition to the importance of including precipitation and stream flow inputs into result interpretation.

SPEAKER: **Luanne Steffy, Susquehanna River Basin Commission | lsteffy@srbc.gov**

SPEAKER BIO: Luanne Steffy has worked as an aquatic ecologist for the Susquehanna River Basin Commission for the past 20 years after completing a bachelors degree in Biology from Geneva College and a Masters in Environmental Science from Drexel University. Most of her experience is in stream ecology but more recently has expanded into lake dynamics and harmful algal blooms.

BEYOND MICROCYSTINS:DEVELOPMENT OF ANALYTICAL STANDARDS FOR MAJOR CLASSES OF BIOACTIVE CYANOBACTERIAL PEPTIDES USING QUANTITATIVE NMR, 15N LABELING, AND LC-UV-MS/MS

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: The ever-increasing occurrence of cyanobacterial blooms worldwide has elevated concerns over the safety of environmental and drinking water reservoirs. Robust analytical methods now exist for monitoring known toxins such as the microcystin class of cyclic peptides and the cylindrospermosin alkaloids, both of which pose significant risks to both human health and ecosystems. As part of this monitoring program, regulatory values have been set globally, federally, and regionally. However, many freshwater cyanobacterial blooms produce other suites of potently biologically active peptides which are often overlooked or ignored in targeted screening due to a lack of reference standards and established methods of assessment. Beyond the known cyanotoxins, there is a pressing need for advanced detection and quantification techniques for other classes of biologically active cyanopeptides that are often major components of these blooms.

Through a decade of laboratory culture work with freshwater cyano-HAB cultures, we have amassed a collection of many of these bioactive peptide classes including anabaenopeptins, aeruginosins, cyanopeptolins, microginins, and many more. Using a combination of orthogonal analytical techniques including quantitative nuclear magnetic resonance (qNMR), 15N isotopic labeling of cyanobacterial cultures, and liquid chromatography ultraviolet coupled tandem mass spectrometry (LC-UV- MS/MS), we are assessing representative members of major freshwater cyanopeptide classes. In our ongoing work, extinction coefficients for calculation of relative response factors will be assigned, and analytical-scale standards generated. These data and products will aid the HAB community and regulatory stakeholders in assessing the prevalence of these potently bioactive, but often overlooked major classes of metabolites, and will enable more accurate detection and quantification using common LC-UV- MS methods.

SPEAKER: **Wendy Strangman, University of North Carolina | strangmanw@uncw.edu**

SPEAKER BIO: Dr. Strangman received her PhD from the Scripps Institution of Oceanography, and her postdoctoral research was performed at the University of British Columbia. Now an associate professor at UNC Wilmington, for over a decade, her research interests have centered on the application of mass spectrometry-based analyses for the discovery and detection of toxins and other bioactive compounds produced by harmful algal bloom (HAB) species. Additional research interests include mass spectrometry-based pharmacokinetic assays to assess digestive transformation and permeability of medicinal plant extracts, the discovery of new bioactive natural products produced by marine bacteria from the microbiomes of marine parasites, pathogen-resistant coral microbiomes, and deep arctic sediments, and chemical ecology of Caribbean coral reefs.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

HARMFUL BENTHIC CYANOBACTERIA AND THEIR ASSOCIATED COMMUNITY STRUCTURES ACROSS THE UNITED STATES

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Proliferation of toxic benthic cyanobacteria is becoming an increasing problem in the United States. Incidences are often only reported when a pet or animal deaths occur due to exposure to toxic benthic mats. These benthic mats are comprised of very diverse microbial communities often containing toxic and non-toxic species and phyla other than cyanobacteria. To understand the relationships between harmful benthic cyanobacteria with other microbial communities would help us to better assess their risks to public health. In this study benthic material was collected from multiple regions across the United States to compare the occurrence of toxic benthic cyanobacteria and the composition of the associated communities among various sampling sites. We used qPCR targeting the toxin genes Ana F, Ana C and mcy E as well as cyanotoxin measurements to establish correlations between toxin gene abundance and toxin concentrations. For the associated community, analyses of the 16S rRNA gene, metagenomic, and toxin gene sequences were conducted to characterize various communities associated with toxic versus non-toxic benthic mats and identify the dominant toxin producing species. Preliminary results of 16 S rRNA sequencing show that benthic cyanobacterial communities are highly diverse, and contain possible toxin producers Phormidium, Pseudoanabaena, and Microseira. Analyses of qPCR data and toxin gene sequencing point to Phormidium (Microcoleus) autumnalis being the dominant toxin producer in samples in which Anatoxin is also detected. Taken together, the information provided from this study would help to identify the potential risk to public health from benthic materials.

SPEAKER: **Ian Struewing, United States Environmental Protection Agency | Struewing.Ian@epa.gov**

SPEAKER BIO: Ian Struewing is a Biological Science Technician working for the United States Environmental Protection Agency. He has 15 years experience working in Environmental Microbiology studying Harmful Algal Blooms and Opportunistic Pathogens.

CO-AUTHORS:
Aim`ee Henderson, David Linz, Nathan Sienkiewicz, Kyle McIntosh, Chris Nietch, Rich Fadeness, Jingrang Lu

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

CHANGES IN WESTERN LAKE ERIE CYANOBACTERIAL BLOOM PHENOLOGY OVER THE PAST TWO DECADES

SESSION: CLIMATE CHANGE

ABSTRACT: Western Lake Erie (WLE) has experienced significant cyanobacteria blooms annually during the recent two decades. The blooms vary substantially in size and intensity between years, primarily due to differences in total spring load of bioavailable phosphorus from the Maumee River. However, there have been changes in bloom phenology in the most recent decade (2012 - 2023) as compared to the previous one (2002-2011). Blooms, including those of similar maximum cyanobacteria biomass, intensify typically in July in the recent decade, as compared to intensification in August during the first decade. In addition, the peak biomass in the first decade usually occurred in early September, but now typically peaks in August. This shift in bloom phenology has altered our understanding and description of bloom severity. We estimate the annual bloom severity as the cyanobacteria biomass measured from satellite during the peak three 10-day periods. In the recent decade, the "peak" biomass tends to last longer, leading to a higher calculated severity than occurred in the first decade for an equivalent cyanobacteria biomass. In contrast to changes in the start of the bloom, duration of the bloom into the fall has shown a less clear pattern of change. While climate change, especially temperature, is an expected factor causing earlier blooms, temperature patterns are only suggestive. During June and July, water temperatures in the WLE were cooler in some early years, but not in others. Lack of winter ice may be associated with more intense blooms, suggesting other ecological factors (e.g., timing of the spring bloom) may play a role. Long time series are vital for recognizing when the past no longer accurately represent the present. Climatological components of models need to account for shifts in bloom characteristics, and use such changes to improve our understanding of bloom dynamics.

SPEAKER: **Richard Stumpf, NOAA | richard.stumpf@noaa.gov**

SPEAKER BIO: https://coastalscience.noaa.gov/staff/richard-stumpf-phd/#:~:text=Stumpf%20has%20forty%20years%20of,algal%20bloom%20monitoring%20and%20forecasting

CO-AUTHORS:
Alexandria G. Hounshell, Timothy T. Wynne, Andrew Meredith, Sachidananda Mishra

CURRENT CAPABILITIES AND OPPORTUNITIES FOR NUMERICAL WATER QUALITY MODELING OF HARMFUL ALGAE BLOOMS (HABS)

SESSION: PREDICTIVE MODELING - FRESHWATER

ABSTRACT: Water quality models can be effective and efficient tools to simulate and analyze water quality, however, there are several barriers that exist to water quality modelling with respect to harmful algae blooms. The main focus of this study was to increase understanding regarding the current state of water quality modelling, with a primary focus on the use of CE-QUAL-W2 (W2) in USACE reservoirs, and the ultimate goal of proposing additional capabilities for improvement of algal simulation. Some of the most common barriers we found that hinder the accurate representation of algal blooms include inability to obtain high frequency data for model validation, parametrization of species-specific behavior, and determination of number of input variables. The potential improvements we propose for addition to the W2 model based on this study are: 1) Improving estimates of parameters (such as maximum growth rate and nutrient half-saturation coefficients) through an updated review of lab and field studies; 2) Expanded test applications of a cyanotoxin model; 3) Incorporating sediment resuspension and entrainment as a function of bottom sheer stress and water velocity; 4) Diversification of algae groups; 5) Improving accuracy of interactions between sediment and water column, especially in regards to dormant algae; 6) Adding algae motility throughout the water column in response to light and temperature levels and specific algae preference. Plans are currently underway to implement these changes into W2 and demonstrate a test within a USACE reservoir.

SPEAKER: **Emily Summers, US ACE | emilyjane1215@tamu.edu**

SPEAKER BIO: Emily Summers is a post-doctoral scholar at the US Army Engineer Research and Development Center (USACE-ERDC). Her research utilizes tools such as multidimensional hydrodynamic and water quality models, high frequency water quality monitoring, and advanced statistics to examine emerging issues in water quality including HABs and microplastics.

CO-AUTHORS:
Isaac J. Mudge, US Army Corps of Engineers, New Orleans District
Jodi L. Ryder, US Army Corps of Engineers, Engineer Research and Development Center
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INTRAGENETIC DIVERSITY IN THE CORE GENE OF SAXITOXIN SYNTHESIS FROM THE TOXIC DINOFLAGELLATE *ALEXANDRIUM PACIFICUM* AND A POTENTIAL IMPACT ON TOXIN PRODUCTION

SESSION: POSTER SESSION

ABSTRACT: Harmful algal blooms (HABs) caused by *Alexandrium pacificum* threaten public health and the economy through the production of Paralytic Shellfish Toxins (PSTs), leading to Paralytic Shellfish Poisoning (PSP). The frequency of PSP events has risen due to climate change and eutrophication. Interestingly, high *Alexandrium* cell densities do not always correlate with elevated toxin levels in shellfish. Furthermore, understanding PST production is complicated by the species' physiological variability and significant genetic diversity in the *sxtA4* gene, yet the link between this diversity and toxin production remains unexplored. Thus, this study aimed to investigate the physiological variability of eight *A. pacificum* strains isolated from Korean coastal waters and to explore the potential effect of intraspecific genetic diversity of the *sxtA4* gene on PST production. We examined these strains under various temperature conditions (15 °C, 20 °C, 25 °C, and 30 °C) to understand how toxin production varies with temperature. Our findings revealed that toxin production increased at temperatures that limited growth, with the highest number of saxitoxin congeners detected at 30 °C. Additionally, we analyzed the genetic diversity of the *sxtA4* gene, which is crucial for saxitoxin synthesis. Results indicated that greater genetic diversity within this gene is associated with a wider variety of saxitoxin congeners, measured using Shannon's diversity index. These findings diversity in *Alexandrium* strains, especially as environmental conditions continue to change, highlighting the need for ongoing research into their adaptive strategies and ecological impact.

