Global Marine Science Summit
Coastal Resilience and the Blue Economy
Nov. 5-8, 2017
Welcome

Dear Guests,

Welcome to the Center of Marine Science at the University of North Carolina Wilmington! Thank you for participating in the first-ever UNCW Global Marine Science Summit. We envision the summit as a catalyst for collaboration, bringing together many of the world’s best scientists, policymakers and industry leaders to explore research opportunities and economic development challenges affecting coastal regions. As a historic port city, Wilmington has long served as an international conduit for global connections between North Carolina and the world.

I encourage you to learn more about the state-of-the-art facilities available at the university’s CREST campus, including the Center for Marine Science and the marine biotechnology building (MARBIONC). UNCW, federal and state agencies, and many industry partners have invested significantly in the programs and services we offer. The university’s expert faculty and staff are also an invaluable resource, and their commitment to excellence is the foundation of UNCW’s great reputation for marine and coastal research and development.

While you are here, I hope you will have the opportunity to visit UNCW’s beautiful main campus, tour downtown Wilmington and walk along our community’s gorgeous beaches and trails. There are many reasons why we love where we live just as much as we love where we work!

Thank you for participating in UNCW’s Global Marine Science Summit. Your commitment to finding ways to collectively address coastal issues serves as a model for our students. Enjoy the conference, our campus and the community!

Best wishes,

Jose V. Sartarelli
Introduction

Convening international scientists, policy makers and industry leaders, the UNCW Global Marine Science Summit focuses on 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

Aswani K. Volety
Dean, College of Arts and Sciences
University of North Carolina Wilmington
USA

Roni Avissar
Dean, Rosenstiel School of Marine and Atmospheric Science
University of Miami
USA

Fred Jean
Professor, University of Brest
France

Lynn A. Leonard
Professor, University of North Carolina Wilmington
USA

Michael De Luca
President, National Association of Marine Laboratories
Senior Associate Director, Office of Research,
Rutgers University
USA

Rachel Mills
Dean, Faculty of Natural and Environmental Sciences
University of Southampton
United Kingdom

Martin H. Posey
Director, UNCW Center for Marine Science
University of North Carolina Wilmington
USA

Philippe Soudant
Director of Research
University of Brest
France

Jonathan White
RADM (Ret.), U.S. Navy
President and CEO,
Consortium for Ocean Leadership
USA

Michael Wilhelm
Associate Vice Chancellor, International Programs
University of North Carolina Wilmington
USA
Jon White joined the Consortium for Ocean Leadership in September 2015 and was instated as president and CEO in January 2016. Prior to this, he had a distinguished 32-year career in the U.S. Navy and retired at the rank of rear admiral.

White's passion for the ocean and science began at a very early age as he grew up near Florida's Gulf coast. He earned a Bachelor of Science degree in oceanographic technology from the Florida Institute of Technology, and a master's degree in meteorology and oceanography from the U.S. Naval Postgraduate School.

White had numerous operational assignments at sea and ashore as a naval meteorology and oceanography specialist, culminating in his assignment as oceanographer and navigator of the Navy from 2012 to 2015. This position included appointments as the director of Navy's Task Force Climate Change and Navy deputy to the National Oceanic and Atmospheric Administration.

Michael De Luca is the senior associate director for the Office of Research at Rutgers University where he leads integrated programs of research, education and outreach for the Jacques Cousteau National Estuarine Research Reserve, Aquaculture Innovation Center and the Coastal Exploration Center. Other key duties include management of major external research, science education and service programs, government relations and marine and coastal science policy. He directs Rutgers’ efforts to support the development, growth and prosperity of aquaculture in New Jersey and the mid-Atlantic region, oversees operation of major field facilities, serves as chair of the Rutgers Dive Control Board and leads efforts to capitalize on environmental sampling and sensing networks to inform coastal management and enrich K-12 science education. He also directs efforts to restore the ecological integrity of coastal systems and communities in the aftermath of Superstorm Sandy, develops science-based strategies to enhance resilience of coastal communities and ecosystems, and conducts research to advance management of marine protected areas. His experience includes service as president of the National Estuarine Research Reserve Association (NERRA), chair of the Science and Technical Advisory Committee for the Barnegat Bay National Estuary Program, past chair of the Public Policy Committee for the National Association of Marine Laboratories (NAML) and member of the Heinz Center Panel on Innovations in Coastal Zone Management. He is currently chair of the Legislative Affairs Committee for NERRA and president of NAML.
Monday, Nov. 6
Morning session begins at 8 a.m.

8:15 a.m. Welcoming Remarks

8:30 a.m. Plenary Speakers

RADM Jonathan White, USN (ret.), President and CEO of the Consortium for Ocean Leadership
Ocean Science + Global Security = Ocean Security

Michael De Luca, President, National Association of Marine Laboratories and Senior Associate Director, Office of Research, Rutgers University
Challenges and Opportunities Associated with a Changing Environment

9:35 a.m. Panel presentations with discussion – Perspectives on the Blue Economy

Moderator: Christopher Dumas, Department of Environmental Science, University of North Carolina Wilmington

Tibor Vegh, Nicholas Institute for Environmental Policy Solutions, Duke University, Durham, North Carolina, USA
Developing Blue Economy Policies: Lessons Learned from North Carolina, the Caribbean and Bangladesh

Aileen 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

Patrick Vrancken, Department of Public Law, Nelson Mandela University, Port Elizabeth, South Africa
African Governance Perspectives on the Blue Economy

Erica Rule, U.S. Integrated Ocean Observing System, National Ocean Service, NOAA, Silver Spring, Maryland, USA
IOOS and the Ocean Enterprise

James Leutze, North Carolina Beaches, Inlets and Waterway Association, Wilmington, North Carolina, USA

Rick Catlin, CATLIN Engineering, Wilmington, North Carolina, USA

Panel Discussion

10:45 a.m. Break

10:55 a.m. Panel presentations with discussion – Coastal Hazards and Community Response

Moderator: Andrea Hawkes, Department of Earth and Ocean Sciences, University of North Carolina Wilmington
Jeffrey L. Payne, Office for Coastal Management, National Ocean Service, NOAA, Charleston, South Carolina, USA
Disaster Preparedness,
Disaster Recovery - The Time Is Now

M. Richard DeVoe, South Carolina Sea Grant, Charleston, South Carolina, USA
Enhancing Resilience
Where It Makes a Difference

Spencer Rogers, North Carolina Sea Grant, Wilmington, North Carolina, USA
Approaches to Shoreline Management

Gregory L. Williams, U.S. Army Corps of Engineers, Wilmington District, Wilmington, North Carolina, USA
Beach Sand and the Coastal Economy

Mona Behl, University of Georgia Marine Extension Service and Georgia Sea Grant, Athens, Georgia, USA
A Tale of Two Cities: How Georgia Sea Grant Helps Save Lives While Saving Money

Roni Avissar, Rosenstiel School of Marine & Atmospheric Science, University of Miami, Miami, Florida, USA
Hurricane Forecasting: Current Capability and Research Directions for Improvement

Panel Discussion
2:15 p.m. Poster Session
3:45 p.m. Depart for USS North Carolina Battleship Reception

Tuesday, Nov. 7
Morning session begins at 8 a.m.

8:15 a.m. Panel presentations with discussion – Innovation and Commercialization
Moderator: Craig Galbraith, Office of Innovation and Commercialization, Cameron School of Business, University of North Carolina Wilmington

Daniel Baden, Center for Marine Science and MARBIONC, University of North Carolina, Wilmington, North Carolina, USA
Translational Science

William A. Gerhard, Department of Civil and Environmental Engineering, Duke University, Durham, North Carolina, USA
Characterizing the Microbiome of Ballast Water

Federico Lauro, Asian School of the Environment, Nanyang Technological University, Singapore
Molecular Methods for Coastal Monitoring and Biological Control of Phytoplankton Blooms

Philippe Soudant, Laboratoire des Sciences de l’Environnement Marin, IUEM/UBO, Technopole Brest Iroise, Plouzané, France
Creating Value from Nutrient Rich Hog Waste Using Algal Culture Technology

Kenneth Mei-Yee Leung, The Swire Institute of Marine Science and School of Biological Sciences, The University of Hong Kong, Hong Kong, China
Eco-shoreline Designs for Sustainable Coastal Development

Jyotika Virmani, Planet & Environment, XPRIZE, Culver City, California, USA
Accelerating the Future of Marine Technology

Panel Discussion

9:45 a.m. Break

Moderator: Doug Gamble, Department of Earth and Ocean Sciences, University of North Carolina Wilmington

Keith Davidson, Scottish Association for Marine Science, Scottish Marine University, Oban, Scotland, UK
Assessing and Managing the Risk of Harmful Algal Blooms

Guan-hong Lee, Department of Oceanography, Inha University, Incheon, Republic of Korea
Restoration Measures of Altered Estuaries

Panel Discussion
Scott Knoche, Patuxent Environmental & Aquatic Research Laboratory, Morgan State University, St. Leonard, Maryland, USA

**Estimating the Ecosystem Services and Economic Impacts Generated by Oyster Reef Restoration in the Maryland Choptank River Complex**

Kenneth Mei-Yee Leung, The Swire Institute of Marine Science and School of Biological Sciences, The University of Hong Kong, Hong Kong, China

**Revealing Ecological Risks of Endocrine Disrupting Chemicals in Marine Protected Areas through an Integrative Approach**

Panel Discussion

11 a.m. Panel presentations with discussion – Risks, Restoration and Resources: Approaches for Management and Policy – Part 2

Claudia Benham, James Cook University, Townsville, Queensland, Australia

**Knowledge Matters – Local Perspectives on Environmental Change and Industrial Development in the Great Barrier Reef, Australia**

Marcus Sheaves, James Cook University, Townsville, Queensland, Australia

**Status, Issues, Trajectories and Future of the Coastal Ecosystem - Social - Economic Interaction for Pacific Island Nations**

Scott Curtis, Department of Geography, Planning and Environment, East Carolina University, Greenville, North Carolina, USA

**Managing Food, Energy, and Water Resources in the Caribbean: Issues and Opportunities**

Donovan Campbell, Department of Geography and Geology, University of the West Indies, Kingston, Jamaica

**Fish Sanctuaries and Food Security in the Caribbean: Challenges and Opportunities**

Abigail Bennet, World Food Policy Center, Sanford School of Public Policy, Duke University, Durham, North Carolina, USA

**The Contribution of Fisheries to Nutrition and Food Security**

Panel Discussion

12:15 p.m. Lunch

Afternoon Session

1 p.m. Panel presentations with discussion – Fisheries and Aquaculture

Moderator: Ami Wilbur, UNCW Shellfish Research Hatchery, University of North Carolina Wilmington

Suguna Tummala, Sri Venkateswara Veterinary University, Fisheries Research Station: Undi, India

**Sustainability of Blue Economy by Resuscitating the Farming of Asian Cat Fish, Clarias Batrachus, in Low Saline Waters**

Yoshihiro Omura, International Exchange Center, Kindai University, Higashiosaka City, Osaka, Japan

**Capitalizing on Kindai Tuna**

Mats Lindegarth, Department of Marine Sciences, Tjärnö, University of Gothenburg, Strömstad, Sweden

**Quantifying Abundance and Distribution of European Oysters (Ostrea edulis) Using Towed Video in Swedish Coastal Waters**

Chang-Keun Kang, School of Earth Sciences and Environmental Engineering, Gwangju Institute of Science and Technology, Gwangju, Republic of Korea

**Sustainability of the Submerged Longline-Cultured Pacific Oyster Crassostrea gigas in a Temperate Coastal Bay System of Korea**

