ADVANCING THE BLUE ECONOMY:
INNOVATION, RESILIENCY & COLLABORATION

Sponsored by the William R. Kenan, Jr. Charitable Trust
Dear Esteemed Guests,

The Center for Marine Science at the University of North Carolina Wilmington welcomes you to our gorgeous coastline for an exciting Global Marine Science Summit. Our focus on innovation, resiliency and collaboration has taken on special meaning since 2017, when UNCW hosted the first-ever summit.

Last fall, Hurricane Florence devastated our campus and this community. Dobo Hall, our primary science building, was significantly damaged and is now undergoing extensive renovation. A campus housing area had to be demolished; a new residential community is now being constructed in its place. Due to the extent of the damage across campus, we canceled classes for a month, but we developed effective strategies to reopen, support our students and employees and finish the semester Seahawk strong.

I hope our innovative and collaborative approach to responding to the challenges we faced during and after Florence will serve as a model of resiliency for other communities now and in the future. We could not have succeeded without UNCW’s expert faculty and staff. Their commitment to excellence forms the foundation of the university’s success in teaching, research and engagement. In December 2018, UNCW’s efforts to advance research and scholarly activities were recognized with the elevated designation of "Doctoral Universities: High Research Activity" from the Carnegie Classification of Institutions of Higher Education.

While you are here, I encourage you to explore our campus, especially the state-of-the-art facilities at CMS and the marine biotechnology building (MARBIONC). I also hope you will have an opportunity to visit historic, downtown Wilmington and walk along the great beaches and trails in our area. You will quickly see why UNCW is proud to be North Carolina’s coastal university!

Thank you for participating in UNCW’s Global Marine Science Summit. With ongoing growth along shorelines worldwide, many communities will continue to look to scientists, policymakers and industry leaders like all of you for solutions to myriad coastal issues for years to come.

Best wishes,

Jose V. Sartarelli
Introduction

Bringing together international scientists, policy makers and industry leaders, the UNCW Global Marine Science Summit focuses on sharing experiences and developing solutions for global marine science issues and improving the economic climate of coastal regions. Providing opportunities for enhanced collaboration in marine science, the summit leverages UNCW's expertise with that of international and U.S. partner institutions with an expressed interest in collective work.

Information from this meeting will be used to communicate and work with resource managers and local, state and federal agencies tasked with setting policies and funding the amelioration of negative impacts on coastal systems while finding ways to improve and sustain coastal economies.

Steering Committee

Amélie Brogden  
Director of Conferences, Events and Reservations  
University of North Carolina Wilmington  
USA

Lynn Leonard  
Interim Director of the UNCW Center for Marine Science  
Professor, Department of Earth and Ocean Sciences  
University of North Carolina Wilmington  
USA

Martin Posey  
Professor, Department of Biology and Marine Biology  
University of North Carolina Wilmington  
USA

Peter Schuhmann  
Professor, Department of Economics and Finance  
University of North Carolina Wilmington  
USA

Philippe Soudant  
Director of Research  
University of Brest  
France

Wendy Strangman  
Assistant Professor, Department of Chemistry and Biochemistry  
University of North Carolina Wilmington  
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Aswani Volety  
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Associate Vice Chancellor, International Programs  
University of North Carolina Wilmington  
USA

R. Thomas Williamson  
Linda and Yousry Sayed Distinguished Professor, Department of Chemistry and Biochemistry  
University of North Carolina Wilmington  
USA
Raymond Andersen received his B.Sc. in chemistry from the University of Alberta, a M.Sc. in chemical physics from UC Berkeley, a Ph.D. in marine natural products chemistry from UC San Diego and he was a post-doctoral Fellow in the chemistry department at MIT. He is a professor of chemistry at UBC and his research focuses on the discovery, synthesis and biosynthesis of bioactive marine natural products and their potential as drug leads. Dr. Andersen is a Fellow of the Royal Society of Canada and has received the Rutherford Medal in Chemistry from the Royal Society of Canada, the Chemical Institute of Canada Medal, the UBC Jacob Biely Research Prize, the Paul Scheuer Award in Marine Natural Products Chemistry, and the American Society of Pharmacognosy’s Farnsworth Award. He is a co-founder of Aquinox Pharmaceuticals and ESSA Pharma.

Joe Pawlik is the Frank Hawkins Kenan Distinguished Professor of Marine Biology in the Department of Biology and Marine Biology at the University of North Carolina Wilmington. He received his B.S. in 1982 from the University of Minnesota, Twin Cities, and his Ph.D. in marine biology in 1988 from Scripps Institution of Oceanography, UC San Diego. He joined the Department of Biology and Marine Biology at UNCW in 1991. He teaches an undergraduate course in invertebrate zoology and biodiversity, teaches “Introduction to Science as a Profession” to graduate students, and directs a research program involving undergraduate, graduate and Ph.D. students. He worked at the U.S. National Science Foundation as a program officer in the biological oceanography program from 2003-05. He and his students and collaborators have authored more than 160 publications, primarily on the ecology of sponges on Caribbean coral reefs.
Pre-Summit Events

Wednesday, Oct. 9

Marine Natural Products Drug Discovery and Harmful Algal Bloom Pre-Summit Symposium

Registration and Check-in
11 a.m.

Welcoming Remarks
11:20 a.m. - Stuart Borrett
UNCW Associate Provost for Research and Innovation

Keynote Presentation
11:30 a.m. - Raymond Andersen
University of British Columbia

Lunch
12:15 p.m.

1 p.m. - Barry O’Keefe
National Cancer Institute (NCI) Head, Protein Chemistry and Molecular Biology Section and Chief, Natural Products Branch, Division of Cancer Treatment and Diagnosis

1:35 p.m. - Carole Bewley
National Institutes of Health (NIH) Senior Investigator, Laboratory of Bioorganic Chemistry

2:10 p.m. - Frank Mari
National Institute of Standards and Technologies (NIST), Team Leader, Marine Biochemical Sciences Team

2:45 p.m. - Break

3 p.m. - Nathalie Valette-Silver
National Oceanic and Atmospheric Administration (NOAA) Science and Technology Team, Office of Ocean Exploration and Research

3:35 p.m. - Antony Williams
Environmental Protection Agency (EPA) National Center for Computational Toxicology

Closing Remarks
4:10 p.m. - Thomas Williamson and Wendy Strangman, UNCW Department of Chemistry and Biochemistry

Poster Session / Tour
4:15 p.m. - MARBIONC

Pre-Summit Interest Group Meetings
1-4 p.m.

Annual Forum - Cape Fear River Assembly
4-6 p.m. Changing Waters, Changing Climate, Changing Times

Keynote Speakers:
Tancred Miller
N.C. Division of Coastal Management, Coastal and Ocean Policy Manager

Ramiro Diaz
Waggoner & Ball Architecture/Environment, Senior Project Designer

Welcome Social
6-8 p.m. - Oyster Roast
UNCW Center for Marine Science
Technical Program

Thursday, Oct. 10

Check-in and Continental Breakfast
7:30 a.m.

Welcoming Remarks
8:30 a.m. - Jose V. Sartarelli
UNCW Chancellor

Christopher Finelli
Dean, UNCW Graduate School and Interim Executive Director of Marine Science

Keynote Presentation
9 a.m. - Joe Pawlik
Frank Hawkins Kenan Distinguished Professor of Marine Biology UNCW Department of Biology and Marine Biology
New Insights into the Resilience of Caribbean Coral Reef Ecosystems

Oral Presentations
Moderator - Christopher Finelli
Dean, UNCW Graduate School and Interim Executive Director of Marine Science

9:50 a.m. - Guan-hong Lee
Department of Oceanography, Inha University, Incheon, Korea
Anthropocene Estuaries: Linking Hydro-Geomorphic Alterations to Climate Change Resilience

10:10 a.m. - Leila Basti
Marine Environmental Physiology Laboratory; Tokyo University of Marine Science and Technology, Tokyo, Japan
Coastal Aquaculture: Vulnerability and Resilience to HAB and Climate Change

10:30 a.m. - Break

Moderator - Martin Posey
Professor, UNCW Department of Biology and Marine Biology

10:45 a.m. - Ramiro Diaz
Waggonner & Ball Architecture/Environment, New Orleans, Louisiana, USA
Living with Water: Urban Resilience in New Orleans, Norfolk and Charleston

11:05 a.m. - Malena Ripken
Centre for Environment and Sustainability Research, University of Oldenburg, Oldenburg, Germany
Marine Spatial Planning – Transboundary Approaches in Northern European Sea Basins

11:25 a.m. - José Guerreiro
Marine and Environmental Sciences Centre, Campus da Faculdade de Ciencias da Universidade de Lisboa, Lisbon University, Lisbon, Portugal
Marine Policy: The Challenge of Blue Growth and the Need for Maritime Spatial Planning: Portugal’s Leading Experience in the EU

11:45 a.m. - David Gill
Duke University Marine Laboratory, Duke University, Beaufort, North Carolina, USA
Which One? Relative Effectiveness of Marine Protected Areas and Implications for Spatial Planning

Lunch
12:05 p.m. - Lunch UNCW MARBIONC

Moderator - Peter Schuhmann
Professor, UNCW Department of Economics and Finance

1 p.m. - Tibor Vegh
Nicholas Institute for Environmental Policy Solutions, Duke University, Durham, North Carolina, USA
Evaluations for Blue Economy Policy Development

1:20 p.m. - Hazel Oxenford
Centre for Resource Management and Environmental Studies, University of the West Indies, Cave Hill Campus, Barbados
Sargassum – A Threat or an Opportunity for the Caribbean Blue Economy?

1:40 p.m. - Diane Durance
UNCW Center for Innovation and Entrepreneurship
Fish 2.0 – Growing Innovation and Investment In Sustainable Seafood

2 p.m. - Vengatesen Thiyagarajan
The Swire Institute of Marine Science and School of Biological Sciences, The University of Hong Kong, Hong Kong SAR, China
Multiple Stresses on Oysters in China: a Novel Threat to Global Shellfish Industries

2:20 p.m. - Break

Moderator - Martin Posey, Professor, UNCW Department of Biology and Marine Biology and Center for Marine Science

2:35 p.m. - Fred Jean
Institut Universitaire Européen de la Mer, Université de Bretagne Occidentale, Brest, France
Integrating Multiple Stress Effects on Life History Traits of Bivalves in Coastal Areas Through Energetic Modelling

2:55 p.m. - Mats Lindegarth
Department of Marine Sciences – Tjärnö, University of Gothenburg, Strömstad, Sweden
Quantifying and Modelling the Distribution of Bivalves in Swedish Coastal Waters

3:15 p.m. - Philippe Soudant
Laboratoire des Sciences de l’Environnement Marin (LEMAR), Université de Bretagne Occidentale, Plouzane, France
Ocean Production of the Healthy Long Chain Omega 3 Polyunsaturated Fatty Acids Under Global Changes

3:35 p.m. - Till Wagner
UNCW Department of Physics and Physical Oceanography
Boom and Bust? How Spring Blooms Depend on Ice Melt in the Arctic Ocean

Technical Poster Session
4 p.m.

Evening Reception
6 p.m. - Historic Kenan House, downtown Wilmington
Friday, Oct. 11

Check-in and Continental Breakfast
7:30 a.m.

Oral Presentations

Moderator - Doug Gamble
Professor and Chair, UNCW Department of Earth and Ocean Sciences

8:30 a.m. - Sergio N. Bordalo
Division of Petroleum Engineering, Department of Energy, School of Mechanical Engineering, State University of Campinas, Campinas, Brazil
Deacommissioning Offshore Production Installations: A Brazilian Perspective

8:50 a.m. - Dylan McNamara
UNCW Department of Physics and Physical Oceanography
The Stability of Human-Occupied Coastlines

9:10 a.m. - Kenny Leung
The Swire Institute of Marine Science and School of Biological Sciences, University of Hong Kong, Hong Kong, China
Design Options, Implementation Issues and Evaluating Success of Ecologically Engineered Shorelines

9:30 a.m. - Bernadette Snow
Department of Development Studies and Institute for Coastal and Marine Research, Nelson Mandela University, South Africa
Integrated Ocean Management in a Social-Ecological System: Algoa Bay

9:50 a.m. - Suzanne Palmer
Port Royal Marine Laboratory, The University of the West Indies, Kingston, Jamaica
Environmental Change Research at the UWI’s Port Royal Marine Laboratory, Jamaica

10:10 a.m. - Break

Moderator - Wade Watanabe
Research Professor and Director of Finfish Aquaculture, UNCW Center for Marine Science

10:25 a.m. - Donovan Campbell
Department of Geography and Geology, University of the West Indies at Mona, Kingston, Jamaica
Fish Sanctuary as a Tool for Strengthening Climate Resilience in Jamaica – Emerging Research Insights

10:45 a.m. - Xavier Basurto
Duke University Marine Laboratory, Duke University, Beaufort, North Carolina, USA
Why Global Marine Science Should Care About Small-Scale Fisheries?

11:05 p.m. - James Morris
NOAA National Ocean Service, National Centers for Coastal Ocean Science, Beaufort, North Carolina, USA
The AquaBlue Revolution: How NOAA is Helping Grow U.S. Aquaculture from Inshore to Offshore

11:25 a.m. - Antonela Paladin
University of Split, Split, Croatia
Adriatic Sea: Fisheries and Perspective

11:45 a.m. - Chris Hauton
School of Ocean and Earth Science, University of Southampton, Southampton, United Kingdom
A New Paradigm of Pathogen Recognition in Decapod Crustaceans; Mechanistic Advances Toward Rational Disease Prevention in Aquaculture

Lunch

12:05 p.m. - UNCW MARBIONC

Moderator - Wade Watanabe
Research Professor and Director of Finfish Aquaculture, UNCW Center for Marine Science

1 p.m. - Reginald Blaylock
Thad Cochran Marine Aquaculture Center, Gulf Coast Research Laboratory, University of Southern Mississippi, Ocean Springs, Mississippi, USA
Sustainable Production of Marine Finfish in Land-Based Recirculating Aquaculture Systems

1:20 p.m. - Kevan Main
Mote Aquaculture Research Park, Marine Laboratory, Sarasota, Florida, USA
Development of the Low Pollution Diet and Feeding Program Based on Nutrient Requirements in Olive Flounder

2 p.m. - Md. Tofazzal Islam
Institute of Biotechnology and Genetic Engineering, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh
Impacts of Biotechnology on the Blue Economy and Resiliency of Bangladesh

Break - 2:20 p.m.