SPEAKER: **Jiyeon Sung, Stony Brook University | giyun.sung@stonybrook.edu**

CO-AUTHORS:
Dong Han Choi, Christopher J. Gobler, Yeonjung Lee, Hyun Ho Shin, Young-Eun Kim, Jae Ho Choi, Jae Hoon Noh, Bum Soo Park

U.S. National Office for Harmful Algal Blooms

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

PHASED MATING AND DIVISION DYNAMICS OF DINOPHYSIS ACUMINATA IN CULTURE AND IN SALT POND, MA

SESSION: BLOOM DYNAMICS & DRIVERS I

ABSTRACT: Dinophysis are kleptoplastidic dinoflagellates, and many species in this genus cause diarrhetic shellfish poisoning (DSP). They feed specifically on the ciliate Mesodinium and sequester their plastids, utilizing them for photosynthesis for up to a couple months. Still, when starved for periods of time without Mesodinium, their photosynthetic capability diminishes, so feeding is also critical for sustained autotrophic activity. Understanding how Dinophysis can persist between feeding opportunities is important to understanding its ecology. In many dinoflagellates, life cycle strategies are interwoven with “bloom-and-bust” cycles; in some, sexual fusion results in a physiological transition of the zygote to a benthic cyst, which may precipitate the termination of a bloom. However, no such process has been described in Dinophysis. The life cycle transitions of Dinophysis, and how it relates to its ecology, are still poorly understood. Here, we present how mating is phased both in a clonal culture and in situ through continuous imaging observation of a Dinophysis acuminata bloom in the Nauset Marsh (Cape Cod, MA, USA). In culture, the persistence of a small 2N cell subpopulation through several days of observed mating and division suggests that cells underwent repeated cycling of mating and meiotic division. The presence of mating in both prey-saturated and prey-limited cultures indicated that mating is not a response to prey scarcity. Higher mating frequencies in the prey-saturated culture and in Nauset bloom years with higher division frequencies suggest mating and division are linked processes. Further studies of sexual life cycle transitions in the field are needed to better understand triggers and consequences of sexual reproduction, particularly given differences between culture and field observations.

SPEAKER: **Serena Sung-Clarke, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution | serena.sungclarke@whoi.edu**

SPEAKER BIO: Serena Sung-Clarke is a Ph.D. candidate in Biological Oceanography at the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution (MIT-WHOI Joint Program). She received her B.A. in Biology (Honors) and Political Science in 2019 from Swarthmore College, where she conducted research on cnidarian immunity with Dr. Elizabeth Vallen. Prior to starting her Ph.D., she spent two years as a contractor with U.S. EPA’s Office of Water on projects related to watershed health, drinking water contamination, and climate resilience. Serena is conducting her thesis research in Dr. Michael Brosnahan’s lab, combining culture experiments and field observations to study the life cycle ecology of the toxic dinoflagellate Dinophysis, and how its bloom dynamics are related to and affected by scarcity of their ciliate Mesodinium prey.

CO-AUTHORS:
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Wenguang Zhang; Zhejiang University
Nour Ayache; Virginia Institute of Marine Sciences
Michael Brosnahan; Woods Hole Oceanographic Institution

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

QUANTIFYING THE EFFECTS OF SARGASSUM BLOOMS ON ACROPORA CERVICORNIS: AN EMERGING THREAT TO RESTORATION CORALS IN ACIDIFYING SEAS

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Considerable research has been dedicated to measuring the effects of acidification on the health and growth of corals worldwide. More recently, focus has shifted to understanding how acidification impacts may be modified by species interactions, such as those between Caribbean coral and increasingly frequent harmful blooms of the algae, Sargassum spp. These blooms may reduce light and alter seawater carbonate chemistry on reefs, ultimately affecting coral health and physiology. We exposed Acropora cervicornis fragments to present-day coastal pH and pH projected for the year 2100 under moderate CO2 scenarios in the presence and absence of Sargassum for two months. At the end of the experiment, we measured visual health, growth, and photochemistry (quantum yield, electron transport rate, and non-photochemical quenching) of the coral. Growth rates were reduced by 3% in the future pH + algae treatment compared to ambient conditions. Similarly, there was a significant reduction in quantum yield and electron transport rate, and a significant increase in non-photochemical quenching in the future pH + algae treatment, indicating deteriorating health and increased stress response. Other studies have shown that Sargassum blooms outcompete growth of new corals and can drown out mature coral colonies, and our study provides more evidence that these blooms also have negative impacts on adult coral physiological processes, especially in a high CO2 environment. This information emphasizes the importance for coral restoration efforts to account for larger and longer seasonal Sargassum blooms.

SPEAKER: **Kathleen Sway, Mote Marine Laboratory | ksway@mote.org**

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EFFECTS OF THE CYANOBACTERIA MICROCYSTIS AERUGINOSA ON EASTERN OYSTER FEEDING

SESSION: SHELLFISH

ABSTRACT: The eastern oyster, Crassostrea virginica, is an estuarine consumer of considerable ecological and economic value, able to select individual phytoplankton species from a mixed community. Estuarine phytoplankton communities are experiencing an increased presence of small, nutritionally poor, salt tolerant, and potentially toxic cyanobacteria, such as Microcystis aeruginosa. To determine how the presence of the potentially harmful cyanobacteria M. aeruginosa affects oyster feeding, we quantified clearance rates, pseudofeces production, and pseudofeces composition across two sets of feeding experiments. Results from both bialgal (M. aeruginosa/Thalassiosira pseudonana) experiments (1st set) and those adding M. aeruginosa to a natural phytoplankton community (2nd set) indicated that ecologically-relevant concentrations of non-toxic M. aeruginosa do not significantly affect oyster clearance rates. In bialgal experiments, oysters showed no difference in pseudofeces production or composition relative to how many M. aeruginosa cells were captured. However, oysters tested using the more environmentally-relevant and compositionally-complex backdrop of a natural community with inorganic particles, produced significantly more pseudofeces when M. aeruginosa cells were added. These combined results yielded non-deterministic views of the fate of cyanobacteria in estuarine waters, and future research efforts should focus on implications that a diet containing the nutrient poor species Microcystis may have on oyster fitness, specifically in relation to other climate- and human-driven stressors.

SPEAKER: **Julia Sweet, University of Louisiana | julia.sweet1@louisiana.edu**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

SYNTHESIS OF MERCAPTAN-BASED BREVETOXIN SCAVENGERS AND EVALUATION OF THEIR ABILITY TO INTERFERE WITH BINDING TO VOLTAGE-GATED SODIUM CHANNEL AND REDUCE CYTOTOXICITY.

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Brevetoxins (PbTx), neurotoxins produced by K. brevis that bloom during red tide events, can cause marine mammal poisoning, mortalities, and deaths of fish, sea birds, and turtles and exhibit adverse human health effects. Brevetoxins can bind to the voltage-gated sodium channel (VGSC) and inhibit thioredoxin reductase (TrxR), a major regulator of cellular redox homeostasis. Currently, no treatments are available for the neurotoxic or respiratory effects of brevetoxins on wildlife or humans. Synthesis and evaluation of mercaptans as potential “antitoxins”, based on the hydrophilic FDA-approved acrolein scavenger, cysteamine, that may react with and thereby detoxify PbTx-2, were conducted. Sulfonamides and amide derivatives were prepared and characterized by HRMS, 1H, and 13C NMR. Partition coefficients (Log Kow) of thiols were determined in an octanol-water system, and reactivity with PbTx-2 assessed using FT-ICR-MS at different time points. Log Kow values showed an increase in lipophilicity of all cysteamine derivatives, which could improve drug uptake and half-life compared with cysteamine. Monosubstituted and disubstituted PbTx-2 adducts were detected in most of the tested reactions. To assess their ability to act as potential PbTx-2 “antitoxins” we performed fluorescent receptor binding assay (RBA) and cytotoxicity assays. Most of the compounds showed the ability to reduce PbTx-2 binding affinity on the RBA, exhibiting some level of “antitoxin” properties. PbTx-2 modified with aromatic sulfonamides containing electron donating (-CH3) and withdrawing (-NO2) groups showed to be effective compared to aliphatic groups which demonstrated similar binding to unmodified PbTx-2. Aromatic sulfonamides with p-bromo and p-methyl, showed the most statistically significant decrease in PbTx-2 cytotoxicity at 43 hours in SJCRH30 cells. Our studies suggest that PbTx-2 conjugation with some synthesized mercaptan drugs could interfere with VGSC binding and lower PbTx-2 cytotoxicity, thus providing a set of compounds that could serve as an emerging treatment for brevetoxicosis in wildlife and humans.

SPEAKER: **Mayra Tabares, Florida International University | mtaba024@fiu.edu**

SPEAKER BIO: Chemist with experience in organic synthesis able to design, optimize reactions conditions and conduct purification and spectroscopic techniques. Furthermore, I had built skills to perform cell culture, receptor binding assays, ELISA, and cytotoxicity experiments. Besides my research experience, I have developed leadership, writing communication and organizational skills as a professor in high school and undergraduate level as well as carrying out research work and being an organizer of a research symposium as an undergraduate student. During my PhD studies, I have contributed with the synthesis of 13 possible treatments for brevetoxin toxicity and have successfully evaluated their effectiveness.

CO-AUTHORS:
Yuan Liu, Jennifer R. McCall, Kathleen S. Rein

PREDICTION OF CYANOHABS VIA MACHINE LEARNING USING COMPREHENSIVE DATASETS

SESSION: Poster Session, Wednesday

ABSTRACT: Harmful Algae Blooms (HABs) occur when algae colonies undergo excessive growth and produce toxic or harmful eTects on all life that the water source supports - people, fish, shellfish, marine mammals, and birds. HABs have been reported in every U.S. coastal state and in multiple freshwater lakes, and their occurrence is on the rise. HAB monitoring is reflected in the collection of disparate types of data - water quality data, environmental data, satellite data and 'omics data. Various machine learning (ML) models exist that use these diverse data sources to train models for HAB prediction. In this work, we focus on freshwater cyanobacterial harmful algal blooms (CyanoHABs), specifically in the Lake Erie region, and attempt to create a ML model that combines the disparate data sources in order to derive a holistic picture of CyanoHAB precursors and indicators. To this end, we relate the various available data sources both temporally and spatially; identify gaps in the data; and use data analysis techniques to create a comprehensive training dataset. Also, we leverage our ML results to identify thresholds for the various measured parameters for HAB onset. Through application of our ML model we aim to identify new relationships in the data that can be used to better understand CyanoHAB dynamics.