Standish K. Allen, Jr., Aquaculture Genetics and Breeding Technology Center, Virginia Institute of Marine Science, Gloucester Point, Virginia, USA

**Paradigm Shift on Recovery of Distressed Oyster Resources: Aquaculture of Native Oysters in Chesapeake Bay**

Panel Discussion

2:30 p.m. Break

2:40 p.m. Working Group Breakouts and Discussion

- Aquaculture and Fisheries
- Innovation, Business and Economy
- Resource and Policy
- Institutional Exchanges and Collaboratives

3:45 p.m. Working Group Summaries, Identification of Next Steps and Wrap-up

4:15 p.m. Tour of CREST Campus

Special thanks to Wilmington Water Tours, the USS Battleship North Carolina and Holiday Inn Resort for supporting UNCW’s Global Marine Science Summit.
Oral Presentation Abstracts

Global Marine Science Summit
Coastal Resilience and the Blue Economy
Paradigm Shift on Recovery of Distressed Oyster Resources: Aquaculture of Native Oysters in Chesapeake Bay

Standish K. Allen, Jr.*

Aquaculture Genetics and Breeding Technology Center, Virginia Institute of Marine Science, 1375 Greate Road, Gloucester Point, Virginia 23062, USA; ska@vims.edu

ABSTRACT

In the late 1990s, harvests of the native oyster, *Crassostrea virginica*, in the Chesapeake Bay were at a nadir. Restoration activities, ongoing in Maryland, were intermittent at best in Virginia. The situation was virtually desperate, as evidenced by a joint proposal from Virginia and Maryland to introduce the non-native oyster, *C. ariakensis*. Introduction of a non-native species after collapse of an oyster fishery has been a common reaction in many parts of the world, including Pacific Northwest of the US, France, and Australia. The difference in the Chesapeake during the "ariakensis-era" was the existence of an extant selective breeding program that provided an alternative to non-native introduction, but of course, the use of this material is predicated on a viable aquaculture industry. There was none before the "ariakensis-era." In order to fully investigate features of the biology of *ariakensis*, field trials with sterile triploids were undertaken, most of these by "industry" participants. To create triploid non-natives, tetraploid technology was required. To create "apples to apples" comparisons of the native *C. virginica* to *C. ariakensis*, triploid natives were also required. Thus set the stage for a paradigm shift to native aquaculture. During the course of the several iterations of non-native trials with industry participants, they had to learn how to grow oysters, many for the first time. They learned that triploid *C. ariakensis* was an amazing creature, but also that triploid disease-resistant *C. virginica* were an acceptable consolation prize. Ultimately, the introduction of *C. ariakensis* was not approved, leaving the industry with the opportunity to grow domesticated native strains. Ironically, it was the specter of a non-native introduction that impelled the development of native aquaculture in Virginia. Continued improvement of genetic lines for aquaculture has contributed to the unrelenting growth of aquaculture of native oysters in Virginia, with Maryland close behind.

Transformational Science

Daniel Baden*

Center for Marine Science and MARBIONC, University of North Carolina Wilmington, 5600 Marvin K. Moss Lane, Wilmington, North Carolina 28409, USA; baden@uncw.edu

ABSTRACT

Marine dinoflagellates arise in the early Silurian Period of the Precambrian Era. Their biochemistry and cell biology, shape and motility, biologics and other cell contents all exhibit characteristics of primordial prokaryotic and eukaryotic life. They produce metabolites that alter neurologic, cardiovascular, pulmonary, and transport properties in higher forms of life. Massive dinoflagellate blooms are toxic. However, dose alone determines toxicity, and when used in smaller amounts, bioactive compounds arising from red tides can become therapeutic in character. Recent drug development activities relate to nerve growth and regeneration, enhancement of solute and drug transport across cell membranes to increase delivery and hence efficacy, and restored water homeostasis across pulmonary membranes for the treatment of mucociliary diseases like CF and COPD. Using a translational sciences paradigm at the institution level, MARBIONC employs the concepts of disruptive technologies, permanent innovation, and “dark-bright” philosophy in the search for new biopharmaceutical candidates. Our collaboration as a Tier I member within the new NIIMBL program provides the opportunity to explore production of sufficient quantities of prodrugs for clinical trials and sales, while at the same time exploring the “permissive” nature of dinoflagellates as an ideal phylum to be exploited as a platform for manufacturing of any number of current and future biopharmaceuticals. Our initial foray sought bioactive materials from marine dinoflagellates. Other single-celled culturable microbes are included in our community of clonal cultures, as clones demonstrate biopharmaceutical potential.
Ocean Warming and Range Shift in Aquatic Organisms in Japan

Leila Basti*

Tokyo University of Marine Science and Technology, Minato, Konan, 4-5-7, Tokyo 108-8477, Japan; lbasti1@kaiyodai.ac.jp

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 the 400 ppm, and the concentration of CO₂ in the atmosphere are 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. Significant changes in biological systems are occurring on all continents and 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. The most basic ecological response to increasing temperature is a shift toward the poles or higher latitudes.

The recent warming of the Kuroshio Current has led to substantial ocean warming in Western Japan which is considered a warming hotspot for biological changes. Warming-driven changes in primary planktonic and benthic productions have been witnessed in this region. Increased water temperature has been linked to the occurrence of several tropical harmful algal bloom (HAB) species and to the geographical expansion of other HAB species to the North. At the same time, macroalgal beds and kelps have witnessed degradations in several areas, and a transition from temperate to tropical species. Coral communities have also witnessed extensive increase in their coverage and species richness concomitant with geographical range extension of associated tropical fish. In the present paper, the range shifts in HAB species, macroalgal species, coral communities and associated tropical fish driven by warming water temperatures in Western Japan are reviewed.

A Tale of Two Cities: How Georgia Sea Grant Helps Save Lives While Saving Money

Mona Behl*

University of Georgia Marine Extension Service and Georgia Sea Grant Program, Athens, Georgia, USA; mbehl@uga.edu

ABSTRACT
Low-lying communities in coastal Georgia are experiencing increased vulnerability to flooding events due to higher storm surges, heavy rainfall, antiquated stormwater infrastructure, and continued development within flood-prone areas. These events have resulted in the loss of property, health, safety, disruption of commerce and governmental services, and huge public expenditures and impairment of the tax base. The Cities of Tybee Island and St. Marys, recognized as major economic drivers of coastal tourism in Georgia, are particularly vulnerable to flooding. To address the impacts of coastal hazards, help communities in sustainable coastal development, and build a cohesive network of coastal leaders, Georgia Sea Grant collaborated with the Tybee Island to develop an award-winning Sea-Level Adaptation Plan. Extension professionals partnered with researchers to canvass a variety of stakeholders, generate cost-benefit analysis, model the impacts of king tides, and facilitate public information meetings. Participatory research, driven by stakeholder engagement, resulted in tangible savings. As a result of Sea Grant's efforts, Tybee Island achieved CRS (Community Rating System) rating of 5, enabling savings of $725,639 annually in flood insurance premiums for property owners on the island. Inspired by the success of Tybee Island Sea-Level Rise Initiative, St. Marys collaborated with Georgia Sea Grant to implement a new Flood Damage Prevention Ordinance, and entered the CRS at a level of 7, resulting in citywide savings of $87,740 annually in flood insurance premiums. To date, Georgia Sea Grant has helped 16 coastal counties and cities in Georgia to become active participants in the CRS.
Knowledge Matters – Local Perspectives on Environmental Change and Industrial Development in the Great Barrier Reef, Australia

CLAUDIA BENHAM*
James Cook University,
Townsville, Queensland, Australia 4811; claudia.benham@jcu.edu.au

ABSTRACT
It is increasingly apparent that sustainable management of marine ecosystems requires understanding both the ecological and social values of these complex environments. Local and traditional ecological knowledge plays an important role in aiding decision making, particularly in data-poor contexts or where values conflict. However, this knowledge is rarely translated into decision making outcomes for large industrial projects – although this is changing. This seminar will explore the role of local ecological knowledge in informing Environmental Impact Assessment (EIA) for Liquefied Natural Gas (LNG) developments in the Great Barrier Reef World Heritage Area, Australia. Drawing on case study research from the Gladstone LNG industry, the seminar will discuss community perspectives on the risks, benefits and environmental impacts of industrial development and examine the extent to which EIA processes currently respond to local values, priorities and concerns, before discussing how project decisions may be improved through the integration of local ecological knowledge.

The Contribution of Fisheries to Nutrition and Food Security

ABIGAIL BENNETT*, PAWAN G. PATIL, KRISTIN KLEISNER, JOHN VIRDIN, DOUGLAS N. RADER, XAVIER BASURTO
World Food Policy Center, Sanford School of Public Policy, Duke University,
201 Science Drive, Durham, North Carolina 27708, USA; abigail.bennett@duke.edu

ABSTRACT
In 2014, the 146.3 million tons of fish destined for human consumption provided a global per capita supply of 20 kg, amounting to about 17 percent of animal protein for the world’s population. Many countries rely on fish and other marine and freshwater products for more than half of their animal source protein, while a growing body of evidence indicates that the most crucial contributions of fish to nutrition are in the form of essential micronutrients. This report describes the state of the field of research and policy related to capture fisheries’ contributions to global nutrition and food security. For a long time, fisheries have played a marginal role in the broader discourse on hunger and food security. At the same time, fisheries policies have often focused on a variety of objectives other than food provisioning per se, for example maximizing economic efficiency or conserving particular species. An emerging body of research is beginning to highlight, with increasing breadth and specificity, the essential role that fisheries play in alleviating hunger and malnutrition in both developed and developing countries. Based on a review of the literature and available data, we assessed the current state of knowledge regarding the contribution of fisheries to nutrition and food security as well the potential for processes such as climate change, overfishing, and economic globalization to affect those contributions in particular places. We then analyzed a number of fisheries policy issues from the perspective of food and nutritional objectives, focusing in particular on tuna, forage fisheries, and coral reef systems. Finally, we outlined knowledge gaps and emerging areas for research to be addressed in order to develop a better scientific understanding of fisheries’ contributions to nutrition and food security and equip policies to balance tradeoffs between economic, sustainability, and food provision goals.
Oceans Acidic and Low in Oxygen: Organismal Resilience

Louis Burnett*, Karen Burnett

Grice Marine Laboratory and Hollings Marine Laboratory, 205 Fort Johnson, Charleston, South Carolina 29412, USA; BurnettL@cofc.edu

ABSTRACT
Changes of just about any variable in coastal waters and estuaries can be rapid, dramatic, and significant. Fluctuations of oxygen and CO₂ can be especially important. For different organisms some life stages, especially larval and juvenile, are highly sensitive to these fluctuations. Adult forms are much more resilient but are nevertheless stressed by changes in oxygen and CO₂. The combination of low O₂ (hypoxia) and high CO₂ (hypercapnia) has been shown to decrease immune function in fish, oysters, and crustaceans. In addition, the ability of the Atlantic blue crab is impaired when it is fighting a bacterial infection. Severe hypercapnic hypoxia also reduces the ability of crustaceans to walk and/or swim. For organisms actively seeking to capture prey or avoid being captured as prey, these immune system challenges, especially in combination with hypoxia, and hypercapnia can influence their ability to survive. We review specific cases of these important events and what they mean to different organisms. Supported by National Science Foundation IOS-1147008.