Moderator - Ami Wilbur
Director, Shellfish Research Hatchery and Professor, UNCW Department of Biology and Marine Biology

2:40 p.m. - Louise Allcock
Ryan Institute, School of Natural Sciences, National University of Ireland, Galway, Ireland
Exploiting and Conserving Deep-Sea Genetic Resources

3 p.m. - Tan Shau Hwai
Centre for Marine and Coastal Studies, Universiti Sains Malaysia, Penang, Malaysia
Approaches to Poverty Alleviation in Rural Coastal Communities in Malaysia - Attempts at Using the Blue Economy as Sustainable Income Generators

3:20 p.m. - James Casey
Department of Economics, Washington and Lee University, Lexington, Virginia, USA
Raising Green for Blue: Increasing Contributions for Marine Conservation Through Better Understanding of Emotional Attachment

3:40 p.m. - Katsuyoshi Mori
World Oyster Society and Tohoku University, Japan
My Blue Economy: Let the Sea Live and Let Us Live with the Sea

Closing Remarks

4 p.m. - Stuart Borrett
Associate Provost for Research and Innovation University of North Carolina Wilmington
New Insights into the Resilience of Caribbean Coral Reef Ecosystems

AUTHOR
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ABSTRACT
Coral reefs have suffered unprecedented losses of reef-building corals in the past few decades. Why have Caribbean reefs in particular transitioned to coral-depleted systems and exhibited less coral resilience? New estimates of water-column processing by sponge pumping activities combined with discoveries related to carbon and nutrient cycling have led to novel hypotheses about the role of sponges in reef ecosystem function. The vicious circle hypothesis proposes that coral loss resulted in more abundant seaweeds that release dissolved organic carbon (DOC), which is consumed by sponges. Sponges return carbon to the reef, but also release nutrients that further enhance seaweed growth. Both seaweeds and sponges compete for space with the remaining corals, and the cycling of carbon and nutrients alters microbial activity, with negative consequences for the coral microbiome. Adding to these interactions are geographic factors that enhance nutrients and DOC on Caribbean reefs, such as river discharge and windblown dust. Relatively higher abundances of sponges and the absence of foliose phototrophic species suggest that sponge communities on Caribbean reefs have adapted to a different nutritional environment than is present on reefs elsewhere in the tropics. Evidence for top-down control of sponge community structure by fish predation has been further supported by gut content studies and historical population estimates of hawksbill turtles, which likely had a much greater impact on relative sponge abundances on Caribbean reefs of the past.

Anthropocene Estuaries: Linking Hydro-Geomorphic Alterations to Climate Change Resilience

AUTHORS
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ABSTRACT
The era of Anthropocene has arrived on Earth where rapid but profound and far-reaching changes occur due to various forms of human impact. In estuaries, human alterations such as dikeing or damming for flood control or water diversion induced a sedimentary regime shift by affecting hydrodynamics and sediment transport. We identified the extent and shape of more than 4,000 estuaries worldwide by analyzing satellite images through time. The change of estuarine area and width throughout the estuary were compared to local dam construction and land use practices to determine the main drivers of estuarine change. Preliminary results suggest that global estuaries have decreased by more than 5,000 km² within the last 30 years. In order to understand the drivers of estuarine change, a more in-depth analysis was conducted to Korean estuaries. It was found that the areal loss was influenced primarily by local farming activity and dam construction. Interestingly, post-industrial estuarine change (early 1900s–1975) exceeded modern change (1984–2015), suggesting estuaries respond quickly to anthropogenic alterations. Currently, Korean-altered estuaries have morphology that is susceptible to higher rates of sedimentation. The implications for estuarine management in the context of climate change are discussed.
Coastal Aquaculture: Vulnerability and Resilience to HAB and Climate Change

AUTHOR
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ABSTRACT
Rapid global change of the environment is occurring at an unprecedented pace in our geological history. The dramatic increase in the atmospheric levels of CO₂ since the Industrial Revolution has already reached 400 ppm, and the concentration of CO₂ in the atmosphere is predicted to reach 750–1000 ppm by the end of the century, depending on the model used for projections. As a consequence, the average global surface temperatures are expected to increase by 1.8 to 4°C, and more in some areas. The subsequent changes in the ocean chemistry have led to a decrease in the pH, a phenomenon referred to as ocean acidification (OA). Both warming and OA induce changes in biological systems that are occurring in most oceans due to global climate change. The effects of this global forcing on marine organisms and ecosystems are still poorly understood, although several range shifts in marine organisms have been reported in response to warming ocean waters and changes in the fitness of organisms due to OA. At the same time, harmful algal blooms (HAB) known to affect aquatic organisms are witnessing changes in their geographical distribution, intensity, frequency and toxicity. Both climate change and HAB are affecting and will be affecting cultured organisms for human consumption and thereby food security. Indeed, aquaculture has become the fastest growing food production system in the world. Despite the expansion of its activities to offshore production, coastal aquaculture remains the primary source of human consumption and is subjected to several anthropogenic stressors, including climate change and HAB. In this paper, the vulnerability and resilience of coastal aquaculture to climate change and HAB will be presented, based on model studies.

Living with Water: Urban Resilience in New Orleans, Norfolk and Charleston

AUTHOR
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ABSTRACT
The slogan of the 1968 French protest movement – “Beneath the paving, there is a beach!” – hints that a new, radically different future lies below the surfaces of our city that we take for granted. In terms of urban water management, the slogan becomes literal: to sustain a delta city in the face of environmental change, we must revolutionize our thinking about urban water by harnessing natural processes that we have worked for centuries to bury, wall off and hide. Architectural and urban designer, Ramiro Diaz, will present what “radical” change looks like in space and time, its economic impact, and its potential to transform education, culture, and identity in New Orleans, Norfolk, Charleston and other coastal cities.
Marine Spatial Planning – Transboundary Approaches in Northern European Sea Basins

**AUTHOR**
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**ABSTRACT**
European seas, and especially the North Sea as part of the Atlantic Ocean, are highly complex and open marine ecosystems. In addition, they are also the busiest seas worldwide for maritime industries. These seas, with shared resources, represent a crucial asset for both stakeholder use and protection and, as such, come with many territorial challenges. Marine Spatial Planning (MSP) is an emerging and much-needed global approach to manage and organize the use of our seas to prevent uncoordinated planning of the marine space. MSP has become increasingly important in recent years and it has attained significant interest among the European Union as well as the global community. Effective MSP has been identified as a main goal for implementing the EU Integrated Maritime Policy and is considered key for giving effect to the EU’s Blue Growth Strategy, while also valuing ecosystem services. Transboundary cooperation with interdisciplinary approaches is therefore key in maintaining related marine policy and governance. Bordering countries are aiming for a foundation of better governance; however diverse approaches by these countries have been characterizing the sea basins for many years, making it difficult for better governance practices to take hold. Developing new tools and best practices for transnational cooperation is key to the success of present and future MSP processes. Of particular interest are interactive tools and methods to collaborate with the blue economy and maritime stakeholders for the benefit of our seas. Different stakeholder engagement tools in MSP have been developed for collaboration in an interactive, communicative and playful environment. The aim is to foster communication and interaction among participating actors, while at the same time generating added value to planning processes by stakeholder engagement in a collaborative setting. This has been valued across northern European seas to eventually add value to MSP across sea basins.

Marine Policy: The Challenge of Blue Growth and the Need for Maritime Spatial Planning - Portugal’s Leading Experience in the EU

**AUTHOR**
José Guerreiro*

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**ABSTRACT**
Since 2012, the European Union (EU) has developed the Blue Growth Strategy as a pillar of its Integrated Maritime Policy, aiming to enhance the development of the maritime economy and focusing on five new strategic sectors: blue biotechnology, ocean energy, aquaculture, coastal tourism and seabed mining. In this context, the densification of maritime space occupation has forced the development of new maritime spatial planning and management instruments, in order to avoid conflicts of use. Accordingly, EU approved, in 2014, the Maritime Spatial Planning Directive, a common framework for maritime spatial planning and integrated coastal management, adopting a set of common minimum requirements to ensure the greater compatibility of decisions and planning at local, regional and national levels, within the EU framework. Portugal, owning one of the largest EEZ in EU was, still in 2014, one of the very first countries to develop a comprehensive legal framework on maritime spatial planning and management. However, it was soon realized that a change in legal maritime spatial planning instruments would not suffice: a new approach of maritime politics and economics also required a new institutional and political framework at the highest level, implying, as such, a rearrangement of maritime governance models. This approach has become more and more adopted by several EU countries and beyond, at the critical transition zone, from North to South Atlantic.
Which One? Relative Effectiveness of Marine Protected Areas and Implications for Spatial Planning

AUTHORS
Sarah E. Lester, David A. Gill*, Christopher M. Free, Gabby N. Ahmodia, Louise Glew, Dominic Andradi-Brown, Megan Barnes, Emily Darling, Helen E. Fox, Jonas Geldmann, Michael B. Mascia, Peter J. Mumby, and Stephen Woodley

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ABSTRACT
There is a large body of literature describing the benefits of no-take marine protected areas (MPAs) to marine fish population recovery. This has led to calls for an increase in the size and number of MPAs that restrict all fishing activity, such as the recent IUCN target of 30% global coverage of no-take areas. Such an increase in no-take MPA coverage is likely to have considerable social implications, and other research indicates that less restrictive MPAs can also deliver significant benefits to population recovery and ecosystem function. Further, many of the previous studies comparing the relative impacts of no-take and fished MPAs do not account for differences in pre-existing conditions or other contextual factors that could affect their relative performance. Here we employ a unique global dataset of over 15,000 fish surveys within over 150 MPAs to examine the relative impacts of no-take MPAs on marine fish populations to other forms of MPAs. We assess pre-existing factors that potentially influence MPA placement and policy, and examine other determinants of relative performance. We believe that this research can offer substantive insight for decision-makers concerning the relative benefits of various MPA policy options, facilitating the design of interventions that better fit the local socio-ecological context.

Evaluations for Blue Economy Policy Development

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ABSTRACT
The term "blue economy" is now widely but differently used by governments, frequently referring to a sustainable ocean economy, where economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy. For governments aiming to promote such a blue economy, policies focus on ensuring the alignment of economic and environmental trends. Developing such policies requires the measurement of the size of and growth trends in ocean and coastal economy sectors as well as status and trends of the natural capital asset base underpinning this economic activity. Challenges with measuring the ocean economy arise when data are not collected in a systematic and disaggregated way about relevant ocean-linked economic sectors in terms of gross value added and employment, and when ocean natural capital stocks have not been properly accounted for. However, the contribution of the ocean environment to economic growth, and the tradeoffs between them, is better considered in decision making processes when this contribution is expressed in economic terms.

Lessons learned through a blue economy assessment in Bangladesh as well as recent developments in the blue economy literature are presented. These include (1) the need for ocean economy data classified and measured similar to the Economic-National Ocean Watch (ENOW) data set to allow for a comprehensive evaluation of ocean economy status and trends, (2) the challenges associated with systematic evaluation of status and trends in the natural capital asset base in the absence of reliable data, and (3) the argument for integrated measures of national income, national environmental and national ecosystem service accounts to allow for better tracking of blue economy policies.
Sargassum - A Threat or an Opportunity for the Caribbean Blue Economy

AUTHORS
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ABSTRACT
As Caribbean countries position themselves to further develop blue economies, they are faced with a new challenge in the form of unprecedented ‘influxes’ of pelagic sargassum seaweed that have been stranding along Caribbean shorelines since 2011. As thousands of tons of sargassum pile up in bays and on beaches, the negative impacts are enormous and multi-sectoral. They affect tourism, fisheries, environment, health, transport and the financial resources of governments and the private sector that bear the costs of repeated removal. With influxes now considered a ‘new normal’ under current levels of ocean eutrophication and climate change, the region is seeking ways to better cope with, and adapt to, these onslaughts, which are threatening key economic sectors of many Caribbean countries. An important aspect of this adaptation will be to turn the current threat into an opportunity for input under a blue economy to encourage research, innovation and development. Investments in research and technology are needed to improve sargassum monitoring and stranding predictions over the short and long term to inform coastal managers, communities and businesses how much sargassum to expect and when. Research and innovation is urgently needed to improve the equipment and methods of removal and disposal of sargassum, which are currently unsustainable both in terms of costs and the environmental damage caused. A critical area for advancement will be the search for beneficial uses of stranded or nearshore sargassum to defray the cost of removal and/or to provide input into viable businesses using sargassum as a raw material.

Fish 2.0 – Growing Innovation and Investing in Sustainable Seafood

AUTHOR
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ABSTRACT
UNCW supports Fish 2.0 in its mission to connect entrepreneurs with the resources and capital they need to commercialize innovations in sustainable seafood and aquaculture.

Fish 2.0 attracts ventures from around the world and evaluates diverse concepts ranging from supply chain transparency and traceability – to next-gen gear, biomimetic fish meal for aquaculture, big data efficiencies, and technologies to reduce waste and mortality. Through a year-long vetting process, 40 top ventures are selected to present to investors with strong interests in these sectors.

Monica Jain founded Fish 2.0 in 2012 to grow an ecosystem “where seafood businesses and investors meet.” Recognizing the lack of investor interest in the newly emerging sustainable fisheries and aquaculture sectors, Jain set out to make connections happen. To amplify her efforts, she built an online business competition with global reach, engaging key investors like Aqua-Spark, a fund investing in aquaculture to address the planet’s health and food security. She garnered support from the Packard Foundation, Gordon Moore Foundation and The Conservation Fund – tapping into their drive to find innovative and entrepreneurial solutions to overfishing, irresponsible aquaculture, habitat loss, and other threats impacting the ocean and its biodiversity.

By early 2019, Fish 2.0 connections resulted in $200 million invested in Fish 2.0 participants and another $200 million being invested as a result of strategic introductions.

According to Jain, there are five accelerating global trends opening up huge market opportunities for innovations in seafood: the need to predict and understand climate change impacts; wild fish stocks nearing maximum sustainable yield; product globalization and the rise of online sales; the worldwide growth of a health-conscious middle class; and aquaculture’s rapid expansion.

In this session, we’ll explore those trends and learn about the innovative companies selected to present to investors at the Fish 2.0 Global Innovators Forum in November.
Multiple Stressors on Edible Oysters of China: A Novel Threat to Global Shellfish Industries

Vengatesen Thiyagarajan*

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ABSTRACT
Globally, edible oysters are facing serious threats from human CO₂ induced coastal acidification, especially when they are developing gonads and larvae. This climate change-associated stressor has already caused observable impacts on oyster seed production in the USA, even in controlled hatchery conditions. China – as the producer of over 80% of the world’s edible oysters – is seriously concerned about this emerging issue because oyster growers in China depend heavily on wild seeds, over which they have no control. Substantiating this fear, Chinese oyster growers have observed unprecedented high “winter” mortalities over the past few years, possibly as an effect of multiple stressors involving acidification. Therefore, we have initiated a project to look at how acidification affecting larval recruitment, calcification products in terms of shell structure and mechanical properties, and important metabolic pathways that are used for acclimation. To our surprise, a significantly higher proportion of the Crassostrea hongkongensis (Hong Kong oyster) populations in China are resilient to near-future levels of acidification. However, their larvae failed to select an optimal habitat (i.e., substrate with biofilms) for recruitment and also early juveniles failed to produce harder protective shells under acidification (pH 7.4). Of particular interest, the rapid “non-genetic” adaptation potential of oysters to acidification was studied by analyzing acidification-induced epigenetic marks on DNA, i.e., DNA methylation. The availability of annotated genome, tissue-specific transcripts, and well-described stress and immune response pathways of the oyster populations in China provided us with solid groundwork for examining the inheritance and memory mechanisms of the acquired stress-tolerating mechanisms. In this presentation, we will summarize these findings. Knowledge generated from these projects are providing an important stepping stone to develop mitigation and adaptation strategies for oyster aquaculture industries in the era of unprecedented global environmental change.