SPEAKER: **Anjana Talapatra, Los Alamos National Laboratory | atalapatra@lanl.gov**

SPEAKER BIO: Anjana Talapatra is an early career scientist in the Materials Science and Technology Division at Los Alamos National Laboratory. Her expertise lies in ML/AI and atomistic calculations. She specializes in the development and application of high throughput electronic structure and atomistic frameworks to understand and design functional ma-terials, with a particular focus on targeted materials design. As a former Director's Post-doctoral Fellow and as an active participant on multiple current and previously funded efforts on materials informatics, she has made significant contributions in developing and applying new techniques for high-throughput screening of materials. She has authored or co-authored over 30 papers on use of atomistic and informatics methods for materials and experiment design that have been cited more than 600 times for an h-index of 16. She has extensive experience in the supervision and mentoring of undergraduate and graduate students during research activities at TEES.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

LABORATORY-SCALE EVALUATION OF ALGAL BIOMASS PERSISTENCE AND MICROCYSTIN DYNAMICS FOLLOWING TREATMENT WITH SIX USEPA-REGISTERED ALGAECIDES AT DIFFERENT TEMPERATURES AND APPLICATION RATES

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Climate change and eutrophication have contributed to the proliferation of harmful algal blooms in aquatic ecosystems globally. Algaecides are a proven treatment strategy for bloom control; however, their efficacy can vary based on temperature, species, and application rate. Three experiments were conducted using site-collected water with associated blooms to assess efficacy of six algaecides. Planktothrix, Microcystis, and Dolichospermum-dominated blooms were collected from freshwater bodies in Ohio, USA, and incubated at collection temperature as well as +/- 5° C. Chlorophyll concentrations, cell abundance, and total and extracellular microcystins were quantified up to 72 and 96 hours after treatment (HAT) to assess the efficacy of treatment. In experiment one dominated by Planktothrix, GreenClean Liquid demonstrated the greatest decrease in chlorophyll, with up to 76% reduction at 10 ° and medium application rate. Concurrently, total microcystins were reduced up to 66% from the control but showed a complete shift to extracellular form. In experiment two, dominated by Planktothrix, GreenClean Liquid showed the greatest reduction in chlorophyll at 20° and medium application rate, with up to a 90% decrease compared to the control. Under the same variables, total microcystins were reduced up to 68% with a complete shift to extracellular form. For experiment three, using a bloom that was co-dominated by Microcystis aeruginosa and Dolichospermum, Seclear at 10° and medium application rate showed the greatest decrease in chlorophyll with reductions up to 92% from the control. Total microcystins under the same variables decreased 88% from the control while 39% of the remaining toxins shifted to extracellular form. These experiments showed that some algaecides were more effective at lower temperatures while others performed better at higher temperatures. For the cases listed above, Seclear and GreenClean Liquid application rates demonstrated the greatest decrease in algal biomass at medium dose. These findings highlight the importance of considering variables such as temperature and application rate as these factors may impact algaecide efficacy and microcystin dynamics. It is crucial to understand these variables when choosing algaecide application strategies to mitigate ecological impacts.

SPEAKER: **Autumn Taylor, University of Florida | autumntaylor@ufl.edu**

SPEAKER BIO: Autumn Taylor is a graduate student at the University of Florida studying interdisciplinary ecology. Her specialization is in harmful algal bloom mitigation and she has previous experience working as a laboratory technician in a water quality lab.

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MONITORING THE 2023 TRIPOS BLOOM IN THE GULF OF MAINE: A COLLABORATIVE RESPONSE

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: A bloom of the dinoflagellate Tripos muelleri, dominated the western Gulf of Maine from April to August of 2023. In response to this highly unusual event a network of collaborators throughout the region coordinated monitoring efforts to track the bloom's extent, progression, and impacts on fisheries and the ecosystem. Of greatest concern was the possible development of a large hypoxic zone resulting from the sinking and decomposition of the bloom. Although low dissolved oxygen levels were detected in Massachusetts Bay the bloom ultimately ended without a major event. Still, the bloom's fate, impact, and cause remained unknown which motivated the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) and University of New Hampshire to host a seminar and workshop. The workshop strived to advance an understanding of the bloom, to evaluate the monitoring response, and recommend improvements for the coastal ocean observation system. It highlighted the need for enhanced monitoring to better understand and anticipate events like algal blooms. Nevertheless, the coastal ocean observing network did a fair job of monitoring the highly unusual Tripos bloom event, and the research community is actively working towards better understanding it. Those successes can largely be attributed to strong networks and the collaborative disposition of the community which may serve as mechanisms for climate resilience. Under future climate change scenarios extreme events are expected to become more common and necessitate rapid responses. Greater observational infrastructure will help in monitoring and responding to such events, as will facilitating collaboration efforts and supporting structured communication.

SPEAKER: **Cameron Thompson, NERACOOS | cameron@neracoos.org**

SPEAKER BIO: I am a marine scientist with a background in zooplankton ecology, aquaculture, fisheries, and marine resource management. I currently work as a Pelagic Ecology Research Fellow at NERACOOS, where I investigate climate impacts and the connections between zooplankton populations and species of concern in the Gulf of Maine, aiming to improve ecosystem forecasting and inform management decisions.

I received my B.Sc. in Biology from the State University of New York at Geneseo, dual M.Sc. degrees in Marine Biology and Marine Policy from the University of Maine, and a Ph.D. in Biology from the University of Bergen, Norway. My doctoral research focused on developing a novel method for monitoring salmon lice in aquaculture settings.

Over the past 15 years, I have held positions at both academic and governmental institutions, including the Norwegian Institute of Marine Research, the University of Maine, and the Gulf of Maine Research Institute. My work often includes collaborations with diverse teams across institutions. I frequently engage with stakeholders on pressing issues and have coordinated workshops and other collaborative efforts.

My research focuses on monitoring and understanding ecosystem change through the lens of zooplankton ecology. I seek to monitor lower trophic levels and mechanistically link them to both drivers of change and impacts on higher trophic levels. Much of my work has centered on the copepod Calanus finmarchicus, which is the foundational species of the subarctic ecosystem of the northeast shelf and the primary prey of the critically endangered North Atlantic Right Whale.

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Jake Kritzer,

MACRONUTRIENT CONTROL OF SAXITOXIN PRODUCTION IN THE HAB-FORMING CYANOBACTERIUM, DOLICHOSPERMUM CIRCINALE

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Freshwater cyanobacteria can be limited by low phosphorus and/or low nitrogen supply, and have been observed to experience shifts in the production of cyanotoxin when exposed to nutrient limited conditions. Nutrient limited conditions have resulted in the uptick and reduction of cyanotoxin production. For example, previous investigations have established that nitrogen can control the production of the nitrogen-rich toxin microcystin in Microcystis. In contrast, little is known regarding the role of nutrient balance in the production of the nitrogen-rich saxitoxin in cyanobacteria. Here, we investigated the influence that phosphorus and nitrogen limitation have on the production of saxitoxin in the freshwater cyanobacteria, Dolichospermum circinale. D. circinale strain ACMB05 was exposed to differing levels of phosphorus and ammonium availability, and growth rates, photosynthetic efficiency, nitrogen fixation, alkaline phosphatase activity and saxitoxin cell quotas were quantified. Despite its diazotrophic capabilities, D. circinale growth rates could be limited by low levels of nitrogen or phosphorus. Saxitoxin cell quota results indicated that there was significant variation between nutrient treatments, with a significantly increased saxitoxin cell quota of Dolichospermum occurring under phosphorus limited conditions. Further results on phosphorus limitation's impact upon saxitoxin cell quotas will be discussed. Understanding the effect of macronutrient limitation on the rate of saxitoxin production will aid in the control of HAB events involving saxitoxin-producing cyanobacteria.

SPEAKER: **John Thraen, Stony Brook University | john.thraen@stonybrook.edu**

SPEAKER BIO: 2016-2020: Earned Bachelors of Science in Marine Vertebrate Biology - Stony Brook University

2020-2022: Earned Marine Biology and Coastal Sciences Master of Science Degree

- Investigated susceptibility for recreational boating to serve as a vector for the spread of Harmful Algal Blooms between separate bodies of freshwater. Study was conducted through the exposure and analyses of slides comprised of materials commonly used in the construction of freshwater boats and were then exposed over a period of time to simulate the usage of boats within a Harmful Algal Bloom setting. Following exposure period, varying drying times simulating those recommended by different state level organizations and environmental groups were conducted upon the slides before laboratory culture and analyses to determine their potential to reestablish blooms after said drying period.

2022-Present: Phd Student in Stony Brook University - Gobler Laboratory

- Topic of study is the investigation on nutrient limitations upon the saxitoxin production by freshwater HAB-forming cyanobacteria

CO-AUTHORS:
Christopher Gobler

MICROCYSTIN PRODUCTION TRENDS IN URBAN LAKES AS A FUNCTION OF COMMUNITY COMPOSITION – A MULTI-ANALYSIS APPROACH

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Harmful Algal Blooms (HABs) are understudied in the urban environment. Over the course of one recreational season in 2021, lakes in three U.S. metropolitan areas were examined to explore traditionally urban contaminants in relation to HAB dynamics. Fourteen lakes in Cincinnati, Ohio; Kansas City, Kansas/Missouri; and Denver, Colorado were included in the study, conducted by scientists from U.S. Environmental Protection Agency Regions 7 and 8 and the Office of Research and Development. Sampling included grab water samples as well as solid phase adsorption toxin tracking (SPATT) resin. Seasonal trends were present both in toxin production, contaminants present, and cyanobacterial community composition. These trends are evidenced through microcystin analysis via enzyme-linked immunosorbent assay (ELISA), liquid chromatography with tandem mass spectrometry (LC/MS/MS), and quantitative polymerase chain reaction (qPCR) technologies. Cyanobacterial community composition was determined through Flowcam imagery and metagenomic analysis. Nutrients, field parameters, and chemical contaminants such as metals, pesticides, and waste indicators were also tracked throughout the season. In this poster seasonal trends in total microcystin and its congener patterns are evaluated with multiple analyses and compared with shifts in community structure. Finally, a brief statistical exploration of nutrients and chemical contaminants with cyanobacteria and cyanotoxins is presented.

SPEAKER: **Marcie Tidd, US Environmental Protection Agency | tidd.marcie@epa.gov**

SPEAKER BIO: Laura Webb is a chemist in the Field Services Branch, Laboratory Services and Applied Sciences Division of EPA Region 7. She is responsible for water quality monitoring, operation of the accredited bacteria monitoring laboratory, and cyanotoxin monitoring and analysis.
Marcie Tidd is a microbiologist in EPA Region 8's Laboratory Services and Applied Science Division in Denver, Colorado. Her duties include analysis of recreational and source water samples for cyanobacteria and cyanotoxins, microbiology and molecular biology methodologies, field work, and management of the region's drinking water laboratory certification program.

Both Laura and Marcie enjoy long walks on any HAB free beach.