Fish Sanctuaries and Food Security in the Caribbean: Challenges and Opportunities for Coastal Communities in Jamaica

Donovan Campbell*

Department of Geography and Geology, University of the West Indies at Mona, Jamaica; donovan.campbell@uwimona.edu.jm

ABSTRACT
Caribbean coastal communities and the ecosystem services they depend upon, are at the frontline of some of the most serious threats from environmental change. Coupled with an already deteriorated marine ecosystems, the impacts on food security, coastal livelihoods and wellbeing are far-reaching. In Jamaica, fisheries have been in decline over recent decades, which poses ecological, social and food security challenges that are being exacerbated by climate change. In recent times, the fisheries sector has been badly affected by a series of natural disasters, which resulted in adverse impacts on the livelihoods of fishers across the island. In response, the Government of Jamaica has established a network of Fish Sanctuaries (Special Fishery Conservation Areas) to combat chronic overfishing, marine biodiversity loss and the resulting socio-economic consequences. The Fish Sanctuaries were created to improve the marine biodiversity and by extension, the wellbeing of fishers. However, there is limited understanding of the impacts of Fish Sanctuaries on the wellbeing of local fishers. This paper is based on ongoing research on the socio-ecological trade-offs, synergies and co-benefits between Fish Sanctuaries and coastal communities in Jamaica. The research focuses on the use of quantitative and qualitative research techniques to assess the interlinkages between Fish Sanctuaries, social well-being and food security. Preliminary results indicate that while Fish Sanctuaries create unique opportunities for ecosystem restoration and private sector partnerships, multi-level governance; attribution and detection of social and ecological change; and the overall sustainability of the Fish Sanctuaries are fundamental challenges.
Managing Food, Energy, and Water Resources in the Caribbean: Issues and Opportunities

Scott Curtis*

Department of Geography, Planning and Environment, East Carolina University, Greenville, North Carolina 27858, USA; curtisw@ecu.edu

Small island developing states have traditionally found supplying adequate, low-cost food, energy, and water for its citizens challenging, and the Caribbean is no exception. This review focuses on Jamaica, where an interdisciplinary research study on agricultural vulnerability to drought led to an examination of the food-energy-water system on the island. Socio-economic stressors, such as volatile markets for farm goods, the high cost of oil, and the uneven access to irrigation, are being exacerbated by climate change. Future projections of high temperatures, aridity, and weather extremes suggest that farming, tourism and other sources of economic stability will be stressed, and that resilience must come from new and inventive was of managing food, energy, and water resources. Examples such as greenhouses, agritourism, and renewable energy projects will be explored. Finally, Jamaica is only one case, and the diversity of issues and opportunities for other Caribbean islands will be compared.

Assessing and Managing the Risk of Harmful Algal Blooms

Keith Davidson*

Scottish Association for Marine Science, Scottish Marine Institute, Oban PA37 1QA, Scotland, UK; Keith.Davidson@sams.ac.uk

Harmful algal blooms are perceived to be an increasing risk to coastal aquaculture. In Scotland human health is safeguarded from shellfish toxicity by an extensive regulatory monitoring programme. However, this programme is not designed to provide the early warning required by government and aquaculture to minimise business risk and allow sustainable development of both shellfish and finfish aquaculture. We have therefore developed a web based alert system (www.HABreports.org) that provides a Scotland wide summary of current HAB and biotoxin conditions, with more detailed weekly early warning bulletins for the important aquaculture area of the Shetland Islands. Many HAB events in Scottish waters are advective in nature and I shall therefore discuss an on-going multidisciplinary study that is investigating the role of oceanographic currents in transporting offshore HABs to the coastal zone and the subsequent use of combined remote sensing and mathematical modelling of these events to provide enhanced HAB early warning within the HABreports system.
Challenges and Opportunities Associated with a Changing Environment

AUTHOR
Michael De Luca*

INSTITUTION
Aquaculture Innovation Center, Rutgers University,
88 Lipman Drive, Cook Campus, New Brunswick, New Jersey 08903, USA; deluca@marine.rutgers.edu

ABSTRACT
Drivers of environmental change have increased the vulnerability of our coasts and coastal communities to flooding and storm damage, and threatened the sustainability of coastal-based economies. The increasing frequency and intensity of coastal storms, rising sea levels, warming ocean temperatures, and human impacts throughout coastal watersheds, ecosystems and communities are just a few of the challenges that we have to meet in order to preserve the environmental integrity, resource and recreational value, and economic vitality of communities that rely on healthy, sustainable coastal habitat and water quality. A variety of management strategies and tools are emerging to help coastal decision-makers select the best options to adapt to or mitigate some of the deleterious impacts of environmental change. Several of these management strategies will be discussed including locally-driven resilience programs, living shorelines that work, aquaculture as a restoration/resilience tool, the value of place-based networks, and development of an early detection system for environmental change—a Sentinel Site initiative. Key investment opportunities for the science and management communities will be identified for conference participants to consider and advance.

Enhancing Resilience Where It Makes a Difference

AUTHOR
M. Richard DeVoe*

INSTITUTION
S.C. Sea Grant Consortium,
287 Meeting Street, Charleston, South Carolina 29401, USA; rick.devoe@scseagrant.org

ABSTRACT
The emergence of more frequent flooding and intense storms in the southeast has presented unprecedented challenges to decision-makers, resource managers, coastal communities, and neighborhoods and families. With this has come a plethora of scientific studies, flood modeling scenarios, vulnerability and adaptation tools, and outreach and educational efforts to assist these constituencies in addressing these threats. And while resilience efforts at the federal, regional, and state levels are critically important, it is at the local level where significant actions will have to be implemented to secure public health and safety, economic continuity, resource protection, and quality of life.
Characterizing the Microbiome of Ballast Water

Authors
William A. Gerhard*, Claudia K Gunsch

Institution
Duke University, 121 Hudson Hall, 100 Science Drive, Durham, North Carolina 27708, USA; william.gerhard@duke.edu

Abstract
According to the World Health Organization, the proliferation of antibiotic resistance is the greatest threat to our way of life in the 21st century. It is vital to examine and monitor possible avenues of global proliferation to minimize risk to human and environmental health. One possible method of global translocation is ballast water. Several studies have examined the microbial community of ballast water but few have collected samples from several distinct geographic regions.

The present study examines the microbial community of ballast water onboard arriving ships and port water at several locations, including: North Carolina, California, South Africa, Singapore, and China. Samples were examined using culture-based techniques to assess compliance with new International Maritime Organization ballast water quality guidelines. Several ships were found to be out of compliance with these guidelines at varying rates in the different ports studied. In addition, Illumina MiSeq 16S amplicon sequencing was performed to determine species diversity and richness of port and ballast water. Finally, preliminary data from targeted qPCR assays indicate that many antibiotic resistance genes are more concentrated in ballast water than port or open ocean water.

This research will provide insight to policy-makers as they work to mitigate the possible impacts of ballast water discharge on human and environmental health. Further research to characterize the microbial community of ballast water will provide valuable information as regulators assess the likely efficacy of new ballast water management technologies.

Sea Otters and Kelp Forests: Real and Potential Transformations in Blue Carbon and Resilience

Authors
Edward Gregr*, Rebecca Martone, Kai Chan

Institution
University of British Columbia, Vancouver, British Columbia, Canada; ejgregr@gmail.com

Abstract
The coastal regions of the Pacific Northwest experienced a dramatic ecological transformation as a result of the near extermination of sea otters (Enhydra lutris) during the historic maritime fur trade. Successful re-introductions in the 1970s allowed sea otters to begin re-occupying former habitat. This in turn has led to conflict with invertebrate fisheries established on species that, when freed from sea otter predation, grew in both size and abundance. Using a combination of field data and population, habitat, and ecosystem service models, we developed an integrated model of coastal British Columbia, Canada, to examine the change in value of key services as a result of the ecological transformation triggered by the recovering sea otter population. Results show that a kelp-dominated system contains 30% more biomass, higher species diversity, higher abundance of commercial finfish, and increased carbon sequestration. The overall increase in value of these ecosystem services far exceeds the losses incurred by the invertebrate fisheries. Evaluation of various spatially explicit management alternatives also shows how space plays an important role in understanding the distribution of benefits, and allows important indicators of social and ecological value to be identified. These indicators are critical to understanding how the resilience of coastal communities has been reduced through decades of ‘ocean grabbing’ - the consolidation of access to marine resources by non-resident license holders. As the Canadian Government now strives towards reconciliation with First Nations, a policy window may be opening to improve the resilience and livability of these coastal communities. A deeper understanding of the relationship between ecological resilience, social resilience, and the emerging blue economy is likely to foster this important social transformation.
Sustainability of the Submerged Longline-Cultured Pacific Oyster *Crassostrea Gigas* in a Temperate Coastal Bay System of Korea

**Author**
Chang-Keun Kang*

**Institution**
School of Earth Sciences and Environmental Engineering, Gwangju Institute of Science and Technology, Gwangju, Republic of Korea; ckkang@gist.ac.kr

**Abstract**
Physiological processes and gross energy budget of the longline-cultured Pacific oyster *Crassostrea gigas* were investigated in Geoje–Hansan Bay, Korea during two entire culturing periods. Based on physiological measurements of food consumption, feces production, ammonium excretion, and respiration, the scope for growth of *C. gigas* appeared to be positive during most of the culturing period, indicating suitable conditions of the bay for oyster culture. Flesh tissue energy production during the entire culturing period was calculated as 27.6 kJ and 27.8 kJ for the first and second experiments, respectively. Directly measured tissue energy increases were closely linked with our physiological estimations for flesh tissue energy production. The high observed assimilation rates suggest that longline-cultured oysters might adjust their physiological performance to relatively low concentrations of suspended particulate matter in the bay system to optimize their energy acquisition. Such an adaptive adjustment includes an increased absorption of energy and a reduced loss of metabolic and excretory energy, resulting in positive production under high culturing density conditions. Based on physiological measurements, we further assessed the feedback effects of the longline aquaculture of oysters on the bay system. Ecological efficiency, estimated by a series of energetic efficiencies at the whole bay level, was low compared with Lindeman’s law of trophic efficiency. Our estimates for biodeposition and ammonia excretion rates were relatively low compared with other intertidal plastic bag cultures. These results indicate that the cultured oysters might have only minor effects on benthic and pelagic environments of the bay. Overall, our results suggest that the adaptive physiological performance of oysters and consequently weak feedback effects on ambient habitats should facilitate sustainable longline aquaculture in the bay for a prolonged period without severe habitational deterioration.

Estimating the Ecosystem Services and Economic Impacts Generated by Oyster Reef Restoration in the Maryland Choptank River Complex

**Authors**
Scott Knoche*, Tom Ihde

**Institution**
Morgan State University Patuxent Environmental & Aquatic Research Laboratory, 10545 Mackall Road, St. Leonard, Maryland 20685, USA; scott.knoche@morgan.edu

**Abstract**
A variety of factors – especially disease, habitat degradation, and overharvesting – have reduced the Eastern Oyster (*Crassostrea virginica*) population in the Chesapeake Bay to 1% of historic abundance. Consequently, there has been a severe reduction in the ecosystem services provided by oysters, such as water filtration, shoreline buffering and habitat for aquatic species. To increase the oyster population and consequently enhance the provision of beneficial ecosystem services, Maryland and Virginia has committed to restoring ten Chesapeake Bay tributaries by 2025. This restoration is quite costly, with an estimated cost of $70 million to restore the first three Maryland tributaries selected. Additionally, the restoration has been unpopular amongst some watermen who now have reduced access to traditional oyster harvesting grounds. Given that oyster restoration is funded by taxpayer dollars, it is important to understand what the return-on-investment is for these costly and at-times contentious restoration efforts. To this end, we examine the ecosystem services and economic impacts generated by oyster reef restoration efforts in the Maryland Choptank River Complex. First, we used ecosystem modeling software Ecopath with Ecosim to estimate the change in the harvest of commercially-important finfish and shellfish species as a result of oyster reef restoration. Then, we use species-specific prices to translate estimates of increased biomass harvested to a change in dockside revenues received by harvesters. Finally, we use IMPLAN economic modeling software to estimate changes in key regional socio-economic metrics, such as sales, jobs, and income. This research project will ultimately provide policymakers and resource managers with much-needed information on how society benefits from large-scale environmental restoration projects such as the construction of oyster reefs.
Molecular Methods for Coastal Monitoring and Biological Control of Phytoplankton Blooms

Fredrico Lauro*
Nanyang Technological University,
50 Nanyang Avenue, SBS-B1n-27/N2-01c-54, Singapore 639798; FLauro@ntu.edu.sg

ABSTRACT
As an island-city, Singapore is highly dependent on its surrounding waters for food from aquaculture, and in the near future, the waters around Singapore may become a significant source of drinking water for general use by the population (e.g. after desalination).