Integrating Multiple Stress Effects on Life History Traits of Bivalves in Coastal Areas Through Energetic Modelling

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ABSTRACT
In coastal areas, climate change induces variations in the physico-chemical parameters of the environment. These variations combine to form multiple stresses that have direct consequences on the life history traits of the organisms that live there. Along the Peruvian coast, high-frequency events of low concentrations of oxygen combined to thermal variations determine marine species distribution and abundance, with consequences for human activities such as fishing and aquaculture. The effects of these multiple stresses in combination on the life history traits of these organisms are difficult to assess. The results of experimental studies and integrative energy modelling using the Dynamic Energy Budget theory make it possible to identify pathways for exploring the trajectories of bivalve populations living in Peru’s coastal bays subject to the influence of this high-frequency environmental variability.
Quantifying and Modelling the Distribution of Bivalves in Swedish Coastal Waters

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Filter-feeding bivalves are conspicuous components of benthic coastal systems around the globe. In the fully marine areas of western Sweden, the blue mussels (*Mytilus edulis*) and the native flat oysters (*Ostrea edulis*) are abundant and widespread, but their ecological significance and the sustainability of current exploitation is poorly studied. Therefore, we used quantitative visual methods to assess the abundance and distribution of *M. edulis* and *O. edulis* at approximately 550 sites along the Swedish North Sea coast. The data were used to (1) estimate the current size of the Swedish populations and (2) to model their respective spatial distributions using species distribution models.

The results show that both species are widespread in the area, but due to highly variable abundances, the majority of populations are concentrated to relatively few particularly valuable sites. The occurrence of both species and particularly high-density areas can be predicted by environmental gradients, such as water depth, bottom-substrate and salinity. The estimated size of the Swedish oyster population suggests that, despite its marginal distribution in Europe, its status is relatively good in comparison to many other populations which have been hit by parasites and high exploitation pressures. Overall, the current level of commercial fishery for *O. edulis* appears to exploit less than 1% of the population annually. The population of blue mussels sampled in natural and artificial habitats in a relatively limited geographic area (30 x 30 km). These analyses suggested that approximately 20% of all mussels live in natural habitats, 5% on artificial structures while 75% are found in the mussel farms.

These results shed new light on the ecological significance and status of these species on the Swedish west coast. This perspective is invaluable for designing sustainable policies and practices, integrating conservation interests as well as innovation in fisheries and aquaculture.

Ocean Production of the Healthy Long Chain Omega 3 Polyunsaturated Fatty Acids Under Global Changes

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The steady increase in human consumption of seafood is partly related to the beneficial health effects of long chain n-3 (Omega 3) polyunsaturated fatty acids, 20:5n-3 and 22:6n-3, on cardiovascular disease, hypertension, autoimmune disorders, neural development, and mental disorders. The majority of 20:5n-3 and 22:6n-3 originates from marine phytoplankton, but their quantity varies significantly with phylogeny and physiology. Their availability is one of the key factors influencing the growth and reproduction of zooplankton and organisms at higher ranks of the trophic hierarchy. There is concern for a potential shortage of 20:5n-3 and 22:6n-3 due not only to stock reduction and overfishing, but also to climate changes, which may affect their production and upward transfer. To address this issue, it is important to i) identify the source and production of EPA and DHA by oceans, ii) evaluate the trophic transfer efficiency of EPA and DHA, iii) quantify the influence of the climate related shifts on both production and transfer, and iv) develop mathematical models making projections on future EPA and DHA production.
Boom and Bust? How Spring Blooms Depend on Ice Melt in the Arctic Ocean


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ABSTRACT
The margins of the Arctic Ocean are among the most productive seas on Earth. This is largely due to the annual growth and melt of sea ice, which helps stratify the upper ocean and provides crucial nutrients in spring when the local ecosystem awakens. Fram Strait – located between Greenland and Norway – is a particularly active region with some of the highest melt water fluxes and intensive phytoplankton blooms. These blooms attract higher trophic-level predators and help turn Fram Strait into a sea teeming with life each spring. However, the region remains a challenging place to study and many open questions remain regarding the exact physical and chemical conditions that provide for this vibrant ecosystem. We conducted an oceanographic expedition to the area in May 2019 during a phytoplankton superbloom. Here, I will present initial results on the ice and oceanographic conditions, as well as chemical and biological factors that appear crucial for such blooms. I will further aim to put our findings into a longer-term context: while recent increases in meltwater flux may have been enhancing plankton growth and boosting the ecosystem, the region will likely face deteriorating conditions as the summer sea ice retreats further and meltwater flux eventually decreases under global warming. This raises the question whether the Arctic’s marginal seas are heading toward a potentially devastating boom-bust cycle?

Decommissioning Offshore Production Installations: A Brazilian Perspective

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ABSTRACT
Concerns regarding the decommissioning of offshore oil and gas production installations have been progressively increasing through the past years among the industry, government and other interest groups. There are at least two important reasons for these concerns. First, several oil and gas fields around the world are entering their mature phases in recent years. Second, there is a growing impact of environmental issues in international business affairs. The procedures for the decommissioning of offshore oil and gas production systems are, to some extent, still an innovative issue, especially in Brazil, despite the fact that there are some publications that address techniques, potential problems and risks related to the abandonment of oil fields. The present paper was motivated by the needs of the Brazilian industry, which is just beginning to deal with "end of leasing" obligations occurring in decommissioning operations. Rather than to propose specific solutions, the authors present a concise review of decommissioning practices for offshore oil and gas production facilities and point out their main attributes, with the intent to contribute to the debate involving the petroleum industry, its national regulatory agency and the environmental government authority.
The Stability of Human-Occupied Coastlines

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ABSTRACT
In many coastal regions, human interactions and natural processes are strongly coupled. The nonlinear nature of this coupling, along with dissipation in both the natural and economic systems, dynamically constrains the system to evolve toward a state that is a subset of its possible configurations, termed an “attractor.” The current U.S. east coast attractor can be qualitatively characterized by human-manipulated erosion rates, dense populations, immobile infrastructure, high property values, and the occurrence of large, infrequent catastrophes. With increasing rates of sea level rise and the eventual inundation of the existing built environment, the human-occupied coastal attractor is destined to become unstable. While the long-term fate of coastal communities facing rising sea level seems clear, there is no quantitative understanding of the evolving stability of the human-occupied coastal system attractor. Such quantitative insight is desperately needed to inform discussions on the related issue of sustainability. We explore using attractor reconstruction to gain quantitative insight into the evolving stability of the human occupied coastal system attractor along the U.S. east coast. Reconstruction of an attractor is possible using a single measured feature from a multi-dimensional system, and for the human-occupied coastal system we use qualified sales data from 1989-2015 for single family homes in counties along the U.S. east coast. From this data, we estimate quarterly and annual price indices at the county level after controlling for structural housing attributes. Our method for measuring stability in the reconstructed attractor builds from the connection between stability and dissipation, or phase space volume contraction. When phase space volume contraction is measured from the reconstructed human-occupied coastal attractor, results show that regions that have long engaged in erosion mitigation are showing stronger phase space contraction through time, thus becoming increasingly stable as sea level rises, while other regions are instead losing stability. This result has important policy implications as it appears that longer-term adaptation to climate forcings is being hampered by short-term mitigation in coastal communities.

Design Options, Implementation Issues and Evaluating Success of Ecologically Engineered Shorelines

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ABSTRACT
Globally, construction of artificial structures along shorelines has been recently amplified by societal responses to reduce flood and erosion risks from rising sea levels and more extreme storms resulting from climate change. Such structures deliver societal benefits, but they also lead to highly modified shorelines and create significant socioeconomic and environmental challenges. Therefore, these structures should be designed and built with the overarching objective of reducing negative impacts on nature, using hard, soft and hybrid ecological engineering approaches. The design of ecologically friendly shorelines should be context-dependent and combine engineering, environmental and socioeconomic considerations. The costs and benefits of eco-engineered shoreline design options should be considered across all three of these disciplinary domains when setting objectives, informing plans for their subsequent maintenance and management and ultimately monitoring and evaluating their success. In this presentation, I will give an overview of current eco-engineered shoreline design options, the drivers and constraints that influence implementation and factors to consider when evaluating the success of such ecologically engineered shorelines. Some successful projects, which engaged with multiple stakeholders (e.g., architects, engineers, ecologists, coastal/port managers and the general public) during their conception and construction, will be highlighted.
Intergated Ocean Management in Social-Ecological System: Algoa Bay

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ABSTRACT
Marine systems deliver ecosystem services upon which human well-being depends. Despite a clear understanding of this dependency, humans continue to impact marine systems in potentially irreversible ways. Complex and ineffective governance and economic regimes also reduce our ability to manage ocean ecosystems sustainably and provide no adaptive capacity or resilience to global change. An urgent need to adopt more integrated ocean management (IOM) approaches has been recognized in policies such as the United Nations Sustainable Development Goals. However, these policies and goals need to be operational at local and regional scales, and national policies tend to be fragmented and sector-specific. In addition, management approaches at local levels need to be dynamic and fair, and should address human and environmental needs and rights in transparent frameworks. Given the inherent complex and dynamic nature of marine systems, as well as the complexity of governance systems that regulate or inform ocean use, effective approaches to IOM can benefit from social-ecological systems frameworks. We are developing a systems thinking and modeling approach in Algoa Bay, South Africa, to support IOM of the Bay at a time when many users are planning or developing new marine industries.

Systems analysis, an approach that addresses complexity, can provide a framework to understand key dynamic interactions, feedbacks and unintended consequences in systems and is suited to IOM. System dynamics (SD) modeling, a structured approach to systems analysis, is a rigorous method for modeling complex systems and building computer simulations for scenario planning and decision support. Using a collaborative dynamic modeling approach, we are building SD models to evaluate trade-offs under different management scenarios designed to prioritize environmental, social and economic goals in Algoa Bay. We intend to provide proof of concept of a systems approach to IOM that can be replicated across geographic and governance scales.

Environmental Change Research at the UWI's Port Royal Marine Laboratory, Jamaica

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ABSTRACT
The Port Royal Marine Laboratory (PRML) is a facility of The University of the West Indies, Mona, Jamaica under the Department of Life Sciences that supports teaching, research and outreach activities. The PRML has an international reputation for conducting coastal and marine research that informs national and regional ecosystem management. Recent upgrades to the PRML include the procurement and installation of a privately funded compressor facility to support the growing scuba diving program and associated research activities, together with the procurement of equipment to establish a Reef Bioindicators Laboratory focusing initially on reef sedimentology and reef carbonate budgets. The PRML continues to evolve and seeks new collaborations whilst welcoming new and returning visitors.

Specific projects investigating the causes and impacts of environmental change include those being conducted by the Caribbean Environmental Research Group (CERG), a cross-disciplinary group of researchers based at the University of the West Indies (UWI), Mona, Jamaica. Here we discuss the current projects that focus on the south coast of Jamaica. They include reconstructing past extreme wave event activity and climatic change from mangrove lagoon sediment records, coral restoration efforts to enhance ecosystem function and bolster their resilience to climate change, a multi-proxy approach to assessing and monitoring the health and future trajectory of urban coral reefs under a changing climate, and developing socio-economic and ecological indicators of fishing pressure on coral reefs in support of developing climate-resilient fishing communities.
Fish Sanctuary Wellbeing and Climate Resilience in Jamaica – Emerging Research Insights

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ABSTRACT
Strategies to foster local well-being and strengthen climate resilience in coastal systems are complex. Near-shore development, aquaculture intensification, the expansion of capture fisheries, and climate change (sea-level rise, acidification) are combining to produce situations of rapid coastal change. In Jamaica, the fisheries have been in decline over recent decades, which poses ecological, social and food security challenges that are being exacerbated by climate change. In response (along with other measures), the Government of Jamaica has established a network of fish sanctuaries to combat chronic overfishing, marine biodiversity loss and improve social well-being in local fishing communities. This paper highlights emerging insights from two coastal case studies on the socio-ecological trade-offs, synergies and co-benefits associated with Fish Sanctuaries and coastal communities in Jamaica. The research focuses on the use of inter- and transdisciplinary research tools and techniques to capture the relationships between ecosystems, their physical functions, value and the service they provide to human well-being. In each stretch of coast we are working, there are also similar and ongoing management initiatives, including co-management efforts linked to the emergence of marine conservation and protected areas, adaptation to sea level rise, and efforts to manage interconnected uses of the coastal space (tourism, fisheries, conservation). The case studies demonstrate how multidisciplinary approaches can provide linked social-ecological insights on how best to craft and implement conservation and resource management interventions and processes (e.g., resource rights allocations, zoning for protection and use, flexible institutions) appropriate in rapidly changing coastal systems.

Why Global Marine Science Should Care About Small-Scale Fisheries?

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ABSTRACT
Did you know that the most biodiverse marine habitats of the world are home to almost 90% of the world’s fishers? And that they produce almost half of the fish we eat? Developing a systematic understanding of the interactions between humans and seascapes of high biodiversity outside marine protected areas is of global interest to the marine science and conservation practitioner communities around the world. Yet, until recently, it has not been. Most science and policy efforts to govern the ocean outside of marine protected areas have been focused on developing and regulating industrial fisheries in developed countries, where a few large boats can produce large quantities of catch. Time has come to turn our attention to small-scale fisheries, which while often invisible in national fisheries statistics, small-scale fisheries are by far the largest employer in the ocean, surpassing shipping, tourism, or oil and gas. To further make the case of why global marine science should care about small-scale fisheries, I will share with you some of the ongoing local and global efforts taking place to build a systematic understanding of the contributions and impacts small-scale fishers have in our society, the ocean and the economy, as well as opportunities for the marine science community for engagement.
The AquaBlue Revolution: How NOAA is Helping Grow U.S. Aquaculture form Inshore to Offshore

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ABSTRACT
The U.S. is recognized as a global leader in responsibly managed fisheries, but market demand for seafood exceeds sustainable wild harvest. It has for quite a few years, which has spurred the growth of the aquaculture industry. We are now observing the remarkable advancement of technology to farm shellfish (oysters, clams and mussels) and algae (seaweed and kelp) in coastal estuaries, as well as finfish farms in the ocean. While we have many challenges ahead, we are confident through innovation and resolute conservation the U.S. can become a global leader in sustainable seafood that is wild-caught and farmed! NOAA is working to advance sustainable aquaculture development all along our nation’s coastlines through science at the NMFS regional offices and science centers; through our Sea Grant programs, which focus on aquaculture extension, outreach, and research and development grant programs; and in the National Ocean Service’s laboratories where we develop innovative aquaculture planning and siting tools such as the National AquaMapper and OceanReports. This presentation will provide an overview of the NOAA Aquaculture Program and highlight some of the new and innovative research findings, tools and services being provided to industry and coastal managers around the U.S.