CO-AUTHORS:
Laura Webb

EVALUATING CLIMATIC AND ANTHROPOGENIC CHANGE AS DRIVERS OF HARMFUL ALGAL BLOOMS: A PALEO PERSPECTIVE INTEGRATING ANALYSIS OF POLLEN, NON-POLLEN PALYNOMORPHS, PIGMENTS, AND TOXINS

SESSION: Poster Session, Wednesday

ABSTRACT: Although recent studies have examined the occurrence and drivers of harmful algal blooms (HABs) in aquatic systems over the last few decades, a longer period-of-record is needed to disentangle the relative influences of natural climate variability, local geomorphology and vegetation, and human modification of the landscape. Hypereutrophic Lake Dora in central Florida contains a sedimentary record extending into the middle Holocene, ~ 6500 years ago. Pollen, algal palynomorphs, and photosynthetic pigments are preserved throughout the record. Using a multi-proxy approach, we generated a high-resolution retrospective analysis for Lake Dora to: 1) evaluate the preservation and utility of non-pollen palynomorphs and pigments to reconstruct algal community structure and the timing and magnitude of past blooms; 2) reconstruct terrestrial vegetation and past climates using pollen analysis; and 3) evaluate how changing climate and land cover have influenced blooms over decadal, centennial, and longer time scales. From 6.5-5.5k yrBP (years before present), marsh vegetation occupied the site and was surrounded by oak-dominated forests; cyanobacterial pigments and algal and cyanobacterial palynomorphs were present. A shift to pine-dominated forests and decreased marsh taxa at 5.5k yrBP was accompanied by a short-lived peak in Botryococcus. Although cyanobacterial pigments are present from 5.5-2.5k yrBP, algal and cyanobacterial palynomorphs are sparse during this interval. At 2.5k yrBP, cypress and wax myrtle pollen abundance increased, and algal and cyanobacterial palynomorphs are present consistently from that time until the turn of the 20th century. Since then, Pediastrum and Spirogyra palynomorph abundance increased sharply, as did concentrations of cyanobacterial, diatom, and green algal pigments. By improving our understanding of how changing vegetation, climate, and land cover influence HAB occurrences over a range of time scales, paleolimnological records can support efforts to anticipate and, potentially mitigate, the future occurrence of HABs under a range of climate and land-management scenarios.

SPEAKER: **Martina Tingley, U.S. Geological Survey | mbixler@usgs.gov**

SPEAKER BIO: Martina Tingley-Bixler works as a physical science technician and palynomorph analyst at the Florence Bascom Geosciences Center located at U.S. Geological Survey headquarters in Reston, VA. Her environmental science background is rooted in Quaternary studies and the use of paleoecological techniques to reconstruct wetland environments. Her past foci include coastal arctic and coastal hemiarctic biomes. Martina's baccalaureate research utilized paleopalynology to reconstruct the Pleistocene/Holocene ecological transition and Tsuga migration near Prince William Sound in southern Alaska. Her master's research examined late Holocene human settlement activity and landscape dynamics through pollen and other proxy records from the Lofoten archipelago of northern Norway. Martina's current palynomorph work focuses on reconstructing histories of past HABs through microscopic identification of key cyanobacterial and algal proxy data within sediment records of the Gulf Coast.

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THE FUTURE OF OCEAN COLOR REMOTE SENSING AND ITS POTENTIAL FOR HAB MONITORING AND FORECASTING IN A CHANGING CLIMATE

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Multi-spectral ocean color remote sensing has been used to delineate cyanobacteria and other algal blooms for decades. In many monitoring and forecasting systems around the U.S., 300-m satellite imagery provides the first detection of algal blooms along the coast or in large lakes. Improvements in spectral, spatial, and temporal resolution are on the horizon. The Copernicus Sentinel-2 mission offers a 20-m spatial resolution that may allow monitoring of many small lakes for algal blooms. The recently launched NASA Plankton Aerosol Cloud ocean Ecosystem (PACE) and the forthcoming Geostationary Littoral Imaging and Monitoring Radiometer (GLIMR) missions provide hyperspectral imagers that cover the UV to NIR spectrum. With coarser spatial resolution, those missions will provide better discrimination of types of blooms in larger lakes and open oceans. GLIMR, as geostationary, will provide a demonstration of repeated imaging each day. Finally, the upcoming Geostationary Extended Observations (GeoXO) mission, developed through a partnership between NOAA and NASA, promises to bring hyperspectral and high-frequency observations to the next generation of operational Geostationary Operational Environmental Satellites (GOES). These various systems will provide significant enhancements to the observation and operational monitoring of U.S. coastal, oceanic, and freshwater systems. Preliminary successes and challenges in incorporating these new capabilities into consistent long-term climate data records, daily monitoring and forecasting systems will be addressed.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ULTRADILUTE TAML®/PEROXIDE UTILIZES BIOMIMICRY TO SAFELY CONTROL FLORIDA RED TIDE

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL I

ABSTRACT: There is an acute need for harmful algal bloom (HAB) control technology that balances effective reduction of cells and toxins, environmental sustainability, ease of use, and economic viability. Hydrogen peroxide (H_2O_2) has been shown to control HAB events with several advantages, including: (i) rapid action, (ii) leaves no chemical residues, and (iii) low cost. Real and perceived disadvantages include: (i) concentrated H_2O_2 burns on contact, causing risk to workers, (ii) scaling H_2O_2 quantities to larger water bodies may be difficult, and (iii) with high natural rates of H_2O_2 degradation, heavy blooms may be minimally responsive. Using the wisdom of nature, biomimicry produces innovative, efficient, and sustainable solutions to complex problems. TAML® catalysts are bioinspired, miniaturized replicas of peroxidase enzymes which activate ultra-low H_2O_2 concentrations. Thus, TAMLs can address the limitations of peroxide-mediated HAB control by enabling rapid remediation at scale with a fraction of the required H_2O_2. This study investigates TAML/H_2O_2 for fast-acting and environmentally safe control of Karenia brevis cells and brevetoxins. We found a new generation TAML, NT7®, markedly enhanced red tide reduction. Specifically, K. brevis (1 million cells/L) was completely killed by NT7® (560 ppb) with H_2O_2 (1.7 ppm) within 4 hours, while brevetoxins (BTX-1, BTX-2, BTX-3, and BTX-B5) decreased cumulatively by 74.8% in 72 hours. In contrast, H_2O_2 (1.7 ppm) alone exhibited no impact on K. brevis or its associated brevetoxins. Ongoing work involves defining even lower treatment concentrations, conducting toxicity tests on representative Gulf of Mexico species, and scaling trials to the mesocosm scale (1,400 liters). Future studies will expand testing to freshwater HABs to assess TAML/H_2O_2 activity against cyanobacteria and cyanotoxins. This project is supported by the National Oceanic Atmospheric Administration through the United States Harmful Algal Bloom Control Technologies Incubator (US HAB-CTI #NA22NOS4780172, PI: Collins).

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE EFFECTS OF HARMFUL ALGAE AND OCEAN ACIDIFICATION ON LARVAL BIVALVE SURVIVAL

SESSION: BIOTOXINS & IMPACTS ON ORGANISMS II

ABSTRACT: Bivalves are an economically important resource whose populations have been declining in recent years. As climate change accelerates, these populations will be increasingly exposed to ocean acidification (OA) and harmful algal blooms (HABs). While HABs and ocean acidification can individually affect larval survival, the manner in which these stressors may interact to alter survival of larval bivalves is unknown. This study exposed larval bivalves (Mercenaria mercenaria, Crassostrea virginica, Argopecten irradians) to a range of pCO2 levels representative of current coastal oceans and three harmful algal bloom species found globally: Alexandrium catenella, Dinophysis acuminata and Margalefidinium polykrikoides. During experiments, there was decreased hard clam and oyster larval survival in OA and M. polykrikoides (500, 1,000, and 2,000 cells mL-1) treatments with the lowest survival in OA and M. polykrikoides combined treatments ($p<0.01$). There was reduced oyster larval survival ($p<0.01$) in OA and D. acuminata bloom (1,750 and 5,000 cells mL-1) treatments, with the combined OA and D. acuminata treatment showing similar low survival. There was decreased hard clam and oyster survival in OA and A. catenella (500, 1,000, and 2,000 cells mL-1) treatments with the lowest survival in combined OA and A. catenella treatments ($p<0.01$). There was consistently lower bivalve larvae survival when simultaneously exposed OA and HAB. Collectively, these findings demonstrate the species-specific responses of bivalve larval survival to the expanding threat of coastal OA and HAB events, which should be considered when choosing sites for restoration projects.

SPEAKER: **Adrienne Tracy, Stony Brook University | adrienne.tracy@stonybrook.edu**

SPEAKER BIO: Adrienne Tracy is a Master's Student in Dr. Christopher Gobler's laboratory at Stony Brook University. She began her career with an undergraduate degree in Biology and Environmental Science from Colby College during which, she interned at Bigelow Laboratory for Ocean Sciences, Colby College Limnology Lab, and CUNY Baruch College. Through these internships she studied the interactions between phytoplankton, nutrients, and oysters. For her undergraduate thesis at Bigelow Labs, she worked to develop a genetic transfection method for oyster cells in vivo and in vitro. After graduation, she worked with the Maine Department of Marine Resources monitoring different regions of coastline for harmful algal blooms and the corresponding biotoxin accumulation in shellfish. She is currently in the second year of her Master's degree studying how ocean acidification and HABs can interact to impact the survival of bivalve larvae. In her free time she enjoys hiking, kayaking, and playing with her cats.

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THE COMPARATIVE IMPACTS OF HURRICANES CHARLEY AND IAN ON SOUTHWEST FLORIDA COASTAL WATERS AND POTENTIAL NUTRIENT LINKS WITH SUBSEQUENT KARENIA BREVIS BLOOMS

SESSION: Poster Session, Wednesday

ABSTRACT: Along the Southwest Florida (SWF) Shelf, harmful algal blooms dominated by the toxic dinoflagellate Karenia brevis are a near-annual occurrence. Factors influencing initiation, magnitude and duration of these blooms are complex and our ability to predict and mitigate them is still developing. Further complicating prediction and mitigation efforts is the coincident seasonal occurrence of severe weather events, namely hurricanes and tropical storms. Hurricanes bring high winds which increase wave action and turbulence, re-suspend bottom sediments and increase turbidity. Heavy rainfall can cause flooding, thereby increasing potential exogenous nutrient inputs to sensitive nearshore water bodies. We compared the impacts of two Category 4 hurricanes, Charley in 2004 and Ian in 2022, both of which tracked similar paths and landfalls in Charlotte Harbor and immediately (within 1 month and 2 weeks, respectively) preceded K. brevis blooms. However, Charley passed relatively quickly, with a focused path, while Ian, a much slower storm with a broader geographical impact, caused substantial coastal flooding extending >50 km offshore. This project leverages historical meteorological datasets, and nutrient and water quality data collected in situ within days and weeks of Charley's and Ian's landfalls to examine potential nutrient links to the K. brevis HABs that formed in their wakes.