However, localized phytoplankton blooms, resulting in significant economic losses to the aquaculture industry and posing a severe threat to human health and wellbeing, periodically affect Singapore's coastal waters. A major hurdle for bloom control strategies lies in the accurate forecasting and rapid characterization of the bloom-causing organisms. Early warning and identification allows for appropriate implementation of the necessary mitigation strategies, greatly minimizing economic losses and leading to sustainable practices in aquaculture and water purification.

In this talk I will present the latest results in developing rapid molecular diagnostic methods for the identification of the phytoplankton species during monitoring programs of water bodies, which could effectively identify bloom-causing organisms even prior to a bloom event. Subsequently I will also show how a combination of genomic and culturing approaches can be used to implement biological control measures for the prevention and mitigation of the blooms.

Restoration Measures of Altered Estuaries

Guan-hong Lee*
Department of Oceanography, Inha University,
100 Inharo, Incheon 22212, Republic of Korea; ghlee@inha.ac.kr

ABSTRACT
We are living in a world of an Anthropocene epoch where the evidence of human impact is substantial on land use, ecosystems, biodiversity, and species extinction. In South Korea alone, about 50 percent of all 354 estuaries have been altered with estuarine dams and slush gates. Land reclamation and channelization would increase the degree of estuarine alteration further. The alteration of estuaries has increased the frequency of coastal eutrophication and degraded water quality and ecosystem. Efforts have been made in recent decades to understand the nature of altered estuaries and the natural response to these modifications with the intension of restoration and/or improved management practices of estuaries.

The Yeongsan River estuary (YRE) of Korea has been altered due to the construction of an estuarine dam as well as the extensive reclamation of tidal flats. These alterations blocked the estuarine circulation, increased the sedimentation up to 10 cm/year, and degraded water quality and ecosystem. Through a comprehensive study to understand the physical and biogeochemical processes and then provide restoration measures of the altered YRE, potential scenarios for restoration were evaluated, which include reduction of nutrient input from watershed, dredging of contaminated bed sediment, pumping of degraded bottom water, and restoration of estuarine circulation. This study suggested that the removal or permanent opening of the dam to restore estuarine circulation appears to be the best solution in the YRE. However, the suggested method is highly controversial in Korea and it requires a better governance to implement the measure.
Eco-Shoreline Designs for Sustainable Coastal Development

Kenneth Mei-Yee Leung*

The Swire Institute of Marine Science and School of Biological Sciences, The University of Hong Kong, Pokfulam, Hong Kong, China; kmyleung@hku.hk

Abstract

Conventionally, reclamation and marine infrastructure projects often adopted simple artificial vertical or slope seawalls as coastal defenses against wave action, flooding and land erosion. But, these structures do not possess any microhabitats that can be readily occupied and used by marine organisms as refuges and feeding grounds. Through incorporating the knowledge of marine ecology and collaboration with ecologists, engineers now are able to design eco-friendly artificial structures (e.g. eco-concretes, bio-blocks, reef balls) to serve dual roles as coastal defenses and functional ecosystems for enhancing marine biodiversity and ecosystem service. For instance, filter feeders like mussels and oysters which grow on these eco-friendly structures will be able to filter and clean up the coastal seawater, while serving as food sources for other marine predators (e.g. crabs, fishes and humans) and as habitats for other organisms to reside. Apart from having engineered structures made of artificial substrates, it is also possible to create living eco-shorelines using natural materials; typical examples include artificial wetlands and intertidal rock pools. Such imitated natural habitats can accommodate many different living organisms and hence augment biodiversity and ecosystem functions, while providing natural landscape for people to enjoy. In this talk, I will introduce the basic ecological principles for eco-shoreline designs and draw examples from different parts of the world. I will particularly highlight the World Harbour Project (www.worldharbourproject.org) and ongoing trials of eco-shoreline designs carried out in Hong Kong and China. Opportunities and obstacles of the development of eco-shorelines will be discussed.

Revealing Ecological Risks of Endocrine Disrupting Chemicals in Marine Protected Areas through an Integrative Approach

Kenneth Mei-Yee Leung*

The Swire Institute of Marine Science and School of Biological Sciences, The University of Hong Kong, Pokfulam, Hong Kong, China; kmyleung@hku.hk

Abstract

Marine Protected Areas (MPAs) in urbanized coastal cities like Hong Kong are often situated in close proximity to urbanized areas and inevitably influenced by anthropogenic activities such as discharges of untreated or partially treated wastewater, and leaching of antifouling biocides from vessels. Hence, marine organisms inhabiting these MPAs are probably at risk. In this presentation, an integrative approach will be introduced and applied to comprehensively assess the ecological risks of eight priority endocrine disrupting chemicals (EDCs) in four MPAs of Hong Kong. First, environmental and biota samples are collected to reveal the current contamination levels of these EDCs in different seasons. Second, the black mussels (Septifer virgatus) and semi-permeable membrane devices are deployed to determine the extent of EDCs’ accumulation. Furthermore, extracts from the environmental samples are also subjected to the yeast estrogen screen and a novel human cell-based catechol-O-methyltransferase enzyme-linked immune-sorbert assay to evaluate the integral estrogenic activities of the contaminant mixtures. The overall assessment results indicate high risks of some of the EDCs in the Cape d’Aguilar Marine Reserve of Hong Kong. This study illustrated a pragmatic integrated approach for effectively evaluating the ecological risks posed by EDCs through linking the EDC concentrations in various matrices of interest to the biological effects as reflected by the two bioassays. Finally, an innovative approach coupling field-based study and hydrodynamic modelling will be introduced as an effective means for tracking major endocrine disruptors in coastal waters.
Quantifying Abundance and Distribution of European Oysters (*Ostrea Edulis*) using Towed Video in Swedish Coastal Waters

**AUTHORS**
Mats Lindegarth*, Linnea Thorngren, Susanne Lindegarth

**INSTITUTION**
Department of Marine Sciences – Tjärnö, University of Gothenburg, Strömstad, Sweden; mats.lindegarth@marine.gu.se

**ABSTRACT**
In Sweden, the European oyster (*Ostrea edulis*) is on the fringe of its distribution range. Still it is of economic and cultural importance in small-scale fisheries and a target for conservation efforts. In order to use and manage the species sustainably, it is important to understand its distribution and population dynamics. Therefore, we have developed and tested a sampling method based on video observations that allows us to assess the distribution and abundance of *O. edulis*. In a set of experiments we estimated identification errors (live vs dead oysters), errors within and among observers and the role of spatial variability. We concluded that, despite some difficulties associated with identification and with observer errors, the method can be used to estimate both occurrence and abundance. Spatial variability at different scales was the main component contributing to the uncertainty of abundance estimates. These observations were subsequently transformed into quantitative recommendations for future sampling programs depending on the required precision.

The video method was used in a large scale study where more than 700 transects were assessed along the Swedish west coast. The data was collected to estimate overall abundance and to model the distribution of oysters using ensemble species distribution models. The models revealed that the distribution of *O. edulis* is strongly related to environmental factors (e.g. depth and substrate) and that there are strong geographic patterns.

The empirical estimates and species distribution models provide important input to efforts to design management plans for sustainable use and conservation of *O. edulis* in the region. Among other things, the information can be used to estimate total population sizes, identify potential habitats and areas of special conservation importance. Furthermore, the rigorous testing of the method and the representative, stratified sampling used in the program also allows reliable comparisons with future sampling efforts.

---

**Title**

Capitalizing on Kindai Tuna

**Author**
Yoshihito Omura*

**Institution**
Kindai University, 3-4-1 Kowakae, Higashiosaka, Osaka, Japan; yomura@kindai.ac.jp

**Abstract**
Rather than focusing on our Pacific bluefin tuna program, this presentation will introduce how our university has been utilizing research findings to promote our university. One such example is of course tuna, which we branded as "Kindai tuna" and utilized to promote our university.

We established our "Kindai Aquaculture Research Institute" restaurants in Tokyo and Osaka, which have been very popular since opening in 2013.

Based on the belief that research should provide tangible benefits to society, we conduct a wide range of research geared to practical application. A major example of this is our aquaculture research, with which we have achieved what many had considered impossible: the world's first successful full-cycle aquaculture of bluefin tuna, a species in danger of extinction.

My presentation will touch on the following: (1) the history of Kindai Aquaculture Research Institute, (2) the lengthy process of continuing research on the lifecycle of Pacific bluefin tuna, (3) branding our research accomplishments, (4) our creation of unique advertising posters, (5) opening the restaurants which serve only our lab-bred fish, (6) our success in receiving the most university applicants in Japan for four years in a row.
Disaster Preparedness, Disaster Recovery – The Time is Now

Jeffrey L. Payne*

Office for Coastal Management, National Ocean Service, National Oceanic and Atmospheric Administration, Charleston, South Carolina, USA; jeff.payne@noaa.gov

Storms, drought, wildfires, sea level rise, chronic flooding, and other events are putting a major focus on the vulnerability of communities, especially coastal. We are facing hard future choices about how we will plan and prepare for, respond to, absorb, recover from and adapt to these changes, some of which are accelerating or intensifying on a global scale. With more people and material assets locating in coastal zones, the relative risk and vulnerabilities, and costs to recover and adapt, are increasing. These challenges will require creative thinking and solutions across the dimensions of smarter planning and permitting, resilient rebuilding, enforcement, and strategies for recovery that take into account the mounting uncertainties involved with global climate change.

Marine Reserves and Habitat Configuration Interact to Facilitate Resilience in Coastal Coral Reef Seascapes

Kylie Pitt*, Andrew Olds, Jean Davis, Paul Maxwell, Rod Connolly

Griffith University, Gold Coast Campus, Queensland 4222, Australia; K.Pitt@griffith.edu.au

Inshore coral reefs exist within a mosaic of habitats, which include mangrove forests. Protecting reefs from fishing generally enhances abundances of fish and can influence rates of important ecosystem processes that can confer resilience, such as herbivory. The configuration and proximity of habitats within the seascape may influence how fish utilise and move between habitats and so may further influence abundances of fish and ecosystem processes. We used the seascape within Moreton Bay, Queensland, to test hypotheses about how the proximity of protected and unprotected coral reefs to mangroves influenced abundances of reef fish and ecosystem processes. Protected reefs close to mangroves supported greater abundances of herbivorous fish and sustained higher rates of herbivory and coral recruitment than protected reefs distant from mangroves and unprotected reefs, possibly because mangroves provide trophic subsidies to mobile reef fish. Protected reefs close to mangrove, therefore, were hypothesised to be most resilient within the Moreton Bay seascape. The devastating flooding of the Brisbane River in 2011 provided a unique empirical test of this hypothesis. Benthic assemblages initially changed on all reefs impacted by flooding but protected reefs recovered within one year of the floods, whilst unprotected reefs did not. Moreover, rates of coral recruitment after the flood were greater in unprotected reefs close to mangroves than protected reefs distant to mangroves and unprotected reefs. We advocate that the ability of reserves to confer resilience can be further enhanced by considering the configuration of habitats within the seascape when prioritising areas for protection.
Approaches to Shoreline Management

AUTHOR
Spencer Rogers*

INSTITUTION
North Carolina Sea Grant,
5600 Marvin K. Moss Lane, Wilmington, North Carolina 28409, USA; rogerssp@uncw.edu

ABSTRACT
To be resilient, coastal communities must find ways to manage their changing shorelines. Management options fall into five categories: land management, planting vegetation, shoreline hardening, sand traps or beach nourishment. No solution works everywhere. Each option has advantages and potential adverse consequences. The tradeoffs for each option will be outlined.