Adriatic Sea: Fisheries and Perspective

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ABSTRACT
By its origin, living world and ecological characteristics, the Adriatic Sea is a part of the Mediterranean Sea as its northern bay. It is connected to the Mediterranean by the Otrant Straight, 72 km wide and 741 m deep. The deepest parts are the Apple Basin, with depth of 273 metres, and the Southern Adriatic Basin, with a maximum depth of 1,233 metres. Fisheries are an important element for the Republic of Croatia with 7% of total exports of agricultural products. With about 449 species and subspecies of fish, the Adriatic Sea is one of the richer seas, but only a small number of species are rich in biomass. The species of small blue fish are the largest in biomass and about another hundred species have fishery and economic importance. Species from the Sparidae family are of great economic importance and are targeted species for various types of fishing. The biology of blackspot seabream, Pagellus bogaraveo (Brünnich, 1768) in the eastern Adriatic has been researched with the aim of learning about the population dynamics of this species, because of its economic importance and role in coastal ichthyological communities. Specimens of blackspot seabream were collected from commercial and experimental catches in the eastern Adriatic Sea. The results of the research contribute to a better understanding of the life cycle and management, breeding opportunities, conservation of the species and biodiversity of the Adriatic ichthyofauna.
A New Paradigm of Pathogen Recognition in Decapod Crustaceans: Mechanistic Advances Toward Rational Disease Prevention in Aquaculture

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Infectious disease outbreaks represent a key limitation to the necessary sustainable expansion of the aquaculture industry to meet the challenges of Global Food Security and poverty alleviation. For example, globally, losses to White Spot Syndrome Virus (WSSV), the causative agent of white spot disease (WSD) in decapod crustaceans, have been estimated to cost between $8-$15 bn. In response, the established paradigm has been to attempt to identify the causative agent and, subsequently, intervention strategies. Research conducted during the last 20+ years has identified a range of compounds that are purported to enhance immunity or disease resistance in crustaceans. Some of these compounds are marketed commercially, some are still in the development stage, and others are on the sidelines awaiting investment. However, the application of immune stimulants or other chemicals is not without challenges. Moreover, despite these advances, the reality is that we still cannot eradicate or prevent pathogenic disease outbreaks within the complex farm environment.

In this presentation, I will argue that a focus on stimulating the immune effector arm of the crustacean immune system is a misguided approach to disease control in aquaculture. I will present data on our new understanding of the complexity of pathogen recognition in the Pan Arthropoda, insights which may – in time – present alternate mechanisms to exploit to enhance disease surveillance with global crustacean culture.

A Brave, New, Bluer World: Advancing Marine Finfish Production in the Gulf of Mexico

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The increasing human population requires an increasing supply of protein. Fish is a rich source of easily digested, high-quality protein, but production from wild fisheries is static. Aquaculture fills the gap between supply and demand and now accounts for over 50% of fisheries production. Most of that production, however, is from freshwater, and U.S. consumers prefer marine fish. The U.S. imports 90% of the seafood it consumes. Trade barriers, food safety and security issues, and sustainability issues call into question a supply strategy that relies on imports.

The U.S. has the world’s largest Exclusive Economic Zone in which to develop a thriving marine finfish culture industry. However, the U.S., and the Gulf of Mexico region in particular, has virtually no domestic marine aquaculture industry. Impediments to the development of an industry include restrictions on land use, environmental concerns, lack of economic feasibility, the uncertainty of the permitting process, and the lack of appropriate production models for species of interest.

The University of Southern Mississippi seeks to cultivate partnerships with private, state and federal agencies to alleviate the constraints on development of the industry. We have advanced the culture of spotted seatrout, Cynoscion nebulosus, in recirculating systems to a state of commercial readiness and have pioneered development of mass culture techniques for copepods for live feeds in recirculating systems. We have facilitated cooperation among academic institutions, a private fish farmer, and NOAA to design a commercial-scale offshore facility for the Gulf of Mexico, scientifically screen for suitable locations, and work with a federal interagency working group to achieve the required permits for the operation. We have worked with the Department of Energy on development of a transformative system for integrated aquaculture that combines macroalgae culture with shellfish and finfish culture to achieve recycling of nutrients with food and biofuel production.
**Sustainable Production of Marine Finfish in Land-Based Recirculating Aquaculture Systems**

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**ABSTRACT**
Expansion of U.S. marine finfish production in land-based recirculating aquaculture systems (RAS) will require the development of a standardized RAS system to address current obstacles, such as high energy demand, biosecurity, and discharge of saline water and organic salty solids. The need to address the obstacles facing standardized RAS systems, expand marine fish production, and improve the economic viability and sustainability of marine RAS technology led to the development of a zero-discharge, integrated marine aquaculture (aquaponic) system (IAS).

A simple prototype, commercial-scale system was designed to reduce energy needs by using gravity and limited pumping to move water, while incorporating solids filtration, a moving bed bioreactor for nitrification, hydroponic plant beds for expanded nitrification, a sand filter for solids removal and denitrification, and ultra-violet light sterilization for water quality. Water treatment capacity, nutrient cycling, and biomass production were evaluated in the prototype IAS that produced red drum (*Sciaenops ocellatus*), edible halophyte plants (sea purslane, *Sesuvium portulacastrum*), and organic solids for three production cycles.

Extensive analysis of solids, organic matter and nutrients (nitrogen and phosphorus) in water and plant biomass was used to develop detailed mass balances for the system. Simultaneous operation of the moving bed bioreactor and plant beds resulted in high ammonia removal rates, allowing the system to support a high fish biomass density (38.8 kg/m³ in year 1, 48.8 kg/m³ in year 2, 45.2 kg/m³ in year 3). This prototype marine IAS demonstrates an effective way to sustainably produce marine fish, edible halophytes and fertilizer. Addition of biological filtration and a denitrifying sand filter was shown to benefit high-density fish production in situations where there are space limitations or niche markets for plants. Recent research trials evaluated the potential to increase biofiltration capacity in a marine RAS using periphyton biofilters.

**Development of the Low Pollution Diet and Feeding Program Based on Nutrient Requirements in Olive Flounder**

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**ABSTRACT**
Olive founder, *Paralichthys olivaceus*, is the most cultured fish species in Korea (37,000 tons in 2018). Although this popular marine species has great commercial importance in Korean aquaculture, there are several challenges for the sustainable development of olive flounder aquaculture industry. Almost 80% of the domestic flounder farmers use the moist pellet diets in flow-through aquaculture systems, which is not sustainable. Also, current domestic formulated diets containing the high amounts of fish meal could not be sustainable. To overcome these challenges, basic research of the nutrient requirements of olive flounder would be required to develop the high-quality, low-pollution diet. Replacement of fish meal by the lower price plant proteins or animal byproducts could be sustainable. Therefore, we would like to discuss the nutrient requirements, the low-pollution diet, the fish meal replacement and the feeding strategy for the sustainable flounder aquaculture industry in Korea.
TITLE
Impacts of Biotechnology on the Blue Economy and Resiliency in Bangladesh

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ABSTRACT
Bangladesh is one of the most densely populated countries with a population of 162 million in 147,570 sq.km of land area. The country is rich in marine biodiversity in 118,813 sq.km of territorial sea, 200 nautical miles (NM) of exclusive economic zone and up to 354 NM of continental shelf from the Chittagong coast of the Bay of Bengal (BoB). These areas are considered untapped reservoirs of bioresources for bioprospecting and sustainable blue economic development of the nation. Although Bangladesh is the third leading country in the world in freshwater aquaculture production, contribution of marine products to the national economy is limited to mainly captured hilsa fish (Tenualosa ilisha) (1.2% of GDP) and a few other fish species. In addition, Bangladesh exports brackish and freshwater shrimp valued at approximately USD $400 million. There is high potential for marine aquaculture of tiger shrimp, Asian sea bass, grey mullet, captive mud crabs, and marine fish species including pomfret and saline-tolerant tilapia. Culture of seaweed, microalgae, mussels, oysters and other shellfishes, pearl, and invertebrates such as sea cucumber and sea urchin is highly promising in the BoB. Genomics and post-genomics approaches are needed to identify and characterize the marine species with commercial aquaculture potential. Application of biotechnology and genetic engineering could promote marine capture fisheries, mariculture, disease diagnosis, development of probiotics as feed supplements, discovery of pharmaceutical drugs and healthcare substances (antibiotics, antioxidants, pigments etc.), production of engineered vaccines for fish/shrimp, industrial use of seaweeds and marine algae, bioremediation, production of biofuels and other high-valued substances. Capacity building and international partnerships are needed for mining Bangladesh marine biogold through interdisciplinary research. This talk discusses progress and potential of our research on marine bioresources of the BoB for promoting the blue economy and resiliency in Bangladesh.

TITLE
Exploiting and Conserving Deep-Sea Genetic Resources

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ABSTRACT
The blue economy depends on our ability to sustainably exploit the resources our ocean provides. In this project, we are elucidating novel natural products from sponges and corals in Ireland's offshore waters and increasing what we know about their economic value and distribution. Deep-water areas are rich in these diverse taxa, which are known to have a high prevalence of bioactivity. The deep-sea has massive promise for biodiscovery because of the extreme environmental conditions which likely promote the evolution of unique secondary metabolites. We describe a sampling and screening program, which focuses on elucidating the chemistry of extracts that display both a dose response and minimal cytotoxicity to healthy cell lines. We iteratively fractionate extracts to produce pure compounds and determine their structures using NMR spectroscopy and other relevant techniques. Simultaneously, we are surveying large areas of Ireland's deep sea, using species distribution modelling to predict the occurrence of species across the whole EEZ. We are developing techniques for statistically inferring the likelihood of any given species producing a useful natural product and applying this information to the occurrence maps to produce predicative maps of biodiscovery potential. We can use these both to maximize the economic impact of future biodiscovery work, and to inform conservation planning such that the protection of genetic resources for future generations is also maximized.
Approaches to Poverty Alleviation in Rural Coastal Communities in Malaysia – Attempts at Using the Blue Economy as Sustainable Income Generators

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ABSTRACT
Capture fisheries are decreasing and traditional fishing is becoming difficult to generate sustainable income. The rural coastal communities are facing financial challenges to sustain their livelihood. Therefore, the rural coastal communities need to rely on alternative activities to overcome poverty. Oyster farming is considered as a green aquaculture since filter-feeding bivalves are able to reduce eutrophication effects on the coastal environment. It is also providing a sound alternative for sustainable income to traditional fishermen. Oyster farming requires low technology, which can be applied by almost all fishermen and will be able to generate additional income for the local community once the oysters reached marketable size (between 8 to 10 months, depending on the site selected). Each farmer is able to sell approximately 2,000 oysters per month at USD $0.50 per piece, and generate an additional USD $1,000 per month on a part-time basis. The farmers are very innovative and they have converted oyster farming into a sustainable ecotourism activity, where lucrative income from tourism packages has been generated, inclusive of getting an experience of culturing oysters on the floating cages, opening live oysters, experiencing various local delicacies using oysters, to name a few of the tourism packages. The oyster farmers now have become social entrepreneurs, where their business involves not only the fishing communities but also women and children. Oyster entrepreneurs have expanded their activities, offering volunteers from overseas the opportunity to be involved in community engagement through providing tuition to the children besides helping on the oyster farm. The oyster culture project has paved the way to improve the living standards of the local communities, which is not only socially sustainable, but also economically and environmentally sustainable.

Raising Green for Blue: Increasing Contributions for Marine Conservation Through Better Understanding of Emotional Attachment

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ABSTRACT
In the early 2000s, Wallace Nichols began using the phrase "Blue Mind" to indicate a shift that occurs when we are around water. There is an attachment, a stirring of the imagination, a shift in our soul when we connect with our watery world. Neuroscientists have confirmed something does change in our brains when we experience "Blue." A fundamental question still remains: how does this feeling and/or attachment affect the way we value the Blue World? It is well known that charismatic megafauna can elicit strong emotional responses from humans. Unfortunately, little is known about the connection between these emotions and economic value. Recent work by Huettel et al. (2013) suggests that emotions and value are processed in the brain in similar ways. In the context of conservation finance, understanding humans’ emotional connection with nature and its impact on economic decision-making may increase the ability to raise financial capital put toward conservation. This paper seeks to estimate tourists’ maximum willingness to pay (WTP) for whale shark excursions in Mexico and to explore the role of emotions in determining this value. Initial results suggest swimming with whale sharks has an emotional impact and this results in greater economic value for the participants in this activity.
My Blue Economy: Let the Sea Live and Let Us Live with the Sea

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ABSTRACT
The term “Blue Economy” relates to both of the preservation and exploitation of the sea, but at present its concept differs among the people and organizations concerned. It should be defined as Let the sea live and let us live with the sea, emphasizing that ocean environments should be preserved, not destroyed, and use the resource (sea) appropriately. One who searches for the meaning of life in “living with the sea” will find life with sea. This concept should be interpreted as “We are sustained by the sea,” and “We are allowed to use the sea.”

Sustainable aquaculture (e.g., shellfish aquaculture) is a great example of using the sea to meet societal needs without damaging the resource. Oysters provide various ecological services as well as economic benefits without negatively impacting the environment. Engaging in aquaculture, seed production of the Japanese oyster (Crassostrea gigas) and resource management of shellfish is an example of this concept. Approximately 55% of world oyster production is constituted by C. gigas from Miyagi prefecture. The Food and Agriculture Organization of the United Nations (FAO) ranks oyster culture as an important means for increasing food production to address the rapid increase in the global population. In addition, as a worldwide tendency, the oyster’s high physiological function of sea water filtration is now being watched with keen interest with special reference with the preservation of the sea.

From the above facts, it is not too much to say that, “The oyster is the savior of both us and the sea.” This is the mission of the World Oyster Society, which brings together the oyster people of the world for the benefit of mankind. The mission of WOS is to be an instrument of goodwill, friendship and cooperation for all who have some linkage to oyster research, production and use anywhere in the world, and to contribute to the “Blue Economy.”
Poster Presentation Abstracts

UNCW GLOBAL MARINE SCIENCE SUMMIT

ADVANCING THE BLUE ECONOMY: INNOVATION, RESILIENCY & COLLABORATION
Lower Cape Fear River Blueprint

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ABSTRACT
The Lower Cape Fear River Blueprint is a collaborative planning effort to protect, manage and restore the river’s estuarine and riverine natural resources. It serves as a long-term guide to protecting the long-term health of the river by ensuring there is a clear plan in place for compatible and sustainable development. The blueprint examines the impacts of short-sighted and unsustainable developmental practices and water quality issues of the coastal lower Cape Fear River and recommends site-specific, sustainable solutions to address these and other issues threatening our valuable resource. By actively engaging with local governments, state and federal agencies and other entities, the North Carolina Coastal Federation works to address current pollution and habitat loss, which is negatively affecting oysters, fisheries and overall water quality within the lower Cape Fear River.

The Coastal Ocean Research and Monitoring Program (CORMP) at UNCW

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ABSTRACT
Since 2000, the Coastal Ocean Research and Monitoring Program at the University of North Carolina Wilmington has conducted a comprehensive, long-term program of ocean observation in the coastal environment. With support from the National Oceanographic and Atmospheric Administration’s Integrated Ocean Observing System and in partnership with the Southeast Coastal Ocean Observing Regional Association, CORMP operates and maintains observing assets in coastal waters of North Carolina and South Carolina. Real-time data on ocean and atmospheric conditions are transmitted from offshore buoys and pier-mounted stations to the CORMP data management system and run through a variety of automated quality control algorithms. An e-mail alert notifies personnel if any data have been flagged as suspect or failed, at which time personnel review the individual flags, graph data to identify trends, and ultimately accept or override the data flag. A record of this review is archived in the data management system. All information and products are easily accessible through a web portal interface at www.cormp.org and www.secoora.org.