SPEAKER: **Sara Turner, Mote Marine Laboratory & Aquarium | sturner@mote.org**

SPEAKER BIO: Sara Turner began her career in marine science as an intern for the Ocean Acidification Program at Mote Marine Laboratory in 2020. She was hired by the Benthic Ecology lab as a research assistant an interim lab manager, and from there, joined the Red Tide Institute as a research technician. After an international hiatus, Sara returned to the Red Tide Institute at Mote in 2024 as a research technician and data analyst on projects aimed at predicting and mitigating K. brevis blooms along the West Florida Shelf. In particular, Sara is working to expand the applications of GIS as a tool for understanding the initiation, maintenance and termination of K. brevis blooms on various time scales.

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THE DEVELOPMENT AND CHALLENGES OF DEVELOPING A QPCR ASSAY FOR THE DETECTION OF ANATOXIN AND GUANITOXIN PRODUCING CYANOBACTERIA IN ENVIRONMENTAL SAMPLES

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: North American lakes and reservoirs have seen an increase in the number and severity of harmful algal blooms (HAB) caused by cyanobacteria (blue-green algae). The cyanobacteria present in the HABs can potentially produce toxins capable of causing illness and/or death. Timely and accurate identification and reporting of these toxins is critical for managing these threats. The current Phytoxigene Quantitative PCR (qPCR) assay has been in use by states and water agencies to for screen for potential risk of the toxins Microcystin/Nodularin, Cylindrospermopsin and Saxitoxin, plus total cyanobacteria by the 16SrRNA gene since 2016. Testing with toxin analysis has previously demonstrate that there is a very high correlation between toxin gene detection and toxin production. The results from these studies indicate that this method can predict HAB risk and simplify the process of toxin analysis. Anatoxin- is a secondary, bicyclic amine alkaloid and cyanotoxin with acute neurotoxicity and can cause death in all mammals, with dog deaths attracting the most attention. The toxin is produced by multiple cyano-bacteria genera throughout the world, most commonly by benthic organisims including Microcoleus, Anabaena, Oscillotoria and Aphanizomenon. Guanitoxin, formerly known as Anatoxin-a(s), is a neurotoxin most commonly produced by the benthic cyanobacteria. A lesser understood toxin as it is more labile, genetic screening for a gene responsible for its's production will provide a better understanding of its scope and subsequent risk. Phytoxigene has developed a multiplex qPCR assay that will detect the presence of an Anatoxin and Guanitoxin gene required for Anatoxin and Guanitoxin synthesis, along with an Internal Amplification Control to check for environmental inhibition. The presentation will highlight the development process and challenges related to the design of this assay

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

THE USE OF EPA APPROVED BIOLOGICALLY DERIVED SUBSTANCES (BDSS) TO MITIGATE HARMFUL ALGAL CELLS AND TOXINS: A NATURAL PRODUCTS REVIEW

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL II

ABSTRACT: Short-term Harmful Algal Bloom (HAB) mitigation strategies, such as the direct application of algicidal chemicals and Biologically Derived Substances (BDSs), have undergone extensive testing in recent years to determine effective ways to control developing blooms. Unlike chemical approaches that can result in secondary pollution and ecological collapse, BDSs readily biodegrade in aquatic environments and have shown selectivity for target algae only. However, while BDSs could be an environmentally friendly solution, regulatory constraints on algaecides discourage further research due to permitting hurdles. With the goals of identifying plausible candidates for testing with Karenia brevis and reducing potential permitting issues, we conducted an extensive literature review investigating the inhibitory characteristics of over 40 naturally derived substances that are approved for pesticide use by the EPA Office of Chemical Safety and Pollution Prevention and are exempt from the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The majority of these substances are terrestrial plant derived compounds or essential oils that have been shown to exhibit antiviral, antibacterial, antifungal, and antiparasitic properties. Preliminary laboratory research examining the impacts of three to five promising compounds on both K. brevis cells and brevetoxins will be presented.

SPEAKER: **Victoria Vossler, Mote Marine Laboratory | vivossler@gmail.com**

SPEAKER BIO: After working for the Florida Department of Agriculture and Consumer Services for a little over a year, Victoria began her career in marine research as an intern for the Ocean Acidification Program at Mote Marine Laboratory in 2023. She was hired by the Red Tide Institute as a Research Technician on the last day of her internship and now enjoys helping the team facilitate several projects that focus on harmful algal bloom (HAB) ecology, water quality, and nutrients. While Victoria loves being in the lab, her favorite days are spent on the water doing fieldwork. Her goal is to assist in the pursuit of scientific knowledge that promotes the wellbeing of the ocean and public health.

CO-AUTHORS:
Cynthia Heil, Sarah Klass, Victoria Devillier, Sara Turner and Kevin Claridge

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

MINING A RIVERINE METAGENOMICS DATABASE TO REVEAL DISTRIBUTION PATTERNS OF FRESHWATER CYANOBACTERIAL TOXIN GENES

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The growth of publicly accessible omics databases enables querying of large datasets for a wide range of species and genes of interest, that may not be aligned with the original study aims. Here, I utilize the new Genome Resolved Open Watersheds database (GROWdb) of 100+ river microbiomes sampled across a spatially distributed global network to identify freshwater cyanobacterial toxin genes, their frequencies, and environmental associations. Despite numerous limitations, this data mining approach offers a relatively quick and affordable way to assess potential locations of emerging toxins of concern.

SPEAKER: **Christopher Ward, Bowling Green State University | chrward@bgsu.edu**

SPEAKER BIO: Dr. Christopher Ward is an Assistant Professor at Bowling Green State University. He is a molecular microbial ecologist with 10+ years of research experience studying aquatic microbial communities, including cyanobacterial blooms, genomics and microbial interactions. Ward received his BA in Chemistry at Carleton College and PhD in Marine Sciences at Duke University.

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

DETECTION OF FRESHWATER SAXITOXINS IN EPIPELIC CYANOBACTERIA MATS IN MARYLAND

SESSION: Poster Session, Wednesday

ABSTRACT: Excessive algal growth is a key impact of eutrophication in aquatic ecosystems. Efforts to decrease nitrogen have led to decreased water column phytoplankton, increased light penetration and proliferation of filamentous metaphyton (benthic algae) and specifically diazotrophic cyanobacteria in many areas. While the metaphyton can be a major primary producer that hosts diverse invertebrate fauna, the potential for cyanotoxin production within these mats is an emerging concern. The presence of microcystin in Maryland waters is well documented; however, recent detection of potent neurotoxins in benthic mats is concerning. Anatoxin has been documented infrequently (max in benthic mats; mostly Phormidium). Recent detection of freshwater saxitoxin has shown the presence to be widespread in benthic mats dominated by Microseria (formerly Lyngbya) wollei. Freshwater saxitoxins were detected in Maryland lakes (<1 -192 ug/g saxitoxin equivalents using ELISA method), streams (EPA region 3 special project; toxin data not completed yet) and in the Susquehanna Flats region of the Chesapeake Bay (0.03-81.22 ug/g saxitoxin) and tributaries (all values based on ELISA). Concentrations are thought to be 16 times than ELISA detection due to limited cross reactivity (e.g. concentrations may be as high as 1300 ug/g). These levels are similar to those observed in other areas (CA, NZ, SC, Canada and Great Lakes). Microseira wollei balls from the Potomac River were analyzed for saxitoxin using both ELISA and LCMS/MS, revealing that ELISA may greatly underestimate the amount of saxitoxin present (48 vs 928 ug/g). More work is needed regarding environmental parameters contributing to toxin production as well as the fate and transport of cyanotoxins in the food web. Impacts to lake biota and downstream transport of toxins are concerning to managers as detached toxic benthic mats have been observed downstream.

SPEAKER: **Cathy Wazniak, MD Department of Natural Resources | catherine.wazniak@maryland.gov**

SPEAKER BIO: Cathy Wazniak is an Environmental Program Manager for the Maryland Department of Natural Resources. She is the head of the Integrated Assessment program in the Division of Tidewater Ecosystem Assessment. Her responsibilities include coordinating Maryland's phytoplankton and harmful algal bloom monitoring programs as well as Maryland Coastal Bays and offshore water quality monitoring and assessments. She earned her master's degree with UMD Marine Estuarine and Environmental Sciences program where she studied community metabolism. She was a Sea Grant Knauss Fellow under the Assistant Secretary of the Navy Office for Installations and the Environment. She is the chair of the Maryland Harmful Algae Bloom Taskforce as well as a member of the Maryland Coastal Bays National Estuary Program scientific and technical advisory and Chesapeake Bay modeling committees. She also serves on the EPA National Aquatic Resources Survey (NARS) Steering Committee and National Coastal Condition Assessment Steering Committee, the National Benthic HAB workgroup, the NASA led Chesapeake Interagency Satellite workgroup, Chesapeake Bay SAV Committee as well as the East Coast SAV cooperative. She has worked for the Department since 1996. During her tenure she has co-authored many reports and peer reviewed articles on the coastal bays ecosystem and harmful algae in Maryland.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

FROM NEW YORK TO NEW SOUTH WALES: INVESTIGATING NOVEL TOXIN PRODUCTION BY NOSTOCHOPSIS SPP.

SESSION: EMERGING TOXINS & SPECIES

ABSTRACT: Awareness is increasing for freshwater benthic cyanobacteria proliferations and their potential to be harmful. As more attention is given to monitoring these populations, we learn more about their ecology, where we might expect them to exist, and what risks they may pose through cyanotoxin production. Globally, most of these data are from flowing systems, despite our knowledge that they also thrive in lakes. The lack of standard sampling and monitoring methods across waterbody types has limited our understanding of these populations and ultimately, the risk they pose to our health. Here, we share observations of a suspected novel toxin producer found in two contrasting environments – one in a small, eutrophic lake in New York State, and one in a low nitrogen concentration creek in northeastern New South Wales, Australia. At both sites, we found dense proliferations of toxic Nostochopsis, both with nodularin (100%) detected in its biomass and in concentrations >1 µg/g. To our knowledge, these two cases are the first evidence of cyanotoxin production by Nostochopsis. We will highlight the environmental characteristics surrounding each of these observations and genomic insights on nodularin production. Preliminary data from experimental methods investigating potential drivers of toxin production (temperature, nutrients, and light intensity) will also be shared. This work expands the scale on which these populations have been studied and has the potential to reveal commonalties of benthic cyanobacteria growth and toxin production under markedly dissimilar conditions and from distant locations.