Status, Issues, Trajectories and Future of the Coastal Ecosystem – Social-Economic Interaction for Pacific Island Nations

AUTHOR
Marcus Sheaves*

INSTITUTION
James Cook University,
Townsville, Queensland, Australia 4811; marcus.sheaves@jcu.edu.au

ABSTRACT
A variety of settings and climates has promoted the development of a diversity of coastal wetlands on tropical Pacific Islands – many with unique characteristics and flora and fauna. These tropical islands are typically small in size and undergoing rapid population growth. They are also typically exposure to cyclones, located on active plate margins so exposed to earthquakes and tsunamis, and are experiencing rapid sea-level change. Together these factors mean that Pacific Islands face a raft of challenges including food and water security, the need to develop sustainable livelihood options, protecting their shorelines from Tsunamis and storm surges, and the need for development to support financial viability and stability. In turn, these challenges interact with coastal wetlands in complex ways; they lead to a range of impacts on coastal wetlands but at the same time resilient and viable wetlandsprovide solutions to many of the issues. This leads to the perverse situation where coastal wetlands have been lost and damaged in pursuit of vital social-economic goals but need to be preserved to support other social-economic needs. I will discuss some of the unique features of these wetlands and the challenges they face, and how the viability and resilience of these often unique coastal wetlands can be maximized in the face of the complex of pressures they face.
Creating Value from Nutrient Rich Hog Waste using Algal Culture Technology

Philippe Soudant*, Luc Chauchat, Denis de la Broise, Gaspard Delebecq, Fabienne Le Grand

Laboratoire des Sciences de l'Environnement Marin (UMR 6539, LEMAR), IUEM/UBO, Technopole Brest Iroise, Plouzané, France; soudant@univ-brest.fr

ABSTRACT

Hog waste contains a large mineral load (N, P, K) allowing their usage in soil amendment by spreading. However, the field surface availability in EU regions/zones/areas with high livestock densities are too limited today to allow the valuation of all the pig manure by spreading and their high water content makes impossible their direct export out of the region/zone/area. In order to facilitate export of such material, a fraction of the insoluble inorganic and organic load can be collected with phase separator in a concentrated form. The leftover liquid effluent can also be treated (aerobic treatment, decanting, etc.). However, these processes are fairly expensive and do not allow an optimal valorization of the constituents, since part of the nitrogen is released to the atmosphere (N₂) and the organic matter is degraded without valuable output. Other options include generation of biogas through anaerobic digestion (AD) and resulting liquids can be used to culture microalgae. To achieve such environmental and economical targets, our objective was to carry out a culture of microalgae in mixotroph (phototroph x heterotroph) condition on hog waste/pig manure or AD effluent using a fed batch bioreactor. Such an approach is expected to concomitantly reduce Nitrate and Phosphate loads and create an algal biomass rich in proteins, lipids and bioactive compounds of value to animal feed and aquafeed.

The initial step was to screen microalgae species in hog waste supplemented culture media. Good growths were obtained with 7 strains of Chlorella vulgaris. Culture conditions (level of hog waste, carbohydrate supply, agitation) were then optimized on the selected strains. Eventually, the most robust and fastest growing strain was adapted to a 120 L pilot bioreactor and its homemade biomass control device based on chlorophyll content measurement. Mixotrophic conditions allowed production biomass concentration up to 5g/L. However, several contamination problems (bacteria and grazers) were regularly encountered and had to be solved prior to designing and scaling up the bioreactor. The on-going stage is to build a bioreactor (2 m³) that can fit within a 20 feet shipping container so that the bioreactor can be easily installed in a farm with or without AD processing of hog waste/pig manure. The system is dimensioned in order to treat hog waste/pig manure released from about 200 female pigs. Once this large-scale biomass production is managed, we will work on biomass concentration and storage before transportation to a downstream processing plant. At the final stage, the sanitary control and regulation conformity of the products will be checked with *ad hoc* agencies and then the gross compounds (protein, lipids) and the compounds with high added value (appetent, Omega 3) will be included in pet food, feed, and aquafeed and tested in nutritional trials.
Sustainability of Blue Economy by Resuscitating the Farming of Asian Cat Fish, *Clarias Batrachus* in Low Saline Waters

**AUTHOR**
Suguna Tummala*

**INSTITUTION**
Sri Venkateswara Veterinary University,
Fisheries Research Station: Undi (A.P), India, W.Godavari District – 534 199; tummala.suguna@gmail.com

**ABSTRACT**
Aquaculture in India has evolved into a promising activity in recent years with emphasis on improving the productivity through farming of diversified species. One of such, the Asian cat fish, *Clarias batrachus* is an indigenous high value food fish species which is on the verge of extinction. As the production of the Indian major carps had increased tremendously, the farmers are in search of alternate species. This has been a ray of hope for the farmers but due to lack of the feeding and breeding techniques the culture is not commercialized. The breeding, seed production, hatchery technology and culture methodologies are developed and standardized to uplift the socio economic standards of the society.

Approaches to Poverty Alleviations in Rural Coastal Communities in Malaysia – Attempts at Using the Blue Economy as Sustainable Income Generators

**AUTHOR**
Aileen Tan Shau-Hwai*

**INSTITUTION**
Centre for Marine & Coastal Studies, Universiti Sains Malaysia,
11800 Penang, Malaysia; aileen@usm.my

**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 USD0.50 per piece, and generate an additional USD1,000 per month on a part-time basis. The farmers are very innovative and they had converted oyster farming into a sustainable ecotourism activity, where lucrative income from tourism packages had 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 had become social entrepreneurs, where their business involving not only the fishing communities but also the women folks and children. Currently the oyster entrepreneurs had expand their activities offering volunteers from overseas to be involved in community engagement through providing tuitions to the children besides helping in the oyster farm. The oyster culture project has paved the way to improve the living standards of the local communities, which is not only society sustainable, but also economy and environment sustainable.
Developing Blue Economy Policies: Lessons Learned from North Carolina, the Caribbean, and Bangladesh

Tibor Vegh*, John Virdin
Nicholas Institute for Environmental Policy Solutions, Duke University, 2117 Campus Drive, Durham, North Carolina 27708, USA; tibor.vegh@duke.edu

ABSTRACT
A “blue economy” refers 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. The development of blue economy policies to ensure the alignment of economic and environmental trends 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 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 environment to economic growth is better included in decision making processes when this contribution is expressed in economic terms. Lessons learned through blue economy assessments in the U.S. State of North Carolina, the wider Caribbean region, and 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 development.

Ocean Science + Global Security = Ocean Security

Jonathan White*
Consortium for Ocean Leadership, 1201 New York Ave., NW, 4th Floor, Washington, DC 20005, USA; jwhite@oceanleadership.org

ABSTRACT
We are at a critical juncture in human history where continued population growth will put unprecedented strain on our ocean for basic needs and resources, at a time when many factors indicate our ocean is at risk in terms of its health and sustainability. This presentation will explore how our ocean specifically relates to many aspects of global security – national defense; homeland security; food, water, and energy security; economic prosperity; and human health and safety. Then it will discuss opportunities for ocean scientific research and development to provide solutions that enable a healthy, sustainable and productive ocean that can answer the basic needs of humanity and thus enhance global security. The essential requirement for international and inter-disciplinary partnerships among scientific, government, and industrial sectors will also be discussed. The global ocean science community can and must speak with a loud and harmonious voice to ensure that the paramount importance of ocean security to our future is well understood and widely embraced.
Beach Sand and the Coastal Economy

AUTHORS
Gregory L. Williams*, Kevin B. Conner

INSTITUTION
U.S. Army Corps of Engineers, Wilmington District,
69 Darlington Avenue, Wilmington, North Carolina 28403, USA; greg.l.williams@usace.army.mil

ABSTRACT
Tourism ranks as a top industry in the United States supporting nearly 10% of all jobs in the economy and accounts for $1.3 trillion of our economy. Among all tourism opportunities, beaches are the number one destination for Americans. In 2001 alone, recreational visits to beaches were estimated at nearly 2 billion, which surpassed the number of visits to all national and state parks and recreational areas combined. Similarly, beach tourism is the number one economy around the world contributing $6.3 trillion to the international GDP and providing 255 million jobs worldwide.

In recognition of this economic value and in support of the tremendous natural resource we have in the United States, many state and local governments have invested directly in beach nourishment, at a time when the U.S. Federal government appears to be stepping back from such work. Florida has a dedicated state funding source to support beaches. Local communities in North Carolina and Virginia have hired full time staff to help manage their beach resources, and politicians are also recognizing the importance of beaches and coastal-related tourism.

However, the most critical element in an effective, beach maintenance program is not necessarily funding, technical expertise or sheer will of local constituents, but availability of sand. In most cases, the primary mechanism of beach maintenance is beach nourishment, which involves dredging beach quality sand from an offshore or inlet site and pumping onto the beach. In many locations in the U.S., these sources of sand are dwindling and/or becoming less cost effective. Additionally, environmental policies designed to protect our fragile coastal environment and fishery further limit the availability of sand that can be dredged for beach nourishment. This presentation will examine the problem as it relates specifically to beaches in North Carolina and discuss possible strategies to address the problem.
Poster Presentation Abstracts
Physical Effects of Oyster Reef Rugosity:
Flume and Field Studies in a Low-Flow Environment

AUTHORS
Kerri Allen*, Lynn Leonard

INSTITUTION
Center for Marine Science,
5600 Marvin K. Moss Lane, Wilmington, North Carolina 28409, USA; kerri.allen@LIVE.com

ABSTRACT
This study examined the role of topographical oyster reef rugosity, a measure of reef roughness, on three-dimensional hydrodynamics in both field and laboratory settings in order to better understand potential effects on oyster condition, feeding, and growth. For this study, flow dynamics over natural and constructed intertidal Crassostrea virginica oyster reefs of varying rugosity were compared to scaled model reefs in a laboratory flume. Reef rugosity ranged from 0.80 (low) to 0.40 (high) and was reflective of natural and constructed reefs in the field area. Vertically integrated velocities over high rugosity reefs were higher than velocities measured over low rugosity reefs in both the field and laboratory, however, the field data were strongly influenced by local environmental variables such as wind. Flow over high rugosity reefs exhibited greater turbulence than flow over low rugosity reefs or flat surfaces. Roughness Reynolds Numbers ranged from 1 over control areas to as much as 226 (fully turbulent) over field reefs and turbulence intensities over high rugosity reefs were significantly greater than those over low rugosity reefs and flat surfaces. In flume simulations, turbulent boundary layer thickness increased with rugosity (3 – 4 cm over low rugosity reefs and 7 – 9 cm over high rugosity reefs). Shear stresses exerted on the bed ranged from 1358 Pa to 330697 Pa and were highest over high rugosity reefs in flume simulations. A similar relationship could not be discerned from the field data. Increased rugosity also resulted in greater variation in shear stress, with lower shear stresses (5618 Pa) over interstitial spaces that are likely to promote larval settling and anchoring. In contrast, higher shear stresses (57905 Pa) existed at peaks along reef which are likely to enhance downward transport towards the bed, therefore facilitating larval recruitment. Ideal characteristics for oyster growth are believed to include higher velocities, sweeps, downward bursts, and low-flow, low-shear quiescent zones and these features were observed in high rugosity reefs during this study.