CORMP’s primary mission is to provide near-real-time observations of oceanographic conditions and marine weather that support a science-based framework for wise coastal use. However, it also strives to engage local and regional user groups and provide observations that equip these stakeholders to face natural and manmade risks to economic growth, prosperity and survivability, and to ensure a safe, productive and resilient ocean and coastal zone. To this end, UNCW has partnered with a variety of private sector and public agency partners to sustain existing observing platforms, improve data management capabilities, and undertake outreach and education activities. CORMP stakeholders include: U.S. Army Corps of Engineers, NOAA’s National Weather Service, National Data Buoy Center, National Estuarine Research Reserve System, and the U.S. Department of Defense. These partners are a significant component of the observing enterprise as they add value to the information collected by the observing array. Although the observing network supports a variety of externally funded applications (e.g., SECOORA Weather Portal, SC Beach Water Quality Monitoring, USACE Model Evaluation and Diagnostics System, etc.), the real-time data are particularly valuable during extreme events, when the buoy data are used to inform NWS forecasts, issue warnings and conduct post-storm assessments. This presentation explores some of these collaborative efforts.
Southeast Coastal Ocean Observing Regional Association (SECOORA): Integrating Meteorological, Oceanographic and Biochemical Data for the Development of Tailored Products

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ABSTRACT
The U.S. Integrated Ocean Observing System has worked with partners to increase access to meteorological, oceanographic and biogeochemical data. IOOS-funded regional associations work with stakeholders to develop products based on coastal and ocean observing data. The Southeast Coastal Ocean Observing Regional Association (SECOORA, www.secoora.org) and partners have developed tools that address stakeholder concerns for marine safety and public health. The Marine Weather Portal is a weather and forecasting website for mariners and coastal communities (https://mwp.secoora.org). The MWP provides 24/7 access to critical marine weather information. The project team includes meteorologists, web designers, data managers, and outreach personnel with SECOORA, Second Creek Consulting LLC, NOAA’s National Weather Service, and the University of South Carolina. The MWP, available since 2007, has been iteratively revised based on stakeholder input. The MWP allows users to access map-based marine weather information, observations, point-and-click coastal waters forecasts, color-coded hazards, and detailed five-day marine forecasts, among other features.

Predictive public health decision support tools for shellfish harvesting, swimming beaches and recreational waters are not widely developed in the U.S. Many coastal states issue swimming advisories for recreational waters based on bacterial sampling results that may be 1-2 days old. A team from the University of South Carolina, University of Maryland Center for Environmental Science, South Carolina Department of Health and Environmental Control, and SECOORA created the online application How’s the Beach? This tool integrates physical oceanographic, biological, meteorological and land use data to produce daily water quality nowcasts. Results are available online and as an app for use by beach goers, public health officials and resource managers (http://howsthebeach.org). MWP and How’s the Beach? highlight how regional coastal ocean observing systems in the U.S. are meeting stakeholder needs.

Biodegradation Rates of Perfluoro-2-Propoxypropanoic Acid (GENX) in Sediment of the Cape Fear River Estuary

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ABSTRACT
The release of perfluoro-2-propoxypropanoic acid (PFPrOPrA), commonly known as “GenX”, into the Cape Fear River Estuary has recently become of great concern in North Carolina. This study investigates the potential biodegradability of this compound over a 32-week time series. Current results reveal an average 45% loss of PFPrOPrA after the first week of the experiment, following an average 68% loss the second week. There was no significant difference in the loss of PFPrOPrA between weeks two to six, with an average of 64% loss. There was also no significant difference between the loss of autoclaved and bioactive mud over the course of six weeks, suggesting that biodegradation was not a dominant loss mechanism for GenX. Future research is needed to investigate the loss of PFPrOPrA in sediments, perhaps due to chemical degradation or adsorption. This study highlights important information in understanding the biochemical cycling of PFPrOPrA in the environment.
Screening of Novel Per- and Polyfluorinated Alkyl Substances (PFAS) in Surface Sediments of Southeastern North Carolina

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ABSTRACT
Replacement poly- and perfluorinated alkyl substances (PFASs) are shorter chain compounds and ether polymers that are similar in structure and function to highly regulated legacy compounds such as PFOA and PFOS. Unlike legacy PFAS, replacement PFASs are not regulated or studied nearly as much. Recent studies revealed that unregulated replacement PFASs were present in river water used for drinking water, downstream of a fluorochemical manufacturer, in the Cape Fear River watershed in NC. However, sediments from the Cape Fear River have not been analyzed for novel PFAS. Sediments are a natural sink for organic contaminants and may also serve as a secondary source.

This study investigates replacement PFASs in surface sediments along the Cape Fear River between Fayetteville and Southport. The aim of this ongoing study is to identify novel PFAS and determine spatial and temporal distributions of these compounds. Q-TOF high resolution mass spectrometry was used for suspect screening and non-targeted analysis of novel PFAS. A suspect screening identified nine replacement PFASs including that of Genx, Nafion byproducts, NVHOS, and various chlorinated PFAS along with other PFECAS and PFESAS. By continuing to identify unknown PFAS in the region, this study will provide an awareness of the occurrence of these contaminants and possible sources.

Protein/Metabolic Engineering of Algal Natural Products in Ulva Intestinalis and Ulva Mutabilis

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ABSTRACT
Approximately 23.8 million metric tons of algae, including seaweed, are harvested from aquaculture annually and are widely used as important raw materials in the animal food, cosmetic and fertilizer industries. Because marine algae have spent the last billion years evolving in highly variable and competitive environmental conditions, they employ a diverse arsenal of chemical compounds for protection from UV radiation, response to the local environment, and growth and development as part of their survival and success strategies. Dimethyl sulfoniopropionate (DMSP) in green algae Ulva intestinalis and Ulva mutabilis is a biologically essential natural product produced by marine organisms and is used as an osmolyte, antioxidant and chemoattractant for symbiotic microorganisms. Its metabolic product, dimethyl sulfide (DMS), is not only crucial in the marine biological system, but it is also a key component of the global ocean sulfur cycle. Annually, marine algae, bacteria and corals produce more than 107 tons of DMS and emit it to the atmosphere, affecting cloud formation, acting in the atmosphere-ocean feedback loop, and possibly controlling global temperatures. In industry, DMS is also an important chemical for petroleum refining, ethylene production and food flavoring processes. In addition, the oxidized form of DMS, dimethyl sulfoxide (DMSO), is a dipolar aprotic solvent widely used in a variety of industries, particularly in the pharmaceutical industry. Despite its important roles in the environment and industry, only very limited biochemical and structural information is available for the enzymes in the DMSP/DMS biosynthetic pathway of green algae. Here, we use the growing availability of genome sequences and structural biology techniques to elucidate novel genes in the algal DMSP biosynthetic pathway and engineer the metabolic pathways for increasing the nutritional and pharmaceutical values of marine algae for human health and regulating the ecological impact for environmental sustainability.
**TITLE**

The Influence of Sea Ice Melt on Phytoplankton Spring Bloom Dynamics in Fram Strait

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**ABSTRACT**
Springtime in Fram Strait is marked by intensive large-scale phytoplankton blooms that are crucially seeded and sustained by sea ice melt. While the close connection between sea ice melt and plankton blooms is well-established, important open questions remain regarding the mechanistic relationships linking the release of meltwater and physical and chemical upper ocean variability to the growth, community composition, and carbon uptake of lower trophic levels. In this study, we examine satellite-derived sea ice and surface chl-a data, in concert with in situ measurements collected during an oceanographic cruise in May 2019, to quantify relationships between spatial and temporal characteristics of spring blooms and the sea ice cover. Satellite observations document a strong ice-edge bloom in May 2019, with maximum chl-a concentrations reaching near 10 mg m⁻³. High resolution ocean color and SST imagery from Landsat exhibit strong submesoscale activity at the ice edge, with eddies and fronts leading to strong gradients in surface properties. Sea ice edge conditions are marked by high variability, ranging from a packed, clearly defined ice edge, to diffusely spread ice floes and filament-like bands of sea ice. Due to the hierarchical importance of phytoplankton blooms for a thriving ecosystem in Fram Strait, it is crucial to understand how their dynamics vary with the current and imminent variations in Arctic sea ice conditions.

**TITLE**

Targeted and Non-Targeted Analysis of Per- and Polyfluoroalkyl Substance in Wet Deposition Events

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**ABSTRACT**
A series of wet and dry deposition samples are being analyzed for the presence of long chained per- and polyfluoroalkyl substances (PFAS). Precipitation samples are being collected on an event basis at the University of North Carolina Wilmington atmospheric collection station for a period of one year. Additional seasonal samples (three during winter and three during summer) are being collected at various sites throughout the state of North Carolina including Bald head Island at the mouth of the Cape Fear River, University of North Carolina at Chapel Hill, University of North Carolina at Charlotte, East Carolina University, and Western Carolina University. PFAS are extracted via weak anion exchange cartridges with acceptable recoveries of 13C-PFOA of 70-120%. Travel blanks, field blanks and procedural blanks show non-detects of PFMOPrA, PFMOBα, PRPOPrA, PFOA and PFOS with concentrations falling below the level of quantification. Preliminary results indicate that there is a significant influence of air mass back trajectory on PFAS abundance and distribution where events coming from coastal origins have very low to non-detectable concentrations of analytes whereas terrestrial dominated events result in higher presence of these compounds. Terrestrial rain events (n=2) indicated PFPOPrA concentrations ranging from 24 ng/l to >500 ng/L. Marine and coastal rain events (n=3) showed non-detects for PFMOPrA, PRPOPrA, PFOA and PFOS. Results of this study are significant because they suggest that PFAS are present in precipitation in North Carolina. Data also indicate that these anthropogenic contaminants have the potential to travel significant distances from where they are emitted.
**MARINEQUEST: Preassessing K-12 Student Understanding of Marine Science**

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**ABSTRACT**
University of North Carolina Wilmington MarineQuest provides K-12 youth with opportunities to experience marine science during summer camps and school programs. Because school programs are only a few hours in duration, assessment is a challenge. Due to time constraints, MarineQuest developed a simple pre-assessment tool to determine what students think of marine science. Marine science is a broad field of study represented by multiple scientific disciplines, however the youth who participate in MarineQuest school programs often demonstrate prior understanding and behavior that suggest they have a narrow view of marine science. Students were asked to identify the first thing they think of when they hear the phrase "marine science." Responses were collected from 2,567 students and categorized by commonalities. Results revealed that overall 71.4% of students thought of an organism, which is symbolic of biology, while 18.58% responded with habitat components, including ocean. When this study was repeated with a similar group of students but using the phrase "ocean science" only 13.82% of the students thought of an organism and 60.65% responded with ocean habitat components. A comparison of these two seemingly similar prompts elicited significantly different responses from the student participants. Marine science was associated with organismal biology and ocean science with the physical ocean. The question is, does this difference matter? If marine science is primarily thought of as biology, then how do we encourage participation of those interested in chemistry, physics, geology and engineering – all of whom are needed to address the critical issues facing the ocean?

**Production Economics of Black Sea Bass in a Recirculating Aquaculture System: Sensitivity to Genetically Induced Growth Increases and Alteration of Protein Sources in Aquafeeds**

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**ABSTRACT**
Black sea bass *Centropristis striata* occupy shelf waters off the eastern U.S. and are sought by commercial and sport fishermen. As demand increases, pressures upon wild stock intensifies, creating opportunities for meeting demand through aquaculture. At present, there is a need to clearly assess the economic viability of a recirculating aquaculture system (RAS) growout operation for hatchery-raised black sea bass that incorporates alternative production practices and improved performance traits that may enable facilities to operate with higher economic efficiency and profitability. Study objectives include a detailed economic analysis of a RAS for production of black sea bass in the southeastern U.S. to identify critical biological constraints to production to aid researchers, investors and policy makers and to accelerate commercial RAS production in the eastern U.S.

Based on engineering, biological and financial data from UNCW research and operation of its pilot marine fish hatchery and RAS growout facilities and data on the current financial environment, a spreadsheet economics analysis will be conducted for a hypothetical commercial scale RAS growout black sea bass facility to explore profitability of different production scenarios via sensitivity analysis. Financial performance of model growout production facilities will be measured by assessing farm input costs, duration of production cycle, time to first harvest, farm gate revenues and returns to owner per production cycle, break even prices, discounted payback period, modified internal rate of return, and cumulative net present value. The model will compare financial performance of a growout facility using a base case empirical biological growth model with alternative growth models based on potential gains through selective breeding. The impacts on financial performance of recent advances in hatchery production of black sea bass fingerlings and the use of sustainable feeds incorporating cheaper terrestrial plant and animal protein sources as replacements for fish meal will be analyzed.
Early Descriptions of the Overwinter Movements and Habitat Use of Young-of-the-Year White Sharks, *Carcharodon Carcharias*, in the Northwest Atlantic

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**ABSTRACT**
There have been recent increases in knowledge regarding the movements and habitat use of white sharks (*Carcharodon carcharias*) in the Northwest Atlantic through the advent of more advanced tracking technologies. However, there is comparatively a limited understanding of the movements of young-of-the-year (YOY) white sharks, particularly in the overwinter season. Recent studies on YOY white sharks suggest that they occur off the southeastern United States during their first winter season. To gain further understanding of their seasonal use of this area, satellite and acoustic tag data from YOY white sharks that were tagged off of Long Island, New York in 2016 and 2017, were examined. A total 96 unique tag locations were recorded from nine sharks and used to characterize habitat with respect to multiple oceanographic variables compiled from earth-observing satellites. The sharks showed residency off the North and South Carolina coasts during their first winter, which generally spanned December to April when excluding migration periods. Sea surface temperature in areas where sharks were located ranged from 18.3°C – 25.2°C with an average temperature of 21.9°C. Chlorophyll a concentration varied from 0.2 – 4.0 mg/L with an average of 1.0 mg/L. The seafloor depth at each pinged location ranged from 6m to 3,283m; however, most positions were confined to continental shelf waters at a mean depth of 140m. Salinity ranged from 33.9 – 39.0 PSU with an average of 36.3 PSU. Sea surface height or elevation ranged from -0.85 to -0.10 m with an average of -0.53. YOY white shark overwinter distribution substantially overlapped with the Mid-Atlantic Closure Area off of North Carolina, a time-area closure designed to protect other shark species during vulnerable life stages. This improved understanding of the movements and habitat use of juveniles is important to help ensure the survival and sustainability of the Atlantic white shark population.

Plastics to Oil

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**ABSTRACT**
The global demand for cheap versatile plastics continues to increase, as does its detrimental impact on the environment. In 2015, an estimated 60 – 99 million metric tons were produced globally with a three-fold increase expected by 2060. In 2016, only 9.4% of the plastic in the U.S. was recycled. Global plastic litter entering the oceans was estimated to be roughly 20 million metric tons in 2010, based on modeling and sparse sampling data approximations. This staggering amount of plastic litter entering the ocean is transported by ocean and wind currents and results in large quantities of plastic particles floating throughout the oceans and depositing on beaches. Converting plastics to oil is emerging as a new waste management technology and could provide a means to convert growing amounts of plastic debris accumulating on islands into valuable products.