SPEAKER: **Abby Webster, SUNY ESF | abwebste@syr.edu**

SPEAKER BIO: Abby is a PhD Candidate at SUNY ESF studying benthic cyanobacteria in near shore zones of the Finger Lakes and sites along Lake Ontario. Specifically, her research aims to characterize the benthic cyanobacteria community in these places over time and space, and investigate their potential to produce harmful toxins. Her background is in biotechnology and toxicology, though she has a love for field work and hopes to pursue a career that will have a healthy balance of time spent on the water and in the lab. In 2023, Abby expanded her work through a research fellowship to Australia, where she is excited to return in late 2024 and continue wading into her work (and writing) down under.

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A NEWLY DEVELOPED DIGITAL PCR ASSAY FOR THE DABA GENE INVOLVED IN DOMOIC ACID BIOSYNTHESIS

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: Marine environments around the world are known to experience blooms of Pseudo-nitzschia that can produce high enough concentrations of the neurotoxin domoic acid (DA) to pose risks to human health and wildlife, and result in economic damage. Predicting and monitoring DA outbreaks in harmful algal blooms presents a number of challenges that are best met by applying a variety of integrated observational and research strategies. Here, we add to the existing suite of tools for detecting toxigenic Pseudo-nitzschia by developing a digital PCR (dPCR) assay that targets one of the genes (dabA) in the DA biosynthetic pathway. Synthetic dabA gene fragments from Pseudo-nitzschia australis, P. multistrata, P. seriata, and P. multiseries, along with non-targets, kabA from Digenea simplex and radA1/radA2 genes from Chondria armata, were used to assess the assay's specificity. We demonstrate that the new dPCR assay is specific to target species tested, and can be used to quantify the dabA gene over a wide range of dabA concentrations in pure culture or in raw water. We used this assay in two ways. First, to investigate presence of dabA in other cultures of various Pseudo-nitzschia sp. isolated from Monterey Bay, CA. Second, to assess the abundance of toxin-producing Pseudo-nitzschia species in field samples collected autonomously using a long-range AUV fitted with an Environmental Sample Processor during toxic blooms of Pseudo-nitzschia in 2022 in the Santa Barbara Channel, CA and in 2023 in Monterey Bay, CA. Here we present the distribution of Pseudo-nitzschia-specific 18S rRNA and dabA genes during those field deployments alongside in-situ DA measurements. These data show that the dPCR assay for dabA provides a way to measure abundance and distribution of potential toxin-producing Pseudo-nitzschia, which may have utility in predicting and monitoring of DA outbreaks.

SPEAKER: **Chloe Weinstock, Monterey Bay Aquarium Research Institute | cweinstock@mbari.org**

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A NOVEL IMMOBILIZED ALGICIDE FOR CONTROLLING RED TIDE: TRANSITIONING RESEARCH TO THE FIELD

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL III

ABSTRACT: Dinoflagellates, notorious for causing toxic HABs, may be effectively controlled by algicidal bacteria, including Shewanella sp. IRI-160. Previous research developed a bio-control technology (DinoSHIELDs) using alginate hydrogel to immobilize Shewanella sp. IRI-160. DinoSHIELDs continuously release bacteria-derived algicides targeting dinoflagellates while limiting the dispersion of bacteria. As with any approach aimed at controlling HABs, assessing the environmental impact of DinoSHIELDs in a controlled setting is crucial before their broader application. To this end, we conducted a 7-day in-situ mesocosm study with natural microbial communities to evaluate the effects of DinoSHIELDs on water quality and non-target microbes under non-bloom conditions. At levels required to control the growth of dinoflagellates in laboratory cultures, DinoSHIELDs effectively reduced dinoflagellate cell densities to 26% of control levels without negatively affecting overall photosynthetic biomass in the mesocosm experiment. Moreover, qPCR analysis of Shewanella released from DinoSHIELDs showed a peak (870 cells/mL) on Day 1, while densities of released Shewanella declined to 20 cells/mL by Day 6. These counts were significantly lower than native total bacterial levels in the study area, which typically exceed 10^7 cells/mL during summer. Only minor decreases in pH (< 0.2 unit decrease) and dissolved oxygen levels (< 1 mg/L decrease, with all concentrations exceeding the hypoxia level) were observed in the treatment compared to the control; this suggests increased heterotrophic activity in the mesocosms treated with DinoSHIELDs compared to the control. Concentrations of inorganic nutrients (nitrate plus nitrite, ammonium, and phosphate) in the treatment were not significantly different from the control. Additional 18S rRNA sequencing analysis indicated DinoSHIELDs significantly increased the species richness and community diversity in the treatment compared to the control. Overall, the results indicated that DinoSHIELDs may be an effective biocontrol strategy for dinoflagellate bloom management without negative impacts on the natural microbial community.

SPEAKER: **Lynn Wilking, CSS, Inc. | lynn.wilking@noaa.gov**

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ASSESSING ALEXANDRIUM CATENELLA BLOOM DISTRIBUTION IN KODIAK, AK IN SUPPORT OF TOXICITY MONITORING AND BLOOM FORECASTING

SESSION: POSTER SESSION, WEDNESDAY

ABSTRACT: The saxitoxin-producing dinoflagellate Alexandrium catenella blooms annually during the spring/summer in the Kodiak Archipelago, Alaska. As a result of these blooms high levels of toxicity are common in Kodiak shellfish, resulting in outbreaks of paralytic shellfish poisoning (PSP) and several deaths over the last few decades. Understanding the distribution of A. catenella cells in Kodiak Archipelago bays and how it relates to environmental drivers will improve monitoring of PSP toxins in area shellfish. Bloom mapping surveys were conducted in May, June, and August 2024 in Chiniak Bay, Kodiak Island and the surrounding area. A. catenella concentrations in surface waters were quantified with qPCR analysis and relative phytoplankton abundance was measured via extracted chlorophyll. Hydrographic data were collected using CTD depth profiles to examine water column stratification and circulation features which may be driving cell distribution. Water samples were also analyzed for particulate PSP toxins and compared to shellfish toxicity at local beach monitoring sites. Previous bloom survey data from July 2023 showed that despite low shellfish toxicity levels at beach monitoring sites (<80 µg/100g tissue), A. catenella cells reached bloom levels in Chiniak Bay, with cell concentrations reaching >4,000 cells/L. Based on the preliminary 2023 survey results and analysis, we hypothesize that in the 2024 bloom season low A. catenella concentrations will be associated with freshwater runoff, and that high cell concentrations will be associated with warmer surface water temperatures and higher salinities in the seaward part of the bay. This pattern of A. catenella cell distribution is expected to yield high toxicity in shellfish from areas with high abundances of A. catenella and high particulate PSP toxin concentrations. These data will be used to improve shellfish toxicity monitoring in Kodiak and reduce PSP risks among subsistence harvesters.

SPEAKER: **Lynn Wilking, CSS Inc. under contract to NOAA | lynn.wilking@noaa.gov**

SPEAKER BIO: Lynn Wilking is a HAB Marine Biologist with CSS Inc. under contract to NOAA, working with the HAB-Forecasting Branch. She has experience as a lab scientist and manager and has worked in water quality, HAB research, and sediment geochemistry labs. She currently studies the impact of HABs in Alaska, including food web dynamics and forecast development, as well as developing control methods for red tides in Florida.

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

GENOMIC CODING OF POTENTIAL ANABAENOPEPTIN-PRODUCING DOLICHOSPERMUM BLOOMS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: The abundant cyanobacteria Dolichospermum are often involved in cyanotoxin production in inland lakes. Some species of this bacteria are known to produce anabaenopeptin, yet the mechanisms of peptide production, toxicity, and fate remain underexplored. Initial investigations into the Dolichospermum genotype of Damariscotta Lake (Maine, USA) has revealed unique deletions in genes responsible for anabaenopeptin production. A popular site of residence and recreation, Damariscotta Lake sits upstream of key commercial oyster aquaculture, on the Damariscotta River. Systematic sampling during bloom season was performed to aid with understanding the ecology of Dolichospermum and the production of anabaenopeptin in relation to environmental factors, such as nutrient concentration. We used ELISA to test for cyanotoxins, and performed genomic investigations into toxin production via Nanopore MinION sequencing. ELISA results reveal that anabaenopeptin was not present in lake samples throughout the sampling period, confirming the current lack of production by Dolichospermum. Deletions in the apnC-D region likely inactivate the proteins necessary for toxin biosynthesis. Our results contribute to baseline sampling data prior to any future detection of toxicity due to anabaenopeptin and provide a better understanding of the mechanisms by which Dolichospermum blooms, and toxin-production gene deletions occur in the environment.

SPEAKER: **Lake Willett, Middlebury College | lwillett@middlebury.edu**

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PROCESSING OF SENTINEL 2 REMOTE SENSING IMAGERY FOR DETECTING HABS IN COASTAL SYSTEMS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Chlorophyll-a and cyanobacteria have not been routinely monitored in many estuaries and coastal rivers, but it is possible to detect blooms using remote sensing. The overall goal of this project is to evaluate the effectiveness of remote sensing to detect algal blooms in coastal systems and to determine our ability to predict cyanobacterial blooms as a function of chlorophyll concentrations and other drivers such as temperature and flow in these systems. Initially, we are refining techniques for efficient processing of Sentinel 2 imagery. To begin, Sentinel 2 data were paired with water quality data observation points in estuaries around the country and combined with S2 cloud and cloud shadow masks via Google Earth Engine (GEE). A subset of these points was selected along a gradient of chlorophyll, turbidity, and salinity as a test series. Using this test series, we are comparing Acolite and Polymer atmospheric corrections. We are also comparing the accuracy of various existing chlorophyll metrics with machine learning estimates. Chlorophyll estimates will be compared across atmospheric correction types and algorithms. We have processed our test series through both Acolite and Polymer and applied batch post-processing scripts on the outputs to correct georeferencing and ensure NetCDF outputs are CF-compliant so that we can use ArcGIS Pro to iteratively process the files further. Since the corrected outputs are NetCDF files, we converted them into feature classes so they could be opened via Model Builder. After some additional processing in ArcGIS Pro, the files are then clipped and joined to the water quality points so we have chlorophyll variables and environmental data for the corrected imagery. Moving forward, we will compare our results from Acolite and Polymer before proceeding with the development of predictive models.