Coastal Impacts of Hurricane Matthew on Masonboro Island, NC

AUTHORS
J.T. Backstrom*, D. Eulie, M. Dionesotes, S.M. Mills

INSTITUTION
Department of Environmental Sciences, University of North Carolina Wilmington,
601 S. College Road, Wilmington, NC 28403, USA; backstromj@uncw.edu

ABSTRACT
High magnitude storms such as hurricanes undoubtedly cause significant and potentially long-lasting morphological change along low-lying sandy coastlines. Hurricane Matthew made landfall near the North Carolina/South Carolina border as a Category 1 storm on Oct 8th 2016 after causing extensive damage across the Caribbean and the southeast coast of the USA. During the peak of the storm at landfall, wave heights offshore of NC reached 5.0 m with wind speeds of up to 22 m/s (50 mph). In order to capture potential coastal impacts attributed to Matthew, a number of RTK beach profile transects, coupled with grab samples and digital photos, were collected one week before and one week after landfall off Masonboro Island, a 13 km long low-lying undeveloped barrier island located in southeastern North Carolina. A comparison of RTK profiles and visual observations before and after the storm revealed significant dune overtopping, coupled with extensive back barrier accretion, overwash deposition, formation of temporary inlets, transport of boulder-size peat blocks and an overall landward translation of the central part of the island. With a predicted increase in sea level rise and potentially increasing hurricane activity due to climate change, this low elevation segment of Masonboro Island is expected to continue to migrate landward, conforming to standard barrier-island rollover processes associated with sea level rise.
Refining the DPSIR Framework

AUTHORS
C. Benham*, A. Diedrich, M. Sheaves

INSTITUTION
James Cook University,
Townsville Queensland, Australia 4811; claudia.benham@jcu.edu.au

ABSTRACT
The resilience of coastal ecosystems to anthropogenic change has been a major concern of scholars and environmental managers for at least two decades. In recent years, however, rapid port development associated with the energy and mining industries has led to new questions about the impacts of port expansion on the resilience of surrounding communities and environments, and the ability of current governance arrangements to manage impacts effectively. Given the role that revenues from fossil fuels and mining play in many national economies, the large number of developments either underway or in the planning stages worldwide, and the reluctance of governments to transition from these industries towards renewable energy technologies, at least in the short term, it is vital to understand the effects of mining and energy booms on communities and environments along the coast. Social-ecological systems (SES) frameworks provide powerful tools to enhance understanding of complex port environments, and in so doing, can guide improved governance practice. However, there is a need to refine these frameworks to reflect emergent ecosystem properties and developments in scientific understanding. This paper applies an established SES framework – the Driver-Pressure-State-Impact-Response (DPSIR) framework – to a large industrial port development in the Great Barrier Reef World Heritage Area, Australia. Drawing on insights from the disciplines of ecology and geography, we demonstrate how this framework can be updated to reflect empirical realities of complex systems in a ports context.

Oyster Reproduction is Compromised by Acidification Experienced Seasonally in Coastal Regions

AUTHORS
Myrina Boulais, Kyle John Chenevert, Ashley Taylor Demey, Elizabeth S. Darrow, Madison Raine Robison, John Park Roberts, Aswani Volety*

INSTITUTION
University of North Carolina Wilmington,
601 S. College Road, Wilmington, NC 28403, USA; myrina.boulais@gmail.com

ABSTRACT
Atmospheric carbon dioxide (CO₂) concentrations have been rising during the past century leading to increase in oceanic dissolved inorganic carbon and ocean acidification (OA). Recent observations demonstrate that some coastal and estuarine habitats already experience seasonal pH variability that vastly exceeds the magnitude of long-term projections in open ocean regions (~0.2 units). Estuarine waters are characterized by extreme fluctuations in pH levels, from the values of 8.2 down to value lower than pH 7, and periods of low pH can persist for weeks during spring, summer and fall.

Estuarine ecosystems provide habitat to ecologically and economically important marine species such as the Eastern oysters (Crassostrea virginica). The sustainability of oyster populations depends upon gametogenesis and reproductive success – activities that coincide with periods of low pH occurrence in estuaries.

Oysters were exposed to moderate (pH 7.5, pCO₂ 2260 µatm) and severe acidification (pH 7.1, pCO₂ 5584 µatm; and 6.7, pCO₂ 18480 µatm) for 5 weeks during gametogenesis (n=117). Exposure at pH 7.1 and 6.7 resulted in a delay and inhibition of gamete development, respectively. Oogenesis appeared to be more sensitive compared to spermatogenesis. However, Eastern oyster reproduction was resilient to moderate acidification projected for the near-future. In the context of projected climate change exacerbating seasonal acidification, OA of coastal habitats could represent a significant bottleneck for oyster reproduction which may have profound negative implications on the natural oyster population.
Rainfall, Temperature and Sea Level Effects on Inflow and Infiltration in Wastewater Collection Systems in Coastal North Carolina

AUTHORS
Lawrence B. Cahoon*, Marc H. Hanke

INSTITUTION
Department of Biology and Marine Biology, UNC Wilmington,
Wilmington, North Carolina 28403, USA; cahoon@uncw.edu, Honors College,
University of Houston, Houston, Texas, 77204

ABSTRACT
Wastewater collection and treatment systems have not received as much attention as other forms of public infrastructure, even though they are vital to public health, economic growth, and environmental quality. Inflow and infiltration (I&I), the intrusion of extraneous waters into collection systems, are among potentially widespread problems facing central sewage collection and treatment systems, posing risks of sanitary system overflows (SSOs), system degradation, and water quality impairment, but remain poorly quantified. Whole-system analyses of I&I were conducted by regression analyses of system flow responses to rainfall and temperature for 93 wastewater treatment plants (WWTPs) in 23 counties in eastern North Carolina, USA, a coastal region with high water tables and generally higher rainfalls than the continental interior. Statistically significant flow responses to rainfall were found in 92% of these systems, with 2-year average I&I values exceeding 10% of rainless system flow in over 40% of them. The effects of rainfall have region-wide implications for sewer system performance and environmental management. The positive association between rainfall and excessive I&I parallels the effects of storm water runoff on water quality because excessive I&I can also drive sanitary system overflows (SSOs), confounding water quality protection efforts. Temperature effects on I&I were also broadly significant and suggested seasonal impacts of groundwater elevation and/or summer tourism. Sea level effects were significant in 18 of 19 communities located directly on estuarine or ocean coastlines, indicating sea level-mediated effects on groundwater levels and I&I as well. Climate change will magnify all these problems.

SECOORA: Southeast Coastal Ocean Observing Regional Association

AUTHORS
Jennifer Dorton*, Abbey Wakely, Debra Hernandez

INSTITUTION
SECOORA,
Charleston, South Carolina 29422, USA; dortonj@uncw.edu

ABSTRACT
The Southeast Coastal Ocean Observing Regional Association (SECOORA) is one of 11 Regional Associations that partner with the NOAA led Integrated Ocean Observing System, U.S. IOOS® to provide information about marine weather and oceanographic conditions in U.S. coastal waters and the Great Lakes. SECOORA is the coastal ocean observing system for North Carolina, South Carolina, Georgia and Florida and encompasses a footprint that spans the eastern side of Gulf of Mexico to South Atlantic Bight. Its mission is to observe, understand, and increase awareness of our coastal ocean; promoting knowledge, economic and environmental health through strong regional partnerships. Over 80% of SECOORA's annual budget supports observing assets, model development, data management and communication, and development of tools that meet the needs of targeted user groups in the southeast U.S. Each endeavor is linked to one of the four SECOORA thematic areas: Marine Operations; Coastal Hazards; Ecosystems, Water Quality and Living Marine Resources; and Climate Variability. The data and information provided by SECOORA is used by a variety of stakeholders to promote safe and efficient maritime transportation and recreational boating, understand the region's complex ecosystems, understand climate variability and its effect on our oceans, and meet the needs of people who live and work along the coast of the Southeast U.S.
Development and Implementation of the GIS Based North Carolina Shellfish Siting and Suitability Tool

AUTHORS
Sarah Eure*, Troy Alphin, Eman Ghoneim, Martin Posey

INSTITUTION
Benthic Ecology Laboratory, Center for Marine Science, University of North Carolina Wilmington, 5600 Marvin K. Moss Lane, Wilmington, North Carolina 28403, USA; spe5129@uncw.edu

ABSTRACT
This GIS based platform is a decision support tool to help reduce user conflicts by providing public data on select water quality parameters, habitat, and conditions relevant to shellfish aquaculture. The tool is designed to provide information to help potential shellfish growers determine the site feasibility and help them identify potential risks and long-term suitability for particular areas. This project is a data visualization tool providing information on specific areas and water bodies related to shellfish aquaculture including salinity, bottom type, depth, shellfish growing area classifications, boat access and surrounding land cover/use and current shellfish growing operations. This tool is not intended to replace actual site visits, but should be used to identify likely areas to place operations and to highlight other public uses in the same region.

Juvenile Permit Size-Class Structure and Population Connectivity

AUTHORS
Eden Garcia*1, Martin Posey1

INSTITUTION
1Department of Biology and Marine Biology, University of North Carolina Wilmington, 601 S. College Road, Wilmington, NC 28403-5915, USA; erg8051@uncw.edu

ABSTRACT
Knowledge about the biology and ecology of Permit fishes (Trachinotus falcatus) is very limited. Permits are key species targeted by the sport fishing industry in the Western Atlantic region, contributing greatly to the local economy of coastal communities such as Belize, Mexico and Florida. Understanding the abundance and size-class structure of juvenile Permits is vital for fisheries managers and the sport fishing industry. Nine sites were assessed for abundance and their size-class structure in the Turneffe atoll in Belize using a 15 x 1.5 m x 3mm mesh size beach seine during the years 2014 – 2017. A total of 1,477 juvenile Permits ranging from 5 – 180 mm in Standard Length (SL) were caught during those years, with the highest abundance observed in the summer of 2016 with a total catch of 608. Overall, Calabash Caye, South of Calabash, and the Grassy Range-Cockroach Caye sites had the greatest abundance of juvenile Permits. No juvenile Permits were caught in sites with mangrove shorelines. Significant differences were observed in size class structures among some of the sites and also within sites over the years. A total of 205 fin clips were also collected to assess regional connectivity of the Permit fish population in the Western Atlantic region using the DLOOP and Cytochrome-b mitochondrial markers. Fin clip samples were collected from Belize (Turneffe atoll and near coastal islands in the north), Mexico (Ixcalak and Ascension Bay), Florida Atlantic, and North Carolina.
Photochemical Alterations in Gas Phase and Surface Water Ethanol Concentrations

AUTHORS
R.J. Kieber, J.P. Powell, L. Foley, R.N. Mead, J.D. Willey, G.B. Avery

INSTITUTION
Center for Marine Science, University of North Carolina Wilmington, 5600 Marvin Moss Lane, Wilmington, North Carolina 28403, USA; skrabals@uncw.edu

ABSTRACT
Renewable fuels have been identified as an alternative to petroleum based fuels in the ever changing energy landscape. Recently, ethanol production has dramatically increased to provide a renewable fuel for the transportation sector however there are fundamental questions regarding the occurrence and fate of the biofuel. Diurnal variations in gas phase and surface water concentrations of ethanol and acetaldehyde were investigated at several locations near the University of North Carolina Wilmington, USA campus. There were distinct diurnal oscillations in gas phase concentrations with maxima occurring in late afternoon near the period of peak solar intensity suggesting that photochemical production is an important process in the cycling of these analytes in the troposphere. The rapid decrease in concentrations after the mid-day maximum suggests that there is also an atmospheric photochemical sink for both analytes most likely involving photoproduced hydroxyl radicals. Ethanol concentrations in the surface microlayer taken at the same time as gas phase samples had a very similar profile with time suggesting radical mediated photochemical processes, in addition to atmospheric deposition, play a role in the aqueous phase cycling of both analytes. In controlled laboratory experiments, the concentration of ethanol and acetaldehyde increased significantly in flasks containing fresh surface water exposed to simulated sunlight for 6 hours underscoring the importance of in situ photochemical processes.