Current research in our labs analyzes oils produced from marine, household and pure plastics using a countertop pyrolysis reactor. Oils are characterized by NMR, FTIR and GCMS. The oils contain long chain alkanes and alkenes, styrene and other aromatic compounds, in differing proportions, depending on the plastic feedstock. Polystyrene pyrolysis produces styrene as the major component along with many larger aromatic compounds, including polyaromatic hydrocarbons. PAHs in the oils have been quantified using GCMS. The concentrations of individual PAHs depend on the plastic feedstock, however oils from plastics collected from marine sources had higher total PAH concentrations than oils from household waste or pure plastics. Physical properties of the oils were found to be comparable to commercial fuels. Through these analyses, and by changing the composition of feedstock plastics, our goal is to use pyrolysis of waste plastics to produce a safe fuel alternative, while recycling waste plastics.
**Seasonality of a Surf Zone Fish Community and Implications for Beach Renourishment**

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**ABSTRACT**
The surf zone is a highly dynamic environment that hosts a large and diverse community of marine fishes, and frequently serves as important nursery habitat for commercially and recreationally important fish species. Sampling effort is often limited due to the high energy conditions that define this system, and as a result, fish assemblages in the surf zone are not well understood. A thorough understanding of fish communities will allow for the development of management policies that more effectively safeguard this ecologically important system and preserve its habitat function. We describe the fish assemblage inhabiting the surf zone of Wrightsville Beach, NC, as well as the seasonal variation exhibited by this community. We highlight the seasonality of 10 species of fish most commonly found in this environment. The abundance of fishes in the surf zone is significantly higher in the summer months. The Shannon-Diversity Indices of the community display a similar trend. The surf zone hosts a larger, more diverse community of fishes in the warm summer months than the rest of the year. We also discuss the implications of these seasonal abundances with regards to regular beach renourishment projects, such as the Wrightsville Beach Renourishment Project. Recommendations of practices that might least impact these fish communities during nourishment projects are offered based on these data.

**The Lower Caper Fear River Program: Long-Term Data Collection with Stakeholder Participation**

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**ABSTRACT**
Long-term scientific data collection has numerous benefits for basic science, applied specific projects, and communication with citizens and stakeholders of all types. In 1995 the Lower Cape Fear River Program was formed to develop an understanding of processes which control and influence the Cape Fear River and to provide a mechanism for information exchange and public education. The heart of the program is a long-term monitoring effort, run by UNC Wilmington, in which 33 stations located throughout the lower river basin are sampled on a monthly basis, including freshwater streams, rivers and the Cape Fear estuary. Point, non-point and naturally occurring sources were considered in developing the monitoring plan, which includes physical, chemical and biological data. The process includes bimonthly meetings in which the researchers interact with regulatory agencies, academic institutions, local industries, environmental groups and other groups to determine additional studies and analysis needed to develop an effective and successful management plan. The program is funded by point-source dischargers who are relieved of state-required stream sampling by contributing to the program. As products we develop scientific information to provide environmental education about the basin, deliver bimonthly oral reports and annual written reports to identify changes or trends, and have produced more than 30 peer-reviewed scientific journal articles. We develop, consolidate and maintain a state regulator-approved data base on the Cape Fear River Basin, including historical and current data, which are subsequently included in USEPA data bases. The data have proven valuable in assessing pollutant spills, major weather events such as hurricanes, climatic change, land-use alterations and habitat improvements. The data sets have also been essential to M.S. and Ph.D. theses development for graduate students from several academic institutions. Upon request, our program makes data available to public and private stakeholders free of charge.
**The Algal Resources Collection: An Asset for the Cultivation, Maintenance and Identification of Toxic Microalgae**

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**ABSTRACT**
The Algal Resources Collection (ARC) was formally established as a public service collection in September 2016, although it had been operating as a private research collection since its initial inception in 1987. Our main goal is to be a resource for both the HAB research community and biotechnology endeavors. Presently, the collection is a major supplier of toxic algal strains for researchers all over the world, with many collaborations, loans and exchanges initiated each year. Focused on the growth and maintenance of toxic microalgae, the ARC currently houses 412 strains distributed across 10 taxonomic groups, 50 genera and 102 species. ARC strains originate from diverse temperate and tropical locations around the globe and about 80% of our cultures have been classified as harmful taxa with known toxin production, found in association with toxic species, or related to known toxin producers. These include type cultures used in the description of new species and a new algal class currently under description. ARC strains have been used in various applied research studies, some of which led to the development of advanced bioassays used for detecting and quantifying marine algal toxins. ARC strains have also been the source from which new bioactive compounds have been discovered and utilized to produce new pharmaceuticals that now treat or cure a variety of diseases. The collection was recently awarded a National Science Foundation grant that will facilitate the necessary adjustments toward its consolidation as a research resource and to achieve the self-sustainability essential for its maintenance and expansion. An overview of the species diversity, photobioreactor culturing and collaborative opportunities will be presented.

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**Temperature Affects the Biological Control of Dinoflagellate Blooms by a Generalist Parasite**

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**ABSTRACT**
The increase in emerging harmful algal blooms in the last decades has led to extensive concern in understanding the mechanisms behind these events. In this sense, generalist parasites are of special interest as they have the potential to control invasive species. However, the outcomes of such newly established host-parasite interactions depend on the biotic and abiotic context in which both partners are inserted. Here, we assessed the growth of three blooming dinoflagellates (Alexandrium minutum, Scrippsiella trochoidea, and Heterocapsa triquetra) and their susceptibility to infection by the generalist parasite Parvilucifera sp. under a temperature gradient (from 13°C to 22°C). The three dinoflagellates showed different responses to temperature that varied from a positive relationship in A. minutum (maximal growth at 20-22°C), to unimodal in S. trochoidea (maximal growth at 18°C), and sigmoidal inverse in H. triquetra (maximal growth at 13-18°C). Interestingly, the effect of temperature on the parasite infectivity also changed depending on which dinoflagellate was infected, with a positive response observed in both A. minutum (maximal infections at 22°C) and unimodal in S. trochoidea (maximal growth at 18°C) and sigmoidal inverse in H. triquetra (maximal growth at 13-18°C). Interestingly, the effect of temperature on the parasite infectivity also changed depending on which dinoflagellate was infected, with a positive response observed in both A. minutum (maximal infections at 22°C) and unimodal in S. trochoidea (maximal growth at 18°C) and sigmoidal inverse in H. triquetra (maximal growth at 13-18°C). Although low temperatures (13-15°C) negatively affected the parasite infections in the three hosts, this effect was more dramatic in H. triquetra (resulting in the failure of Parvilucifera sp. to control this dinoflagellate under low temperatures). These results are particularly relevant under the current scenario of climate change, with shifts in temperature conditions potentially affecting not only the competition between microalgal species but also their control by parasites.
An Overview of Cape Fear Public Utility Authority’s Cape Fear River Source Water Protection Plan

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ABSTRACT
To ensure a community’s public water supply is clean and sustainable, source waters across the United States must be protected and monitored for signs of pollution. Aquifers, rivers, lakes and oceans can all act as source waters for communities, each with unique susceptibilities to contamination. In New Hanover County, the majority of residents are supplied with drinking water from Cape Fear Public Utility Authority’s Sweeney Water Treatment Plant, which sources water from the Cape Fear River. In 2014, the North Carolina legislature passed HB 894—a bill that requires all public water suppliers operating surface water systems to implement a source water protection plan (SWPP) to address the threat of contamination.

To create the plan, CFPUA must first identify Potential Contaminant Sources (PCS) within a suggested geographical threat radius supplied by NCDEQ, assess the risk they may pose to our water supply, and create communications and emergency drinking water plans in the event an acute contamination event was to occur. CFPUA has voluntarily extended the threat radius under our consideration from the suggested 10-mile radius around our intake in Bladen County to the entire Cape Fear River watershed up to Fayetteville. This decision allows our plan to consider a more realistic range of potential contaminant sources on the Cape Fear River.

To ensure the creation of an effective plan that can assess and respond to the entirety of this range, CFPUA is utilizing a host of technologies including: GIS software, monitoring technology at the intake, modelling software created by the Department of Defense, and communications tools that will allow stakeholders to view an interactive version of our plan. These efforts will enhance our ability to protect our source water, while also creating new partnerships and alliances within the Cape Fear River watershed.
**Overcoming Technical Barriers to Cost-Effective Production of Marine Finfish Fingerlings and Expanded Growout Production: Optimizing Nursery Stocking, Feeding and Harvesting Strategies**

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**ABSTRACT**
A critical variable cost in the development of a finfish mariculture industry is the price of a reliable source of juveniles (fingerlings) to support growout operations. The black sea bass *Centropristis striata* is a heavily exploited, high-value marine finfish that inhabits coastal waters of the eastern US and an important candidate for mariculture. Based on the operation of UNCW's pilot marine fish hatchery (Wrightsville Beach, NC), an economic analysis of a hypothetical commercial scale hatchery supplying advanced stage black sea bass fingerlings (5 g, 105 days post-hatching) at a nursery tank (NT) stocking density of 1.5 fish/L produced 92,340 fingerlings per year at a breakeven (BE) price of $1.67 each. To lower production costs, we conducted pilot trials to raise post-metamorphic stage juveniles (47 days post-hatching) in NTs at much higher densities of 4.5 and 6.5 fish/L and fed a UNCW-formulated diet under 23.5°C and 18 L: 6 D photoperiod. At 60 days post-hatching, fingerlings stocked at 4.5 fish/L were slightly larger (P < 0.05) than those stocked at 6.5 fish/L (1.68 vs 1.58 g), but with no differences in survival (88.0 - 87.4%), FCR (0.69 - 0.73), or in growth variation (CVwt = 26.7 - 29.5%). Early fingerlings harvested from both density treatments showed ~100% survival during simulated air- and ground-shipping trials. Updated economic analyses revealed that a hatchery producing early (1-g) fingerlings at a harvest density of 5.7 fish/L output 583,200 fingerlings per year at a BE price of $0.43 each. By maximizing safe nursery tank stocking densities and shortening the rearing cycle to a transport-ready stage, fingerling BE prices were lowered. Fingerlings sourced from UNCW’s hatchery are enabling startup farmers on the eastern U.S. seaboard to grow and market black sea bass from their private facilities and to develop sound business strategies for scale up.

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**Harmful Algal Bloom Species Trades-Off Growth and Toxicity in Response to Cues from Dead Competitors**

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**ABSTRACT**
Organisms are under selection pressure to recognize predators and assess predation risk to avoid becoming prey. In some cases, the presence of injured competitors alerts individuals to the likelihood that predators are nearby. Previous studies have shown that the harmful algal bloom species *Alexandrium minutum* responds to chemical cues from copepods by dramatically upregulating sodium channel-blocking toxins that appear to function as defenses against copepod grazing. However, it is unknown whether *A. minutum* uses other cues, such as damaged competitors, to assess predation risk and subsequently increase its resistance to predators. To determine if *A. minutum* uses dead competitors as a proxy for predation risk, *A. minutum* was exposed for three days to six different phytoplankton competitors killed by cell lysis. Chemical cues from dead, unrelated, historically co-occurring competitor species caused *A. minutum* to increase cellular toxicity coupled with a decrease in growth. In contrast, exposure to chemical cues from more closely related dead competitors, either conspecific or congeneric, suppressed toxin production in *A. minutum* relative to the absence of dead competitors. This was coupled with a modest, yet significant, increase in growth. In an additional experiment with a closely related dead competitor, *A. minutum* suppressed toxin production and increased growth in response to the dead competitor cues in dose dependent manner. The apparent inverse relationship between toxin production and growth suggests that *A. minutum* experiences a trade-off. Together, these results reveal that relatedness of dead competitors, and therefore predation risk, is important to *A. minutum* when assessing whether to defend or grow.
TITLE

Temporal Variability of Emerging Perfluoroalkyl Substance in the Cape Fear River, North Carolina, USA: Impacts to Drinking Water Source

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ABSTRACT
Water from the Cape Fear River North Carolina, USA was sampled for 40 continuous weeks from a local drinking water utility intake. Water was analyzed for a suite of replacement PFAS compounds including perfluoro-2-methoxyacetic acid (PFMOAA), perfluoro(3,5-dioxahexanoic) acid (PFO2HxA), perfluoro(3,5,7-trioxaoctanoic) acid (PFO3OA), perfluoro(3,5,7,9-tetraoxadecanoic) acid (PFO4OA) and Nafton byproduct 2. There were variations in abundance of these compounds in the river water possibly attributed to industrial spills from a fluorochemical manufacturing facility upstream and other potential non-point sources. There was no correlation between river discharge and the targeted PFAS suggesting a constant background level of contamination most likely from long-term non-point sources. A variety of emerging PFAS compounds were also detected which included isomers of perfluoro ether sulfonic acids and a series of monochlorinated perfluoroether carboxylic acids. Data presented in this study are significant because they represent the first detailed high-resolution temporal measurements of replacement PFAS in a watershed used for drinking water. Results are also important because they provide a more comprehensive picture of PFAS contamination in the environment with sediment and precipitation samples analyzed from the same geographical vicinity as water samples. These latter results may have long-term ramifications as they underscore the potential for input and transport of these replacement compounds within the system after discharge from the point sources ceases.

TITLE

An Assessment of Microplastic Pollution in the Commercially Valuable Black Sea Bass (C. Striata) Across Mutiple Life Stages

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ABSTRACT
Microplastics, synthetic polymers ranging between 1 nm – 5 mm in one dimension, have emerged as a global threat to aquatic ecosystems. Coastal and estuarine waters that serve as critical habitats for commercially important fish species are susceptible to microplastic pollution due to their proximity to terrestrial inputs and tidal processes that provide favorable conditions for accumulation. As such, we explored the occurrence and effects of microplastic exposures on the commercially valuable black sea bass (Centropristis striata). Fish were exposed in the laboratory to virgin and contaminated microplastics across larval (10-14 dph), early juvenile (50-60 dph), and late juvenile (320-330 dph) life stages. Larval fish obtained more plastics via trophic transfer from their prey, and juvenile fish from some treatments appeared to have a decrease in immune response and increased respiration at high plastic concentrations. Microplastics remained in the GI tracts of late juvenile fish for up to 120 h post-feeding and analysis revealed no significant pollutant loss from the plastic. However, livers from late juvenile fish will be analyzed to verify the potential for accumulation of pollutants and associated metabolites in tissues. Wild-caught adults were also analyzed to investigate the occurrence of macro- and microplastic ingestion. The results from field study showed 3 macroplastics and more than 60 possible microplastics, which are currently being analyzed through u-FTIR to determine the plastic type. We anticipate that our results from both field and lab experiments will contribute to the current knowledge on the plastic pollution in C. striata and will inform fishery management about the potential concerns regarding human consumption of black sea bass that have ingested plastics.
Natural Products to Protect Algal Biofuel Ponds

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ABSTRACT
Open outdoor raceway ponds for cultivating microalgae are easily infected by pathogens and predators. “Pond crashes” often result within a matter of days after infection and pesticides must be added on a reoccurring basis to prevent microalgal crop loss. In the biofuel industry, lipid-rich marine microalgae have traditionally been grown in raceway ponds as monocultures. Considering that the lack of biological diversity in these systems may leave microalgae more susceptible to threats, we are exploring co-culturing algae with protective marine bacteria as a zero-cost solution. Preliminary studies identified several bacterial consortia comprised of multiple marine bacterial species that offer microalgae (Microchloropsis salina) protection from their rotifer (Brachionus plicatilis) predators. While these bacterial consortia offered varying degrees of protection against rotifers, some may offer better protection against harmful infectious pathogens such as chytrids. We hypothesize that specific bacterial species within these communities exude either secondary metabolites or biomacromolecules which act as natural pesticides. The goal of this project is to identify these natural products and the bacteria that produce them so that microalgae cultivation methods can be optimized for co-culturing with the identified protective species. NMR spectroscopy and mass spectrometry-based metabolomics methods are used to obtain chemical profiles of bacterial consortia exometabolomes in order to identify putative defenses against algal pond threats. In the long term, we aim to use the method developed for identifying protective molecules in this system to target predators and pathogens that threaten additional commercially valuable microalgal species.