SPEAKER: **Tori Wolters, ORISE fellow working at US EPA | wolters.tori@epa.gov**

SPEAKER BIO: I am currently an ORISE fellow working at the US Environmental Protection Agency. I got my B.S. in Wildlife Conservation at Brigham Young University and a M.S. in Marine Science from Hawaii Pacific University. During my undergrad I began working on some GIS projects with The Nature Conservancy, and have continued to enjoy working with remote sensing projects. When I am not working, I enjoy hiking with my 2 dogs and spending time on the water.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

NON-TARGET ANALYSIS OF MARINE ALGAL TOXINS IN PUGET SOUND USING PASSIVE SAMPLERS WITH LIQUID CHROMATOGRAPHY–HIGH-RESOLUTION MASS SPECTROMETRY

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Liquid chromatography–high-resolution mass spectrometry (LC–HRMS) offers significant potential for non-target analysis (NTA) of marine algal toxins. In this study, over 200 passive samplers containing Diaion HP-20 resin were deployed across 11 locations in Puget Sound, Washington State, between 2016 and 2018, and were analysed by LC–HRMS with data-dependent acquisition using metabolomics software for data handling. The initial aim of the sampling study was to investigate the presence of azaspiracids (AZAs), specifically AZA59 which was reported in a species of Azadinium poporum isolated from Puget Sound, using targeted LC-MS/MS screening for AZA1, AZA2, AZA3, and AZA59 only. While AZA59 was only present at trace levels and no other AZAs were detected, confirming the initial targeted analysis results, re-analysis of these samples with the NTA approach revealed a rich lipophilic toxin profile that was highly informative. The primary toxins observed over the three-year study were consistent, with variations between sites and in trends over time. Dinophysistoxin-1, pectenotoxin-2, yessotoxin, and 13-desmethyl-spirolide C were the prevalent analogues of their respective toxin classes, with over 100 class-related analogs detected that are not typically monitored using targeted methods. This work demonstrates the power of LC–HRMS and NTA in algal toxin screening, and the data on spatial and temporal distribution of toxins in Puget Sound is valuable for future research on harmful algae and toxins in the region.

SPEAKER: **Elliott Wright, National Research Council of Canada | Elliott.wright@nrc-cnrc.gc.ca; pearse.mccarron@nrc-cnrc.gc.ca**

SPEAKER BIO: Elliott Wright is a technical officer with the Biotoxin Metrology team at the National Research Council of Canada. His research has focused on the detection of environmental contaminants with a focus on the development, optimization, and validation of high-accuracy methods for algal biotoxins
Pearse McCarron obtained a PhD from University College Dublin (Ireland) and took up a research position at the National Research Council of Canada (NRCC) in 2008. Pearse has been leading the Biotoxin Metrology group at the NRCC for almost ten years with a primary research focus on understanding the chemistry of algal and cyanobacterial toxins, development of chemical analytical methods, and production of reference materials.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

TRAVELING HAB LAB: EMPOWERING CITIZEN SCIENTISTS TO PROTECT WATER RESOURCES

SESSION: ENGAGING COMMUNITIES & STAKEHOLDERS

ABSTRACT: New Jersey has seen significant increases in cyanobacterial harmful algal blooms (HAB) that produce cyanotoxins, which can be dangerous for humans, pets, livestock, and wildlife. As New Jersey encompasses roughly 1,900 lentic waterbodies, eight major river systems, two major estuaries and nearly 130 miles of coastline; government agencies are unable to effectively monitor all waterbodies across New Jersey. Hence, Montclair State University developed the Traveling HAB Lab to educate the general public to identify HABs and take actions to reduce water pollution and future blooms. The Traveling HAB Lab includes three components: a citizen science program, an education program, and a teacher training program. Community members in the citizen science program were equipped with necessary supplies and materials and trained to follow established standard operating procedures to perform HAB monitoring. These citizen scientists were also tasked to spread the message about HABs and their impacts with their fellow community members. For the teacher training program, education modules about water quality, harmful algal blooms, and water conservation were developed; all materials were designed to align with the New Jersey Student Learning Standards for Science. The education program provides students and community members with educational materials and discovery-based activities focusing on water quality and HAB. Educational programming both in classrooms and at outreach events gives students and community members an understanding of water quality issues in their immediate environments, help foster environmental stewardship and inspire them to take action in reducing water pollution and to control future blooms.

SPEAKER: **Meiyin Wu, Montclair State University | wum@montclair.edu**

SPEAKER BIO: Dr. Meiyin Wu, Director of New Jersey Center for Water Science and Technology and Professor of Biology at Montclair State University, is an aquatic ecosystem ecologist whose research focuses on water quality, aquatic ecology, harmful algal blooms, drinking and recreational water safety, seafood consumption safety, pollution transport and control, microbial source tracking, and ecosystem restoration. In addition to teaching and conducting research, Dr. Wu directs a water analysis laboratory (NJDEP Laboratory Certification # 07105), organizes a citizen science program for HAB monitoring, and coordinates an environmental education and outreach program. The author of more than 50 articles, books and educational DVDs, she also holds three U.S. patents on innovative technologies for water treatment.

CO-AUTHORS:
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INCORPORATING PACE HYPERSPECTRAL SATELLITE DATA INTO AN EXISTING MULTIPLE SATELLITE-BASED TIME SERIES

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Multi-spectral ocean color remote sensing has been used for delineation of cyanobacteria blooms for over 20 years. Several sensors have been used to find and monitor these blooms, including MODIS, MERIS, and OLCI. Starting in 2024, NASA's Ocean Color Instrument (OCI) aboard Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) satellite provides hyperspectral data, allowing the simulation of OLCI algorithms and the development of new ones. Creating a way to weave observations from these various sensors into a long-time series will allow for exploring interannual and interdecadal variability in cyanobacteria blooms. A previously published and widely used algorithm, the cyanobacteria index (CI), was used to create a long timeseries using MODIS (2000-2002), MERIS (2002-2011), MODIS (2012–2016), and OLCI (2016-2024). Here, we will look into adding PACE to the multi-sensor timeseries. Given PACE's enhanced spectral capabilities, we aim to refine the signal-to-noise ratio, producing data that aligns with the existing 25-year time series. This addition will allow enhancement of the time series into the future.

SPEAKER: **Timothy Wynne, NOAA | timothy.wynne@noaa.gov**

SPEAKER BIO: https://scholar.google.com/citations?user=ykmP690AAAAJ&hl=en

CO-AUTHORS:
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IMPROVED SAXITOXIN ELISA PLATE KIT FOR SHELLFISH

SESSION: METHOD VALIDATION & REFERENCE MATERIALS

ABSTRACT: Harmful Algal Blooms (HABs) precipitate different toxic compounds known as Saxitoxins. This neurotoxin family notably includes Saxitoxin (STX), Neo-saxitoxin (NEO), and Gonyautoxins (GTX), of which STX is the most potent. Filter-feeding marine organisms concentrate these toxins within their tissue, leading to Paralytic Shellfish Poisoning (PSP) when consumed by humans and other animals1.
Beacon Analytical Systems (www.beaconkits.com) developed a competitive Enzyme-Linked Immunosorbent Assay (ELISA) test kit for Saxitoxin (Cat. No. 20-0173). Included within the kit are six calibration standards (0, 0.02, 0.04, 0.08, 0.16, and 0.32 ppb) for use with the 96-well microtiter plate, alongside an anti-Saxitoxin polyclonal antibody and enzyme conjugate. The total assay time is one hour, not including sample preparation. Shellfish may be prepared by extracting tissue homogenates with 0.2 M acetate buffer pH5.0.
Recently, the ELISA method was compared with HPLC data from Bigelow Analytical Services (East Boothbay, ME). Forty-five samples were tested independently by both parties, the resultant of which found a strong correlation between methods. Statistical analysis included a Wilcoxon signed-rank test at a significant level of 0.05. From this test, the z-score was 0.9312 with a p-value of 0.3524. This ELISA method can be used to screen for shellfish samples with concentrations below 30 µg/100g. For regulatory purposes, samples identified as positive (30 -100 µg/100g) must be confirmed by an approved National Shellfish Sanitation Program (NSSP) method.

SPEAKER: **Jingping Xie, Beacon Analytical Systems Inc. | jingping@beaconkits.com**

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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

EVOLUTION OF SARGASSUM FORECASTING PRODUCTS FOR PUERTO RICO AND THE VIRGIN ISLANDS: FROM REGIONAL TRACKING TO HIGH-RESOLUTION MODELING

SESSION: PREDICTIVE MODELING - MARINE

ABSTRACT: The management of Sargassum inundations in coastal regions demands progressively refined forecasting tools. The Caribbean Coastal Ocean Observing System (CARICOOS) has embarked on a multi-stage development of such tools to enhance accuracy and utility. Initially, the Sargassum forecasting was supported by an AMSEAS-based tracker, providing a macroscopic view of the Sargassum drift towards the coast. Its latest version, calibrated with Sargassum influx rates estimated from data collected in traps in the outer reefs of La Parguera Marine Reserve, yields a weekly Sargassum biomass arrival to the outer insular shell. This product is inherently restricted by its coarse spatial resolution and the model domain not including near coastal areas. In response to the need for improved nearshore forecasting, CARICOOS implemented an unstructured-grid regional Finite Volume Community Ocean Model (FVCOM), specifically designed to accommodate the complex coastlines of Puerto Rico and the Virgin Islands. This transition marked a significant advancement in the predictive capability of the system by incorporating fine resolution towards the shore. Further refining the approach, CARICOOS developed an extremely high-resolution (up to 4 meters) nested FVCOM model. This model is set to be implemented not only in response to acute Sargassum accumulations in La Parguera, southwest Puerto Rico, but also along the surrounding coasts of St. Croix. The high-resolution model facilitates detailed local forecasting and allows for the strategic placement of Sargassum traps, enhancing validation processes with empirical data alongside satellite imagery. This evolutionary approach underscores a significant leap in the predictive management of Sargassum events, aiming to mitigate its environmental and economic impacts on the region.

SPEAKER: **Haibo Xu, University of South Florida | haiboxu@usf.edu**

SPEAKER BIO: After obtaining a Ph. D. in marine science in 2022 at the University of Puerto Rico, I am currently working as a post-doc scholar at the College of Marine Science, University of South Florida.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

COLLABORATIVE EFFORTS TO MONITOR MARINE BIOTOXINS IN VIRGINIA'S SHELLFISH GROWING AREAS

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Expanded collaborative efforts continue to be incorporated in Virginia's monitoring of algal blooms and marine biotoxin control plan. These efforts include additional toxin and molecular assays as well as the deployment of sentinel shellfish throughout the state's shellfish harvest areas. Annual algal blooms in Chesapeake Bay and its tributaries, as well as the Atlantic coastal bays, are comprised of taxa capable of producing marine biotoxins including Pseudo-nitzschia (linked to Amnesic Shellfish Poisoning: ASP), Dinophysis (linked to Diarrhetic Shellfish Poisoning: DSP), and Amphidomataceae (linked to Azaspiracid Shellfish Poisoning: AZP). Despite the presence of these taxa, toxin concentrations in Virginia's shellfish have not been found to exceed closure criteria, and there have been no reported biotoxin poisoning cases linked to Virginia shellfish. To manage these potential risks, monitoring strategies continue to adapt to include a robust monitoring program of morphological, molecular and toxin analyses which includes routine collections of water and shellfish samples from around the state's shellfish areas. New efforts are underway to develop and integrate automated imaging platforms and computer learning into our routine field screening for HABs with our academic partners. Remote sensing is used to identify potential blooms that occur outside of routine monitoring areas or between sampling events. In 2024, a notable Pseudo-nitzschia bloom of 10^4 cell/mL was observed in mesohaline waters within Chesapeake Bay. Domoic Acid was not detected in any of the seawater or shellfish samples collected from the area. Molecular screening tools have been developed and deployed to supplement the microscope screening by targeting AZP, ASP, and DSP producing taxa using qPRC. While Domoic acid and Pseudo-nitzschia spp. have been identified in water samples, predominantly from the Atlantic coastal areas, toxin levels have been low, with concentrations in shellfish remaining generally below detection limits and well below the National Shellfish Sanitation Program closure criteria.