Effects of Causeway Construction on Vegetation and Sedimentation in North Carolina Tidal Marshes

AUTHORS
Aaron Knowlton*, Lynn Leonard, Narcisa Pricope, Devon Eulie

INSTITUTION
Department of Earth and Ocean Sciences, University of North Carolina Wilmington, 601 S. College Road, Wilmington, North Carolina 28403, USA; adk5749@uncw.edu

ABSTRACT
Causeways, especially those constructed to facilitate transportation across low lying tidal marshes, are known to affect tidal exchanges and thereby potentially influence geological and biological processes in these ecosystems. While these impacts have been documented in several expansive marsh systems with large tidal ranges, the extent of these impacts in smaller tidal creek watersheds is less understood. This study examined how the presence, absence, and removal of small causeways affected sedimentological processes and vegetation characteristics in two small tidal creek watersheds in Wilmington, NC. Surficial deposition rates, determined using petri-dish sediment traps, indicate that mean deposition landward of a small causeway (1.64 mg cm⁻² day⁻¹) is significantly lower (p<0.05) than mean deposition seaward of the causeway (2.05 mg cm⁻² day⁻¹). When compared to a similar marsh watershed without a causeway, the natural systems exhibited no difference in mean deposition on either side of an implied causeway (p=0.38). Sediment bulk density characteristics also indicate a causeway effect with the non-causewayed system exhibiting a gradual landward decrease in density and the causewayed system showing abrupt changes adjacent to the causeway. Partial causeway removal in one of these systems in 2006 also provided the opportunity to evaluate how the marsh canopy responded to causeway removal. Using Juncus roemerianus and Spartina alterniflora as a proxy for changes in tidal exchange, spectroradiometer data and aerial imagery available in 2006 and 2016 will be used to quantify changes in canopy coverage subsequent to causeway removal. Although this study is ongoing, the preliminary results indicate that small causeways, similar to their larger counterparts, significantly affect the rate and characteristics of sediment delivered to landward marshes and also affect tidal exchanges that lead to changes in vegetation characteristics.
The Coastal Ocean Research and Observing Program (CORMP): Meeting User Needs in the Carolinas

AUTHORS
Lynn Leonard*, Jennifer Dorton

INSTITUTION
Department of Earth and Ocean Sciences and Center for Marine Science, University of North Carolina Wilmington, 601 S. College Road, Wilmington, North Carolina 28403, USA; lynnl@uncw.edu

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 (NOAA) Integrated Ocean Observing System (IOOS) and in partnership with the Southeast Coastal Ocean Observing Regional Association (SECOORA), 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 and, with additional non-real time data, periodic water quality data, and archived AUV data, incorporated in the data management system. Since 2010, UNCW has leveraged additional support from private sector and public agency partners to sustain existing observing platforms, data management activities, and outreach and education. All information and products are easily accessible through a web portal interface at www.carolinascroos.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. CORMP stakeholders include: US Army Corps of Engineers (USACE), NOAA's National Weather Service (NWS), National Data Buoy Center (NDBC), National Estuarine Research Reserve System (NERRS), the Lower Cape Fear River Program (LCFRP), US Coast Guard (USCG), and Camp LeJeune Marine Corps Base. These partners are a significant component of the observing enterprise as they add value to the information collected by the observing array. The observing network also supports several externally funded applications including: the USC/NERRS Beach Water Quality Monitoring in South Carolina; the USACE Model Evaluation and Diagnostics System; and, data products in support of environmental detection efforts (NCDENR, LCFRP). This presentation explores some of these collaborative efforts.

Testsite AKVAMARIN – Centre for Innovation in Aquaculture and Marine Biomass Use in West Sweden

AUTHORS
Susanne Lindegarth*, Kristina Sundell1, Ingrid Undeland2, Torsten Wik2, Friederike Ziegler3, Mia Dahlström3

INSTITUTION
1University of Gothenburg, 2Chalmers University of Technology, 3RISE Research Institutes of Sweden

ABSTRACT
The west coast of Sweden is characterized by a diverse marine environment and comprehensive research in marine biology, biotechnology and food science. An extensive fishing and fish processing industry, landing ports and a growing number of entrepreneurs and businesses in aquaculture is also present in the region. Value-adding and resource efficient use of fish, shellfish and algae are important parts of the development of a marine circular economy. Testsite AKVAMARIN is a new initiative bringing together test facilities and competences from aquaculture, fisheries, food industry, technology development, research and public enterprises. Testsite AKVAMARIN, with its main center at Kristineberg Center for marine research and innovation in the township of Lysekil, links existing infrastructures and offers a wide range of possibilities for cultivation of organisms and biotechnological processing of marine raw materials. Testsite AKVAMARIN is a partnership between the University of Gothenburg, Chalmers University of Technology and RISE Research Institutes of Sweden
Impacts of Deepwater Horizon Oil and Dispersants on Various Life Stages of Oysters Crassostrea Virginica

AUTHORS

INSTITUTION
Center for Marine Science, University of North Carolina Wilmington, 5600 Marvin Moss Lane, Wilmington, North Carolina 28403, USA; lohan@uncw.edu

ABSTRACT
The 2010 Deepwater Horizon Oil Spill released oil into the Gulf of Mexico. Many of the polycyclic aromatic hydrocarbons and other oil constituents found in oil are toxic. The oil spill, which continued for three months and which resulted in extensive exposure of nearshore habitats well beyond the period when oil was being discharged from the wellhead, coincided with the spawning season of the Eastern oyster (Crassostrea virginica), an environmentally and commercially important shellfish species in the Gulf of Mexico. The long planktonic nature (14 to 21 days) of oyster larvae, sedentary nature of adult oysters, high filtration rates and their micro algal/particulate diet make them vulnerable to acute exposure to contaminants both in solution and bound to suspended sediment, and adsorbed onto algal and other particles. We conducted a series of experiments to examine the effects of the Deepwater Horizon (DWH) oil and dispersants on various life stages of oysters ranging from gametes to adults. Oysters were exposed to water accommodated fractions of oil (with and without dispersant), sediment elutriates, contaminated sediment, and contaminated algae. Fertilization success, morphological development, growth, survival and settlement success after these exposures were measured. Fertilization success decreased, developmental abnormalities increased, and larval growth, survival and settlement, and reproductive development of adults decreased in a dose-dependent manner relative to oil exposure and exposure duration. Results suggest that exposure of various life stages of oysters to oil and/or dispersants will have a negative impact on overall growth and survival and may have implications on the population structure.

An Examination of Living Shoreline Design in the Cape Fear River Estuary, North Carolina

AUTHORS
Frank Marshall*, Mark Moore, Lynn Leonard

INSTITUTION
Department of Earth and Ocean Sciences and Center for Marine Science, University of North Carolina Wilmington, 601 S. College Road, Wilmington, North Carolina 28403, USA; fmm8426@uncw.edu

ABSTRACT
As anthropogenic activities continue to increase in estuarine environments, so does the need to find management approaches that minimize the lost of valuable coastal wetlands. One such approach is the use of living shorelines, a conservation strategy employed to stabilize the edge of a coastal wetland and provide benefits to the local habitat. Living shorelines typically make use of natural features such as oyster reefs and/or salt marsh grass to attenuate erosive wave energy and created conditions conducive to sediment deposition and vegetation growth. In contrast to conventional erosional control structures like seawalls and bulkheads, living shorelines provide important ecosystem services (e.g. water filtration, flood mitigation, fish nurseries and habitat, carbon sequestration) and can be constructed for less cost. While numerous studies have addressed the ecosystem impacts associated with living shoreline construction, fewer efforts have quantified the physical changes resulting from their construction. In a previous study, oyster reef and marsh grass models were constructed and deployed along the open water edge of an eroding Spartina alterniflora marsh in Wilmington, North Carolina. The goal was to determine which shoreline type, if any, enhanced sediment trapping. The results indicated that both oyster and grass significantly decreased flow velocity but that only oyster reefs led to increased sediment deposition. Based on these results, the current study seeks to understand how the combined used of oyster + grass, the design most frequently used in southeastern North Carolina, influences wave attenuation and resultant deposition. This presentation will describe the results of recent field experiments and discuss how changes in shoreline design (i.e. reef height and plant density) may affect the physical function of a living shoreline.
Restoring Oysters to Urban Estuaries: The Importance of Genotype and Habitat Quality for Eastern Oysters Near New York City

AUTHORS
Katherine McFarland*, Matthew Hare

INSTITUTION
Department of Natural Resources,
Cornell University, Ithaca, New York, 14850, USA; kmm447@cornell.edu

ABSTRACT
Resource managers face increasing challenges in restoring coastal resilience due to current and predicted effects of climate change. Oyster restoration, in particular, faces threats from alterations in precipitation, warming water temperatures, and urbanization of coastlines that dramatically change salinity patterns, foster the proliferation disease, and disrupt habitat connectivity, respectively. New York coastal waters, once a booming oyster fishery, are now nearly void of live oyster reefs. However, recent surveys have documented substantial remnant populations of adult oysters in the upper estuarine zone of the Hudson River Estuary (HRE) near Tarrytown, NY. This portion of the estuary frequently has prolonged periods with salinities below 5 ppt, near the lower threshold typically reported for *Crassostrea virginica*. Growth, survival, and reproduction of experimental oyster outplants were monitored across an environmental gradient in an urbanized estuary, the HRE in New York City, to evaluate habitat suitability on an estuarinescale. This work demonstrates that although extreme wet years result in high mortality of hatchery outplants, reproductive maturity was reached with advanced gametogenesis observed under prolonged salinity depression (<4 ppt; February – July 2017). Wild recruitment was consistent over 5 years near the remnant population and for wild spat deployed in experimental cages at one low salinity site, survival rates over the first year of growth were 83% compared to 61% for hatchery outplants. It is thus possible that nearby remnant wild populations are locally adapted to low salinity conditions and capable of seeding restored settlement substrate. These results suggest that the remnant Tarrytown oyster population is a robust, self-sustaining population and further work is needed to test its performance in lower reaches of the estuary. This paper aims to assess habitat suitability across an estuarine gradient and address the feasibility of focusing efforts on substrate restoration expanding southward from the existing remnant Hudson River populations.
ABSTRACT
A state-funded project to analyze a suite of metal and organic contaminants in oyster tissues and ambient sediments was carried out nearly exclusively by over 10 undergraduates at the University of North Carolina Wilmington. Concentrations of various trace metals (most notably arsenic, copper, mercury, and zinc) and organic contaminants (polycyclic aromatic hydrocarbons and the antibacterial, triclosan) have been determined in oyster tissues and adjacent sediments in New Hanover and Brunswick counties, southeastern North Carolina. Trace metals that exceeded national median levels at multiple sites in this study included arsenic, copper, and zinc. Elevated levels of arsenic (exceeding the national median and, often, the national 85th percentiles) in oyster tissues are characteristic of much of the southeastern United States; these elevations are attributed to high natural background levels in the underlying bedrock and sediments as well as historical contamination by arsenic-containing agricultural pesticides. Another metal of national concern is mercury; however, concentrations of this metal were mostly at the national median for oyster tissue. Polycyclic aromatic hydrocarbons (PAHs) barely exceeded or were near the national median at only 3 sites, 2 in Lockwood Folly estuary, Brunswick County and 1 at Bradley Creek, New Hanover County. Concentrations at the remaining sites were 4 to >10 times less than the national median. Triclosan, an antibacterial compound used in many consumer products, was found in oyster tissues and sediments at the 4 sites at which it was examined. Oyster tissues contained triclosan at levels 2 to 43 times as high as adjacent sediments, indicating its bioaccumulation potential. Levels of metals and PAHs in oyster tissues are consistently elevated near more urbanized areas but are unlikely to be at levels harmful for human consumption.
Modeling Vulnerability to Inland and Coastal Inundation in North Carolina Using High-Resolution Finished Floor Elevations