Validating Multi-Scalar Remote Sensing Approaches for Monitoring Harmful Algal Blooms

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ABSTRACT
Harmful algal blooms (HABs) are aquatic phenomena defined by a rapid increase in phytoplankton biomass that create adverse water quality conditions harmful to surrounding biota. Exposure to HABs can cause health-related illnesses to domestic animals and humans, which can be fatal. Since 2015 the Chowan River in North Carolina has experienced numerous HABs each year, costing state officials millions of dollars to fund HAB monitoring programs. Current HAB monitoring methods incorporate spatial and spectral analyses of multispectral satellite images to measure the extent and activity of HABs. However, satellite imagery collection is temporally inconsistent, atmospheric conditions hinder image quality and spatial resolutions are coarse, limiting their reliability for the near-real time image acquisition needed for optimal HAB monitoring. Drones are operationally versatile and more capable of collecting near-real-time multispectral imagery than satellites. I propose a new approach for HAB monitoring that incorporates on-demand drone imagery, collected as HAB conditions develop, while using HAB specific algorithms. My specific objectives are to 1) utilize previously-recorded data of HAB location and respective water quality parameters to ground-reference multi-spectral satellite image classifications, 2) collect and then integrate high-resolution UAV imagery with lower-resolution satellite imagery to enhance area specific spatial and spectral resolutions of HAB imagery, 3) derive a multispectral imagery classification workflow that is applicable to both UAV and satellite imagery, and 4) create an open-source geospatial toolkit that integrates UAV and satellite imagery with in-situ water quality samples that is applicable for any coastal environment.
Leveraging the Highly Regenerative Sea Anemone *Nematostella Vectensis* to Investigate Novel Gene Therapies

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**ABSTRACT**
Every year, approximately 735,000 people experience a heart attack. Most of these patients will survive but the damaged heart muscle forms scar tissues, making the patient much more susceptible to future heart disease. This is just one example of the human body’s poor regenerative ability. By contrast many organisms possess the extraordinary capacity to regrow and regenerate damaged tissues effectively bypassing scar formation. One of these organisms is the sea anemone *Nematostella vectensis*, which can regrow its entire body after bisection after just a few days. We have identified many of the genes responsible for the regenerative ability of *Nematostella* and curiously many of these genes have not been described in any other species to date. We hypothesize that these *Nematostella* specific gene products could unlock the regenerative potential of humans and are developing a workflow to introduce these genes into human cells using Adeno Associated Virus (AAV) gene delivery. The goal of this research is to identify and characterize novel gene products that can be used to treat a variety of illnesses from neuro degenerative disorders to heart disease.

Short-Term Fluctuations in Magma Supply Rate and Magma Dynamics at Axial Seamount

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**ABSTRACT**
Axial Seamount is an active volcano located at the intersection of the Juan de Fuca Ridge and Cobb hotspot approximately 480-km west of the Oregon coast. Research conducted at Axial Seamount has benefited from long-term (months to years) vertical deformation monitoring that has allowed researchers to observe and quantify inflation and deflation during three eruptions (1998, 2011 and 2015) and two complete eruption cycles. Despite advancements in our understanding of long-term deformation cycles, identifying and interpreting short-term (hours to days) fluctuations in the magma supply rate between eruptions has previously not been possible, due to limited spatial coverage and residual oceanographic noise at individual stations. Here we combine data from autonomous and cabled bottom pressure recorders (BPRs) to identify variations in the inflation record that are likely caused by changes in the magma supply rate or redistributions within the shallow magma storage system. We identify these short-term anomalies using a differential technique, where noise coherent over large areas is removed by subtracting the pressure time series from a stable reference BPR from every BPR in the network. Remaining deviations from a linear uplift trend consistently seen in the BPR network are interpreted as variations in the magma dynamics of the system. For the first time, periods of anomalous deformation within the overall inflation signal are discernable. The largest identified anomaly occurs over a 29-day period from the 2017-2018 inter-eruption period with a magnitude of several millimeters. The identified anomaly timing and duration is slightly different for each of the BPRs, which suggests spatial complexity in the magmatic system that requires a multifaceted mechanism, such as a combination of magma movement and fault slip to explain. We estimate the best fitting deformation source for these anomalies using the MATLAB package dModels to fit the anomalous signals with inflation and fault models.
Development of Environmentally Friendly, Cost-Effective and Nutritionally Balanced Alternative Protein-Based Diets for Mariculture of High Value Marine Finfish

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ABSTRACT
With increasing exploitation of wild stocks along with very little domestically grown seafood, the U.S. seafood trade deficit now exceeds $15 billion. Environmental issues, economics and fish feed are factors vital to the sustainability of the aquaculture industry in the context of blue economic growth. Fish meal is costly protein source in aquafeeds for marine finfish. Nitrogen and phosphorus are nutrients in fish meal that can have a great impact on the environment, and their release can result in eutrophication. Alternate protein sources such as terrestrial animal and plant protein sources can reduce the amount of wild fish used as protein. An important goal of our research at the UNCW-CMS is to develop sustainable marine finfish aquafeeds with less inclusion of fish meal.

A series of experiments were conducted to test the effects of different levels of soybean meal, poultry by-product meal and ultra-low gossypol-based glandless cottonseed meal in the diet of black sea bass and southern flounder reared in a recirculating aquaculture system in short term laboratory-scale and longer term semi-pilot-scale experiments. Growth performance, feed utilization and digestibility, and biochemical composition of fish tissues were evaluated. Results suggest that about 68 and 39% fish meal protein could be replaced by soybean meal protein, whereas 82 and 100% fish meal protein could be replaced by poultry meal protein in the diet of black sea bass and southern flounder, respectively. On the other hand, up to 100 and 75% fish meal protein could be replaced by glandless cottonseed meal protein in the diet of black sea bass and southern flounder, respectively. These findings reveal species-specific differences in effective substitution levels of alternative protein sources to fish meal protein, and provide a basis for developing environmentally-sound and cost-effective alternative protein-based aquafeeds for mariculture of these high-value marine finfish.
**Intraspecific Comparison of the Venom Peptidome of *Conus Purpurascens***

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**ABSTRACT**
Cone snails produce venom comprised of highly modified peptides (conotoxins) and proteins. Conotoxins are a diverse group of natural products that display a wide mass range, wide range of post-translational modifications, and many potential molecular targets. Conotoxin diversity makes venom a valuable source of novel pharmacological agents, but also complicates peptide identification and characterization. In this study, we employ combined proteomic and transcriptomic approaches to maximize conotoxin identification and compare venom profiles from *Conus purpurascens*.

Two venom duct transcriptomes from *C. purpurascens* were assembled de novo using Trinity. Open reading frames were extracted and translated and putative toxin transcripts were mined using BLASTp function. Milked venom samples from 27 *C. purpurascens* individuals were analyzed by LC-MS/MS on an Orbitrap Fusion Lumos. Peptide IDs were obtained using the Proteome Discoverer software. The search database was comprised of putative toxin transcripts and known conotoxin sequences deposited on UniProt. Cluster analysis was performed to compare the venom profiles between the *C. purpurascens* specimen.

This study shows that conotoxin expression at the transcript level is not indicative of conotoxin expression in the injected venom. Thirty conotoxins and their corresponding modified congeners were identified from the injected venom of *C. purpurascens* using our proteo-transcriptomic approach, twenty of which are described here for the first time. Cluster analysis of conotoxin IDs across the venom samples revealed two distinct venom profiles. The two profiles are comprised of toxins that target two different neuronal pathways. The venom expression pattern may help predict the molecular targets of uncharacterized conotoxin.

We address venom complexity at the primary sequence and post-translational levels by proteo-transcriptomic conotoxin identification from injected venom of *Conus purpurascens*.

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**Effects of Oyster Reef Design on Hydrodynamic Characteristics: A Field and Wave Tank Study**

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**ABSTRACT**
Intertidal salt marshes are critical ecosystems for marine and terrestrial species and provide important ecosystem services such as water filtration, sediment retention, storm surge buffering, and fish nurseries. Since 1900, the United States has lost 46% of its intertidal wetlands and, of the 25,200 hectares of intertidal wetlands lost between 2004 and 2009, 83% were converted into areas of deep water due to anthropogenic activities and climate change. To reduce upland and salt marsh edge erosion caused by boat wakes and wind-generated waves, North Carolina coastal communities are constructing living shorelines. Living shorelines, created from oyster reefs and salt marsh plantings, are a shoreline stabilization technique designed to reduce erosion while also creating conditions conducive to marsh grass growth. In North Carolina, however, approximately 30% of living shoreline projects resulted in higher erosion rates post-construction, and the reasons for this remain unknown. Understanding why specific living shoreline designs are successful while others fail is vital to advancing living shoreline-based stabilization techniques. This project examines the effectiveness of three living shoreline designs (linear, staggered, sill) on wave attenuation. Field data were collected at the living shoreline of St. James Plantation in southeastern North Carolina. Laboratory wave tank data were collected at UNCW’s Center for Marine Science. The goal of this project is to identify which structural design best optimizes conditions that reduce erosion and promote marsh recolonization while also meeting oyster reef gap requirements established to enable movement of water and aquatic organism through the reefs.
**Title**

**A Partnership Between a Coastal Community and University Researchers to Support Coastal Research, Habitat Protection and Restoration**

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**Abstract**

Coastal habitats (marshes, tidal creeks, waterways, seagrasses and oyster reefs) are critical for the maintenance of surrounding ecosystems. More than 50% of the U.S. population lives within 50 miles of the coast, increasing the pressure on coastal systems directly and indirectly through development and use. Community involvement is critical for the success of any effort that seeks to protect, restore or enhance coastal environments. The UNCW Benthic Ecology Lab and the Town of St. James, a coastal town along the southeast North Carolina coast, created a citizen scientist program to restore, enhance and monitor the critical habitats around the Town of St. James. This project has focused on the establishment of a series of living shorelines (mainly oyster reefs) at a community park, adjacent to the intracoastal waterway (Waterway Park) to reduce shoreline erosion and enhance nekton utilization. This project has also helped enhance marsh development along these shoreline areas through the panting of *Spartina alterniflora* and other critical marsh plants. Involvement of the town has been critical to these restoration efforts, with >100 town citizens routinely involved in reef construction and marsh planting activities. This project does more than just create the habitats. UNCW interns and volunteers in the program monitor the development of these habitats by examining the composition of benthic and epibenthic species utilizing the reef habitat, as well as nekton community adjacent to the reefs providing important educational opportunities and scientific information on success of the projects. It also provides a unique opportunity to involve the town citizenry in habitat development and educational opportunities for the wider area. Marsh characteristics indicate an expansion of marsh vegetation. Monitoring of reef associated species indicates a rapidly developing biological community and increased utilization of habitat by nekton.

**Title**

**In Situ Measurements of Coral and Algal Respiration, Photosynthesis and Calcification: CISME**

**Authors**

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**Abstract**

Physiological rates, such as respiration, photosynthesis and calcification, can provide insight into the health and well-being of an organism. Concerned with world-wide coral reef decline, we have developed a new tool to non-destructively measure coral and algal bioenergetics in situ. CISME (Coral reef In Situ MEtabolism, pronounced "KiSS ME") to reflect the gentle interactions between the substrate and instrument) measures changes in dissolved oxygen and pH, from which rates of respiration and photosynthesis are calculated. The instrument can be deployed over many corals and benthic organisms such as turf, coralline and macroalgae. The instrument has a sample port for withdrawing samples for analyses that require discrete samples (e.g., total alkalinity for calcification) or introducing reagents (e.g., metabolic inhibitors, CO2 enriched seawater). Laboratory and field tests show that with this instrument we can produce quick, consistent and non-destructive (to the coral) measurements of respiration (5 minutes), photosynthesis (5-10 minutes), photosynthesis vs irradiance response curves (30-40 minutes), and calcification rates (15-20 minutes) on corals and reef algae in their natural environment. These features make CISME a potential tool for monitoring the health of coral reef benthic organisms and research into coral response to stressors such as global warming, ocean acidification, and anthropogenic effects.
Changing Climate and It’s Effects on Deep Water Circulation in the Arctic

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Abstract: The Arctic Ocean is experiencing rapid changes in temperature and salinity under current climatic conditions, which can affect global ocean circulation. While past major changes in thermohaline circulation have been well documented in the North Atlantic, the deep circulation in the Arctic is much less understood. In this study I hope to better understand the relationship between temperature and deep-water circulation in the Arctic as well as the Atlantic influence on Arctic circulation. Grain size and foraminiferal isotopic analysis will be done on sediment cores collected during the R.V. Polar Sea AOS94 expedition to determine changes in bottom water current speeds and oceanic conditions. Grain size is expected to be larger during cold periods due to increases in bottom water current speeds, with smaller grain size reflecting weaker currents during warm periods. I also expect to see more stable conditions in cores taken from the center of a basin than in those cores taken in shallow water depths near the continental shelf, due to deep waters being more isolated from changes at the surface. Comparing these cores at different water depths will allow us to look at changes in the water columns vertical structure. In addition, comparing conditions between the Eurasian and Amerasian basins, which are separated by the Lomonosov Ridge, will give a better understanding of Atlantic influence, expected to be stronger in the Eurasian basin. Benthic foraminifera assemblages will be used to calculate the oxygen index which can be used as an indicator of Atlantic water influence. Oxygen and carbon stable isotope analysis on foraminifera will allow us to look at the relationship between current speeds, water temperature and primary productivity.

Oxidative Damage and Protein Synthesis in Red and White Muscle of The Pinfish, Lagodon Rhomboides

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Abstract: An unavoidable consequence of aerobic metabolism is the production of reactive oxygen species (ROS). While ROS are important molecular signals in cells, excess ROS cause damage to cellular components such as lipids and proteins. While there is general agreement that mitochondria are the primary sources of ROS, it is not clear how variation in mitochondrial density or metabolic rate among tissues influences ROS-induced damage and rates of protein synthesis. Fish skeletal muscle is comprised of highly aerobic red muscle and highly anaerobic white muscle, offering an excellent model system in which to evaluate the role of tissue aerobic capacity on ROS-induced damage. The present study characterizes protein and lipid oxidative damage, as well as markers of protein degradation and measurements of protein synthesis rates, in red and white muscle of the pinfish, Lagodon rhomboides. Red muscle had a greater mitochondrial volume density and had more oxidative damage than white muscle, including elevated protein carbonylation and lipid peroxidation. Protein degradation in muscle occurs via the lysosomal-autophagy or ubiquitin-proteasome pathways and has been shown to be tissue dependent. Lysosomal degradation markers and autophagosome volume density were greater in white muscle, while ubiquitin expression and 20S proteasome activity were significantly greater in red muscle. However, ubiquitin ligase expression was significantly higher in white muscle. Red muscle also had a higher basal metabolic rate and higher rates of protein synthesis, presumably due to the higher mitochondrial volume density and the associated increase in oxidative damage. Together these results support the concept that a consequence of an elevated aerobic capacity is greater costs associated with protein synthesis. This research provides baseline data for understanding oxidative damage in skeletal muscle of estuarine fishes exposed to environmental stressors.
**Effects of Temperature on Muscle Development in Juvenile *Hemiscyllium Ocellatum***

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**ABSTRACT**
Temperature is known to affect embryogenesis and myogenesis in many fish species. Understanding effects of chronically elevated temperatures on fish muscle development is important for understanding potential effects of warming waters on organism health. Epaulette shark (*Hemiscyllium ocellatum*) eggs were reared at their normal mean environmental temperature (27°C) and at an elevated environmental temperature (31°C), and markers of muscle development as well as oxidative damage were evaluated on average 63 days post-hatching. We measured muscle fiber size, nuclear density, and satellite cell density as markers of muscle development, and heat shock protein expression (Hsp70), protein and lipid oxidation (2,4-DNPH and 4-HNE, respectively) as markers of global oxidative damage. We found that elevated temperatures caused individuals to hatch earlier (100 days to hatching at high temperature, and 126 days at normal temperature) and to have smaller body sizes. Also, skeletal muscle growth was at an earlier stage at high temperature compared to the normal temperature. Muscle fibers at both temperatures were similar in size and nuclear density, but satellite cell density was higher in the sharks raised at the elevated temperature (p< 0.0001). Fibers associated with satellite cells were significantly smaller at the elevated temperature than those at the normal temperature (p<0.0001). Generally, at the normal temperature, muscle fiber growth followed a linear trajectory with age post-hatch while muscle fiber growth under the elevated temperature showed greater variability with age. Total oxidative damage was higher at the elevated temperature (p=0.004) and increased with time (p=0.010), showing that these temperatures may induce oxidative stress, which could be detrimental to organismal function and development.