SPEAKER: **Evan Yeargan, Virginia Department of Health: Division of Shellfish Safety and Waterborne Hazards | evan.yeargan@vdh.virginia.gov**

SPEAKER BIO:
Evan Yeargan is a Marine Scientist Sr. with the Virginia Department of Health: Division of Shellfish Safety and Waterborne Hazards where he has served as a technical lead for marine biotoxin evaluation and pollution source assessment for the last 8 years. He completed his B.S. in Marine Science at Coastal Carolina University before receiving his M.S. in Environmental Engineering Science from the University of Florida. Prior to working at VDH, Evan completed internships working in the shellfish aquaculture industry as well as the Catawba Riverkeeper Foundation where he worked in water quality monitoring and educating the public on water related issues within the watershed. Evan's research focus includes studying the distribution and abundance of harmful algal species and algal toxins around the Chesapeake Bay as well as identifying pollution sources that impact shellfish waters through molecular source tracking.

CO-AUTHORS:
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USING A COUPLED SATELLITE IMAGE-NUMERICAL MODEL FRAMEWORK TO SIMULATE MARGALEFIDINUM POLYKRIKOIDES IN THE YORK RIVER ESTUARY

SESSION: REMOTE SENSING

ABSTRACT: Recent advances in satellite remote sensing technology for detecting harmful algal blooms (HABs) make it possible to combine numerical modeling approaches and satellite imagery to track and predict HABs in estuarine and coastal waters. We employed a particle-tracking model using a high-resolution hydrodynamic model capable of simulating algal mixotrophic growth, respiration, and vertical diurnal migration to predict the spatial distribution and temporal evolution of a Margalefidinium polykrikoides (M. polykrikoides) bloom in the lower York River, VA USA, where HABs have occurred nearly annually over the past decade. Particle release location and density were determined by chlorophyll-a concentrations obtained from Ocean Land Colour Imager (OLCI) satellite imagery collected during August-September 2022. Numerous high-quality satellite images (n=34) available in the two-month bloom period allow for a comprehensive examination of the model framework. We demonstrate the potential of the coupled satellite-model framework to predict short-term bloom movement by comparing model predictions and satellite observations 1-5 days after the particle release date. We also carried out sensitivity tests and demonstrated that setting a maximum swimming depth and including sub-surface aggregation depth for phytoplankton vertical migration significantly improved the model performance. A forecasting operational model based on this framework is under development for the lower Chesapeake Bay.

SPEAKER: **Xin Yu, ORISE / NOAA | xin.yu@noaa.gov**

SPEAKER BIO: I am a postdoc fellow at ORISE sponsored by NOAA. By combining observation data, remote sensing, and high-resolution numerical model, my research focus on harmful algal bloom dynamics and am currently developing numerical model that used to predict spatial distribution of harmful algal bloom for the lower Chesapeake Bay region.

CO-AUTHORS:
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12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

ASSESSING THE SYNCHRONICITY OF ANATOXIN-PRODUCING BENTHIC CYANOBACTERIA AND RIVER ECOSYSTEM PRODUCTIVITY

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Anatoxin-producing benthic cyanobacteria have been increasingly detected in rivers worldwide, yet our ability to predict the timing of their occurrence and toxin production is limited. Benthic cyanobacteria in rivers have similar controls as river productivity including exogenous factors such as light and flow and harder-to-measure endogenous factors such as density dependent growth. Assessing the synchrony between reach scale productivity and benthic cyanobacterial dynamics may help us further understand the environmental factors influencing benthic cyanobacteria occurrence and anatoxin production in rivers and lay the foundation for ecological forecasting of anatoxins. From June to September in 2022 and 2023, we conducted field surveys in northern California on the South Fork Eel, Russian, and Salmon Rivers to estimate percent cover of benthic cyanobacteria Microcoleus and Anabaena and to collect surface water samples and benthic mat samples for microscopy and toxin analyses. We used high-frequency temperature and dissolved oxygen sensors to collect data to estimate daily river metabolism. In 2023, on the South Fork Eel we saw an increase in Microcoleus cover (0.0 to 8.4-22.7%) from June to September, while Anabaena cover peaked in early August and subsequently declined (0.0 to 1.5-11.9% at peak, ending at 0.0-2.0%). On the Salmon, Microcoleus also increased in cover from June until sampling interruption by wildfire in early August (0.0-0.6 to 3.5-16.4%). Preliminary metabolism estimates show peak productivity in early July in the South Fork Eel (3.2 g·O2·m-2·d-1) and late September in the Salmon (5.8 g·O2·m-2·d-1). This asynchrony suggests that the exact processes controlling cyanobacteria accrual may be different from those that govern the entire autotrophic community. Future work will evaluate the potential for forecasting cyanotoxin production with lags relative to ecosystem productivity and explore the influences of the surrounding benthic community.

SPEAKER: **Jordan Zabrecky, University of Nevada, Reno | jzabrecky@unr.edu**

SPEAKER BIO: Jordan is a 3rd year PhD student at the University of Nevada, Reno. Broadly, she is interested in the intersection of water quality, ecological & public health, and data science. Her dissertation research focuses on understanding the timing of and environmental controls on benthic cyanobacteria and anatoxin production in rivers of northern California.

CO-AUTHORS:
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U.S. National Office for Harmful Algal Blooms

NANOBUBBLE-BASED FOAM FRACTIONATION REMOVAL OF ALGOGENIC ODOROUS COMPOUNDS

SESSION: HAB MANAGEMENT, MITIGATION, & CONTROL II

ABSTRACT: Due to climate change and pollution, natural lakes and reservoir water suffer increasingly serious algal blooms and associated water quality problems due to the presence of algal or algogenic organic matter (AOM) such as algal odour and toxins. Effective removal of these micropollutants, especially in summertime or the event of algal blooms, is critical to drinking safety. The study investigated the removal efficiency of two common odorous compounds, trans-1,10-dimethyl-trans-9-decalol (geosmin) and 2-Methylisoborneol (2-MIB) using foam fractionation enabled by air nanobubbles with addition of two representative cationic and anionic surfactants, sodium dodecyl sulfate (SDS) and cetyltrimethylammonium bromide (CTAB), to enhance foaming ability and stability. The results showed that the cationic surfactant (i.e., CTAB), a low pH, and high ionic strength significantly promoted the removal of geosmin and 2-MIB. For example, the optimized parameters based on the removal performance obtained from synthetic water experiments are pH = 7, [CTAB] = 20 mg·L-1, IS = 10 mM as NaCl, which reached both the highest geosmin removal rate of 91.81% and highest 2-MIB removal rate of 85.0%. The removal of two odorous compounds in real lake water was evaluated under optimized foam fractionation conditions, which yielded removal rates of 83.2% for geosmin and 48.1% for 2-MIB. The discoveries may offer valuable perspectives for developing advanced water treatment approaches aimed at addressing the complexities associated with emerging micropollutants originating from diverse sources, including harmful algal blooms.

SPEAKER: **Yihan Zhang, New Jersey Institute of Technology | yz27@njit.edu**

SPEAKER BIO: My name is Yihan Zhang, a Ph.D. candidate at the New Jersey Institute of Technology (NJIT) majoring in Environmental Engineering. Solid waste environmental problems firstly caught my attention during site remediation classes at the first semester at NJIT. During the past few years, I have devoted myself to the research of solving energy, environmental, and sustainability problems related to solid waste/wastewater treatment and resource recovery. I am interested in the innovative technology development to improve the efficiency of solid waste treatment processes, such as the use of nanobubble water mixture to remove heavy metal or organic pollutants from water and soil. For example, my current research employs nanobubble-enabled foam fractionation to remove algogenic odor compounds (e.g., Geosmin) and PFAS from impaired water, soil and landfill leachate. Additionally, there is a growing interest in the circular economy model, which emphasizes the recovery and reuse of materials from waste streams. In this regard, we are studying how to use foam fractionation to separate algae especially those oil-producing algae species so we can concentrate algal biomass with minimum chemical and energy consumption to increase economic viability of the algae-derived products. Overall, my goal is to promote sustainable waste management practices and reduce the environmental impact of waste treatment.

12TH U.S. SYMPOSIUM ON HARMFUL ALGAE

GAMBIERDISCUS SANYAINUS SP. NOV. (DINOPHYCEAE) IN COASTAL SANYA, SOUTH CHINA SEA: MORPHOLOGY, TAXONOMY, AND TOXICITY

SESSION: POSTER SESSION, TUESDAY

ABSTRACT: Ciguatera fish poisoning (CFP) is a global issue that is caused by consumption of sea products contaminated by ciguatoxins (CTXs) produced by Gambierdiscus and Fukuyoa dinoflagellates. Although CTX contamination in reef fish from Sanya in the South China Sea (SCS) was confirmed, the toxin origin remains unclear in this region. Here, we report the isolation of an undescribed Gambierdiscus species from the SCS, namely Gambierdiscus sanyainus sp. nov. Evolutionary divergences indicated G. sanyainus were similar to G. carpenteri and G. caribaeus. Phylogenetic analyses of nine G. sanyainus strains based on D1-D3, D8-D10 LSU rDNA and SSU rDNA supported its cluster into a separate group. The species have smooth cell surface with common Gambierdiscsus Kofoidian plate formula: Po, 3′, 6″, 6c, ?s, 5‴, 1p and 2⁗. Besides, toxin profiles of G. sanyainus were determined and cell quotas of 44-methylgambierone (also previously reported as MTX-3) varied from 28.0 to 116.6 pg/cell, suggesting high interspecies variety. However, no gambierone, P-CTX-2 and P-CTX-3 were detected from the G. sanyainus extracts. Though roles of G. sanyainus as CTX origins in the SCS need further exploration, putative production of 44-methylgambierone (MTX-3) suggests the long-term contamination of this toxin in this area, posing potential threats to human health.

SPEAKER: **Wenguang Zhang, Woods Hole Oceanographic Institution | wenguang.zhang@whoi.edu**

SPEAKER BIO: My name is Wenguang Zhang, a PhD student from China. Now, I am doing my research at Woods Hole Oceanographic Institution as a guest student. My reseach interest mainly includes monitoring, early warning of harmful algal blooms and phycotoxins

CO-AUTHORS:
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