Lauren Rosul*, Narcisa Pricope

Department of Earth and Ocean Sciences, University of North Carolina Wilmington, 601 S. College Road, Wilmington, North Carolina 28403, USA; lmr1106@uncw

The coastal environment is densely populated and particularly vulnerable to threats associated with climate change (McGranahan et al., 2007). In the US millions of people residing in inland and coastal areas will be affected by inundation related to sea-level rise (SLR) in the coming decades (Curtis & Schneider, 2011). With such a large population at risk, the identification of social and physical aspects of a population that are most vulnerable to a potential hazard is essential (Frazier et al., 2014). The development of vulnerability assessments have gained recognition as a useful tool to identify vulnerable populations and has been integrated into mitigation and hazard adaptation planning (Cutter et al., 2003; Rygel et al., 2006; Frazier et al., 2014). However, most of the vulnerability assessments to date have been conducted at the county scale, thereby hindering the effectiveness of mitigation and adaptation in real-world settings, which are often socially and physically diverse. The objective of this study is to develop a model that measures population vulnerability to inland and coastal inundation at the block-group level using a variety of socio-economic variables and high-resolution finished floor elevations, allowing for more accurate identification of areas with potentially vulnerable populations.

Nuisance Flooding: A National to Locally Significant Issue

Roger D. Shew*

Department of Earth and Ocean Sciences, University of North Carolina Wilmington, 601 S. College Road, Wilmington, North Carolina 28403, USA; shewr@uncw

The National Oceanic and Atmospheric Administration (NOAA) has identified nuisance flooding as “high tide flooding that leads to public inconveniences such as road closures.” However, coastal flooding is more than an inconvenience with coastal infrastructure increasingly in jeopardy. The East Coast is one of the “hotspots” for nuisance flooding and Wilmington, NC and Charleston, SC are two of the highest impact areas with even greater projected incidences before mid-century. Wilmington currently has over 24 nuisance flooding events annually, but the projection is for over 100 events by 2030. Sea level rise and local subsidence are key to the increased occurrences of inundation but other factors, e.g. slowing of the Gulf Stream in the Fall, are suggested to be controls, too. Coastal resiliency studies have already indicated that manholes, water treatment plants, gravity fed sewer lines, and pump stations are at risk with 10 year to 100 year storm events. Sea level rise and nuisance flooding, coupled with increasing development along the Cape Fear River and Coastal Zone will lead to even greater damages including degraded infrastructure, damaged roads, road and business closures, changes in wetlands and low-lying conservation areas, saltwater intrusion, and even health risks. Sea level rise, nuisance flooding, and storm inundation maps illustrate the current issues in selected areas of the Lower Cape Fear River watershed.
Linking Peoples Knowledge, Values and Attitudes Towards Marine Ecosystems

AUTHOR
Bernadette Snow*

INSTITUTION
Nelson Mandela University Development Studies,
PO Box 77000 Port Elizabeth Eastern Cape 6031, South Africa; bernadette.snow@nmmu.ac.za

ABSTRACT
Marine, coastal and ocean development has gained impetus around the globe and in particular along Africa's coastal states. In South Africa Operation Phakisa: Unlocking the blue economy has turned attention towards utilising marine and maritime resources and at the same time attention is being drawn to building resilience addressing wicked problems e.g. climate change, poverty alleviation and governance structures. A socio-ecological systems framework approach was adopted to explore marine and coastal socio-ecological systems in Algoa Bay, situated in the Eastern Cape, South Africa – a Bay with a rich history steeped in culture and diversity (biological and cultural).
To understand how people within the Nelson Mandela Bay Municipality value the marine and coastal environment, their knowledge of phytoplankton and services provided, governance knowledge, attitudes towards the future of the socio-environment landscape and value positions that would identify pro-environmental behavior of the communities surveyed. Data was collected using face to face administered questionnaires allowing for both quantitative and qualitative data to be collected. Language was used as a proxy for culture. Attitude towards the future showed a general pessimistic view towards the environment and society. Most viewed the ecosystem as being in crisis, that there will be an increase in power struggles and inequality and that society will transform with a general breakdown in traditional systems. Area and age seemed to be determinants in relation to how the respondents answered the futures questions.

Oceans Fuel Our Brains and Hearts: Role of Ocean Primary Production in Sustaining the Healthy Demand of Long Chain Omega 3 Polyunsaturated Fatty Acids

AUTHORS

INSTITUTION
Laboratoire des Sciences de l’Environnement Marin (UMR 6539, LEMAR), IUEM/UBO, Technopole Brest Iroise, Plouzané, France; soudant@univ-brest.fr

ABSTRACT
The steadily 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.
CISME: A New, Diver-Operated Underwater Respirometer for Measuring Coral Metabolism *In Situ*

**AUTHORS**
Alina M. Szmant,* Robert F. Whitehead

**INSTITUTION**
Center for Marine Science, University of North Carolina Wilmington, 5600 Marvin K. Moss Lane, Wilmington, North Carolina 28403, USA; szmanta@uncw.edu & whiteheadrf@uncw.edu

**ABSTRACT**
A diver-portable, underwater respirometer, named CISME (Community In Situ MEtabolism, pronounced ‘kiss-me’ to reflect the gentle interaction between the instrument and the substrate), was developed to non-destructively measure metabolic rates of corals, algae and other low-relief benthic substrates *in situ* under ambient conditions. The value of CISME is to be able to rapidly assess the “vital signs” and metabolic health of corals and key reef substrate types. CISME measures oxygen fluxes and delta pH during short incubations in which water flow and light levels are user controlled. Respiration (R) and photosynthesis (P) are calculated from these concentration changes. Sample loops collect water samples for total alkalinity (TA) to measure calcification rate (CA). R and P can be calculated both based on O2 and CO2 fluxes, from which RQs and PQs can be calculated. The sample loop can also be used to experimentally introduce substances that might affect coral metabolism (e.g. acidified seawater for OA studies). CISME was used to measure seasonal changes in the metabolic rates of 40 tagged colonies of the Caribbean coral *Orcibella faveolata* on two coral reefs in La Parguera, PR. Measurements were repeated four times over an annual cycle. Results show elevated R during late summer, but no change in P, and thus lower P/R ratios during the late summer. P, CA and P/R ratios were ≥ than published laboratory measured rates, suggesting that *in situ* conditions were better than those provided in land-based seawater systems. CISME represents a valuable new technology that will help expand the scope of *in situ* physiological ecology research. Among the technical innovations of CISME is control of the instrument by an underwater tablet connected by WiFi which displays a real-time strip chart of the run. We have several CISME instruments available for testing by qualified diving scientists.

Importance of Estuarine Habitats for Juvenile Finfish

**AUTHORS**

**INSTITUTION**
Benthic Ecology Laboratory, Center for Marine Science, University of North Carolina Wilmington, 5600 Marvin K. Moss Lane, Wilmington, North Carolina 28403, USA; hrt2805@uncw.edu

**ABSTRACT**
Starting in 2016, the North Carolina Division of Marine Fisheries (NCDMF) and the University of North Carolina Wilmington (UNCW), initiated a novel partnership for investigation of fisheries issues of interest to the state of North Carolina. This program focuses on the mentoring of graduate and undergraduate students to address issues related to management of key coastal species critical to the maintenance of healthy coastal ecosystems and supporting recreational fisheries. Study design and sampling approach are coordinated through regular meetings among subject matter experts within NCDMF and UNCW and annual reviews of management needs. Student led studies supplement ongoing NCDMF monitoring efforts to address timely coastal issues. Ongoing efforts are gathering needed data on juvenile life history stages of highly valuable managed species providing information on data gaps and utilization of critical estuarine habitat areas for juvenile finfish, including Red Drum (*Sciaenops ocellatus*), Black Drum (*Pogonias cromis*), Spot (*Leiostomus xanthurus*), Croaker (*Micropogonias undulatus*), and Sheepshead (*Archosargus probatocephalus*). Distribution and relative abundance of early juveniles and sub-adults as well as major prey species are being evaluated in a river dominated estuary to understand the role that shallow water (<1m) habitats, including marsh channels, marsh edge, woody debris and unstructured areas, play in the movement of juveniles across the estuarine gradient.
Vegetation Survey and Shoreline Change Analysis of Battery Island, NC

AUTHORS
Allison Weide*, Emma York

INSTITUTION
Department of Environmental Sciences, University of North Carolina Wilmington, 601 S. College Road, Wilmington, North Carolina 28403, USA; adw4590@uncw.edu

ABSTRACT
Battery Island, located in the mouth of the Cape Fear River, North Carolina, is an important breeding area for a variety of tree-nesting shorebirds including white ibis (*Eudocimus albus*). Nesting on the island occurs in red cedar (*Juniperus virginiana*), yaupon (*Ilex vomitoria*), and several shrub species. Shoreline erosion is a potential threat to the nesting habitat on Battery Island, although the extent of erosion over time has not previously been quantified. The objectives of this study were to survey the vegetative community in the nesting area and assess the extent of shoreline erosion. Our results indicate that low recruitment of red cedar and ongoing shoreline erosion both have the potential to impact the nesting area. Between 2008 and 2017, the shoreline adjacent to the nesting area eroded an average of 2.2 meters overall. Projecting the 2008-2017 shoreline change rate fifteen years into the future indicates that erosion will continue to occur along the northwestern side of the nesting area. These data will be useful in developing a plan to mitigate shoreline erosion and sustain the trees necessary for nesting on Battery Island.

Cape Fear River Partnership: A 5-Year Implementation Plan

AUTHOR
Dawn York*

INSTITUTION
The Cape Fear River Partnership and Dial Cordy and Associates, Wilmington, North Carolina 28401, USA; dyork@dialcordy.com

ABSTRACT
The mission of the Cape Fear River Partnership is to restore and demonstrate the value of robust, productive, and self-sustaining stocks of migratory fish in the Cape Fear River. The vision of the Partnership is a healthy Cape Fear River for fish and people. A 5-year implementation plan has been developed to carry out feasible actions to restore migratory fish populations in the Cape Fear River Basin.
Global Marine Science Summit

Coastal Resilience and the Blue Economy