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**Sea Surface Salinity Subfootprint Variability from a High-Resolution Global Model**

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**ABSTRACT**
We have studied the subfootprint variability (SFV) of sea surface salinity (SSS) using the LLC4320 version of the MITgcm, a very high-resolution (1/48deg) global simulation. SFV is the weighted standard deviation within the footprint of an SSS satellite like Aquarius or SMAP. SFV was studied as a function of footprint size and of space and time. It was found to be large in areas of strong frontal zones such as the Gulf Stream, Antarctic front and Brazil-Malvinas Confluence. SFV also tends to be larger where rainfall is heavy. It was found to have a seasonal and hemispheric component, being generally larger in the southern hemisphere and summer than the northern hemisphere and winter. For a 100 km footprint, the most likely values of SFV are (0.05, 0.06, 0.03, 0.05) for (southern summer, northern summer, southern winter, northern summer) respectively. Outlier high values were much more likely in summer than in winter. SFV follows a power law relationship with footprint size, increasing as ~s^-0.7, where s is the footprint size.
The Cape Fear River Assembly: Helping Protect North Carolina's Largest and Most Developed Watershed

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ABSTRACT
The Cape Fear River Assembly (CFRA) brings together many groups and individuals, often with divergent viewpoints, to find solutions to water quality and quantity problems impacting the entire river basin. We accomplish our mission by providing education, encouraging dialogue and promoting projects. We are committed to promoting sustainable management of conditions in the Cape Fear River and land use within the watershed. Over the past 45 years, CFRA has accomplished a number of successful projects. These include: water opinion leader survey, water quality monitoring program, riverfront planning, online data repository, and a student scholarship award. CFRA is also committed to education, outreach and research. Such activities include: an annual conference, subbasin public forums, newsletter, website, and education about emerging contaminants. CFRA is now focused on climate change and resiliency, particularly in terms of education and communication for opinion leaders within local communities. Our diverse membership includes representatives from local government, academia, agriculture, industry, nonprofit organizations, and the basin's major water supply utilities. We strive to maintain and improve quality of life for all citizens within our complex river basin. More information can be found on our website: cfra-na.org.

Masonboro Island, NC; Before, During and After Hurricanes Florence and Dorian

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ABSTRACT
Coastal communities and resources rely on beaches and barrier islands to play a vital role in protecting them from elevated waves and water levels during storm events. A lack of available data from immediately before and after storm events to document and study coastal change hinders advancement in our fundamental understanding of the impacts these storms have on the nation's coastlines. These types of data are also necessary to develop operational models to predict how coastlines will change during storms and prepare areas at high risk for erosion, overtopping, and flooding. After a storm, coastal areas are typically expected to have narrower and lower sloping beaches, scarped dune faces, and/or dune sediments overwashed into back barrier regions. Unfortunately, this type of impact is not unique or consistent; the southeastern coast of NC was affected by hurricanes Matthew (2016), Florence (2018), and Dorian (2019); despite similar predicted storm characteristics (wave height, surge, storm intensity) hurricane Florence was an erosive event while Dorian resulted in accretion along Masonboro Island.

Previous studies show that these storm-related coastal changes occur in a matter of hours to days, which are then followed by years to decades of recovery. This study includes a unique dataset consisting of two cross-shore transects of pressure sensors measuring storm-induced shoreline water levels, two vertical sediment trap arrays measuring wind- and wave-driven sediment transport, and pre/post-storm topographic surveys. In addition, UAV, topographic surveys and aeolian sediment transport were measured bi-monthly in the intervening period between hurricanes Florence and Dorian. Here we use the volumetric change and grain size to investigate the varying erosion and accretion responses across the island and link the hydrodynamic processes of the storm with the coastal response.
A Multi-Disciplinary Approach to Cyanobacterial Bloom Research

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ABSTRACT
Harmful and nuisance algae blooms are a global issue that threaten water quality, fish, wildlife, domestic animals and public health. Changes in climate and population growth are predicted to increase the frequency of both marine and freshwater blooms. Blooms of cyanobacteria, or blue green algae, are specifically concerning as they impact freshwater and brackish systems, including drinking water sources. As such, their occurrence is cosmopolitan and presents worldwide concern. Many of the taxa associated with harmful cyanobacterial blooms (cyanoHABs) produce potent toxins inducing a suite of illnesses and even death in aquatic organisms and humans. The severe consequences associated with cyanoHABs make researching them a priority. Several lab groups at the University of North Carolina Wilmington, including the Aquatic Ecology Lab (AEL), the Algal Resources Collection (ARC), and the Drug Discovery Lab (DISCO), have collaborated to investigate the ecology, biology, and metabolomic/toxicology of cyanobacteria and cyanobacteria blooms. A total of 18 blooms have been sampled and collected in New Hanover County from May 2018 to the present. Of these blooms roughly five different representative genera have been identified and grown in culture, and several potentially novel metabolites have been observed. Establishing cultures and identifying metabolite production coupled with determining the abiotic factors associated with bloom incidences, creates a comprehensive depiction of local cyanobacteria bloom causes, consequences and concerns. This enhanced understanding can aid in improvement of environmental health through mitigation strategies as well as stimulate progress in public health through drug discovery and better municipal and recreational water quality.

Environmental Constraints of Subsea Power Cable Installation for a Proposed Offshore Wind Farm in Southeastern North Carolina: An Overview

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ABSTRACT
The offshore wind industry is poised to grow considerably in the United States over the next few decades. In 2009, the Bureau of Ocean Energy Management released regulations for the Outer Continental Shelf Renewable Energy Program. This new program, coupled with The Energy Policy Act of 2005, provides a structure for issuing leases, easements, and rights-of-way for renewable energy production and transmission. Offshore wind farms require a subsea power cable to transmit power from offshore to a land-based station. The cables are often buried a few meters below the seafloor to minimize damage from anchors, fishing gear and to reduce environmental impacts on sensitive receptors. Currently, there are no identified export cable routes or known landfall locations for the proposed offshore wind farms off southeastern North Carolina. Export cable routes are primarily chosen based on economic viability, seafloor characteristics and environmental considerations. This preliminary study will provide an overview of potential impacts to biological, physical and human receptors. The impact that cable installation would have on the receptors will be classified into four groups: negligible, minor, moderate and major based on the magnitude of the effect and sensitivity of the receptor. The primary sources of information used for this study include NOAA and BOEM’s joint global marine information system database. The main aims of this study are to identify potential environmental impacts, propose mitigation techniques to guide optimal route selection and to improve coastal management decision-making.
The Caribbean Environments Research Group (CERG)

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ABSTRACT
The Caribbean Environments Research Group is the first regional interdisciplinary research group that adopts a holistic approach to the study of the causes and impacts of environmental change on the coastal zone across the Caribbean. Based at the University of the West Indies, the group currently comprises five senior academics and a cross-disciplinary and diverse range of postgraduate students. Here, we present a snapshot of our diverse research projects, which include the management of marine protected areas and invasive species, assessing the impacts of shipping on the marine environment, delivering health assessments of coral reef and fish communities, providing guidance for climate change adaptation and disaster risk reduction, assessing the carbon stock for mangrove communities and reconstructing past climatic and environmental change. We provide a Caribbean perspective on global environmental matters and draw on our growing network of regional and international collaborators to generate a track record of cutting-edge research that is published in high-impact international journals. Our ultimate aim is the transfer of knowledge and enhanced research capacity to the next generation of Caribbean researchers.

Impacts of Oyster Structures (Reefs and Aquaculture Operations) On Adjacent Infaunal Community Assemblages

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ABSTRACT
Predators’ use of subtidal structural habitats is often associated with a shift in the abundance and/or composition of adjacent benthic communities. Evidence of this impact is often identified by areas of reduced infaunal abundance or shifts in community composition near the structure. These “halos” are evidence of more intensive foraging on adjacent soft substrate habitats, the same may be true of intertidal and subtidal oyster structures. Oyster reefs are known to have influences that occur far beyond the reef itself through a variety of mechanisms such as organic and nutrient enhancement, attraction of finfish and crustaceans, sediment stabilization, alteration of flow, and impacts to larval settlement. The objective of this study is to compare patterns in infaunal community composition and abundance surrounding subtidal oyster aquaculture operations, intertidal natural and created oyster reefs, and sand flats located in southeastern North Carolina. The goal is to determine and compare the nature, spatial extent, and magnitude of detectable impacts. This was accomplished through direct assessment of benthic organisms at varying distances from each structural habitat.
Marine Fish Distributions Link to Wetlands, Prey, Geomorphology and Oceanography

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Abstract
Marine ecosystems are under increased pressure to accommodate multiple resource uses spanning from commercial and recreational fishing, offshore energy development, oil and gas extraction, and mining of mineral resources. Yet, the spatial distribution and habitat relationships of fish are often not identified at the scale needed to assess potential impacts from human uses. Here, we used species distribution models to inform planning and assessment of sand dredging in the Gulf of Mexico, plus provide observations on species in the South Atlantic, USA. We modeled select fish species to represent a variety of trophic levels and fish guilds, including shrimp, juvenile reef-associated fish and shark species. Predictor variable development aimed to untangle the role of geomorphology, nearby wetlands/estuaries, prey species, and oceanographic conditions in shaping species’ distributions. We used machine-learning statistics to model the most influential variables and to map species’ distributions. Our results show that prey species, oceanographic conditions, and nearby wetlands and estuaries were the best predictors of species distributions. The influence of geomorphology habitat variables was limited. Examples of newly discovered habitat relationships quantified in our study include sharks related to nearby wetlands and red snapper related to mixed layer depth and prey species. Overall, the modeling of marine species’ distributions revealed that the value of sand resources to marine species is highly dependent on context, including ocean characteristics and nearby estuarine ecosystems. The application here is for sand dredging, but such results could also inform decision-making and spatial planning for a variety of marine ecosystem uses.

Invasion of the Sea Squirts: Characterizing the Microbial Communities of Introduced Ascidians

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Abstract
Sea-squirts or ascidians seem unlikely invaders at first glance; they are sessile as adults and their larvae are short-lived, non-feeding and capable of only limited dispersal. Yet several sea squirts exhibit a worldwide distribution, due in part to their remarkable capacity for adapting to local environmental conditions, growing and reproducing rapidly and competing successfully for available substrate. In order to determine the potential role microbial symbionts may play in mediating introductions into new regions, we characterized the diversity, structure, and host-specificity of the microbial communities of three globally introduced ascidian species. Replicate samples (n = 5) of the non-native Distaplia bermudensis, Polyandrocarpa anguinea, and P. zorritensis were collected in Wrightsville Beach, NC along with ambient seawater. Microbial communities were characterized via next-generation (Illumina) sequencing of partial (v4) 16S rRNA gene sequences. Ascidians hosted highly diverse microbial communities, with 5,696 total unique microbial taxa detected spanning 44 bacterial and 3 archaeal phyla. A high degree of host-specificity was revealed, with microbial communities clustering strongly in response to source. In addition, significant structural differences between the three ascidian species were detected, as well as with the seawater bacterioplankton community (PERMANOVA, P < 0.015). We further examined the core microbial community (present in all ascidian replicates) and identified 103 unique core microbial taxa, including taxa with putative links to ammonia-oxidation, denitrification, pathogenesis, and heavy-metal processing. Taken together, these results suggest introduced ascidians form intimate associations with highly host-specific and diverse microbial communities, which may assist with host adaptation to new habitats.
Geologic Potential, Economics, and Issues of Offshore Oil and Gas and Wind Energy – Mid-Atlantic and North Carolina

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ABSTRACT
The debate over offshore energy is about much more than the total hydrocarbon and wind potential available on the Outer Continental Shelf. Opposition to offshore energy exploitation results from concerns over the possible loss of revenue from fisheries and tourism, which are $100 million and multi-billion dollar industries, respectively. And although most of the concern is related to hydrocarbon exploration, including potential seismic survey impacts, there is concern from communities about the visual impacts of wind turbines on tourism. In this discussion, reserve estimates at multiple pricing scenarios from BOEM are compared with revenues from fisheries and tourism. We also investigate the wind energy off our coast compared with what is now available with distance from shoreline restrictions requested by the National Park Service and coastal communities. Requested distances from shoreline range from 20 to 30 nm, reducing by more than ½ the amount of wind energy potential and deeper water depths and distance from shore increase the investment costs to develop wind farms. Summaries of the economics and issues are focus of this study.

Riparian Loss of Natural and Cultural Resources: Brunswick Town - Fort Anderson, North Carolina

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ABSTRACT
Anthropogenic water and land use development are amplifying the frequency and magnitude of forces impacting riparian shore zones. North Carolina State Historic Sites are integral to the conservation of cultural heritage and natural resources, this is exemplified at Brunswick Town/Fort Anderson (BTFA) State Historic Sites in the Cape Fear River Estuary, North Carolina. Although State Historic Sites are largely protected from development, surrounding water and land use practices and external nature-based forces, such as sea-level rise, storms, and wave action place many sites at risk of damage or loss. Sections of shoreline at BTFA have eroded to the high marsh-upland transition—over 100 m in 80 years—resulting in steep vegetated bluffs and threatening historic earthen works created during the Civil War. The shore zone erosion has resulted in the complete loss of intertidal habitat along sections of the shoreline and the loss of transition zones and upland vegetation, including large (height +15 m) mature mixed trees. This study sought to quantify the rate of shoreline change over the course of 80 years and determine potential factors responsible for observed changes in the shoreline by utilizing a combination of in-situ surveys and remote sensing through shoreline position data digitized from historic aerial imagery, and real time kinematic (RTK)-GPS surveys. Historically (1938-1998), erosion has been -0.30±0.12 m yr⁻¹; however, modern (2006-2018) shoreline erosion has increased to -0.57±0.29 m yr⁻¹. Results of this study show an increased rate of erosion that is associated with the most recent navigation channel widening project. Future management strategies of the site will need to have the capacity to mitigate an increased rate of erosion in a riparian environment.