The wave of change starts with a ripple

OCEAN VISIONS 2019

Program Book

Georgia Tech

Smithsonian MarineGEO

Scripps Institution of Oceanography

Stanford Center for Ocean Solutions

MBARI Monterey Bay Aquarium Research Institute

Monterey Bay Aquarium

Georgia Aquarium

Stanford Woods Institute for the Environment

Skidaway Institute of Oceanography University of Georgia

University of Georgia

Birch Aquarium at Scripps Institution of Oceanography UC San Diego

Scripps center for Climate Change Impacts and Adaptation

http://www.OceanVisions.org/OceanVisions19

The **OceanVisions2019 - Climate Summit** "**Successes in resilience, adaptation, mitigation, and sustainability**" is co-organized by researchers at Georgia Tech, Stanford University, Scripps Institution of Oceanography, and the Smithsonian Institution in coordination with the IOC-UNESCO, the Ocean Conservancy, COMPASS and Georgia Aquarium. The goal is to highlight ocean-based science and engineering successes in the areas of resilience, adaptation, mitigation and sustainability and promote scalable solutions across human, climate and ecological dimensions.

Meeting is held on the Georgia Tech Campus, April 1-4, 2019

Meeting Coordinator
Susan Ryan
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OceanVisions2019 Organizing Committee

http://oceanvisions.org/ocean-visions-initiative

Emanuele Di Lorenzo
Professor & Director
Program in Ocean Science and Engineering
Georgia Institute of Technology
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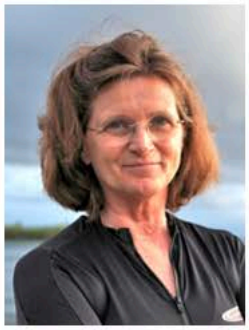

Nancy Knowlton
U.S. National Academy of Sciences
Sant Chair of Marine Science
National Museum of Natural History, Smithsonian
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Fiorenza Micheli
David and Lucile Packard Professor, Co-director
Center for Ocean Solutions
Stanford University
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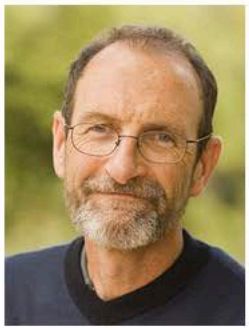

Christopher Field
Melvin and Joan Lane Professor
Director of Stanford Woods Institute for the Environment
Stanford University
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Mark Merrifield
Presidential Chair Professor & Director
Center for Climate Change, Impacts and Adapta
Scripps Institution of Oceanography
Read More

Martin Gray
Senior Vice President & Chief Marketing Officer
Georgia Aquarium
Read More

OceanVisions2019 Venues

http://oceanvisions.org/oceanvisions19/logistics

The website contains most of the information on logistics and transportation. Below is a list of the main venues followed by a map of the Georgia Tech Campus. You can Google on your mobile devices all these venues for walking and driving directions.

Caddell Building, Georgia Tech

Main Conference Room

280 Ferst Dr NW, Atlanta, GA 30313

All Sessions April 1-4

Clough Commons Building, Georgia Tech

Rooftop Reception

266 4th St NW, Atlanta, GA 30313

Monday, April 1, 5:30 PM - 8:00 PM

Georgia Aquarium, Ballroom Entrance

Ocean Solutions & Startups Event and Reception

246 Ivan Allen Jr Blvd NW, Atlanta, GA 30313

Tuesday, April 2, 6:00 PM - 9:00 PM

Ford Environmental & Technology Building, Georgia Tech

Poster Session

311 Ferst Dr NW, Atlanta, GA 30332

Wednesday, April 3, 5:30 PM - 7:00 PM

Georgia Tech Campus Map

http://map.gatech.edu/

Directions from Caddell Building to Georgia Aquarium

https://goo.gl/maps/C1ubcuKBdx82

Walking Directions
10-15min walk
https://goo.gl/maps/C1ubcuKBdx82

OceanVisions2019 Program

http://oceanvisions.org/oceanvisions19/program

Monday, April 1			**Opening Ceremony and Tethys Award**	**9:20 AM - 12:00 PM, Caddell Building**
8:30 AM			Registration Opens	Atrium of Caddell Building (pickup name tag)
9:20 AM	-	9:30 AM	Organizers	Welcome and Logistics
9:30 AM	-	9:45 AM	**Wayne Clough** Secretary Emeritus Smithsonian Institution, President Emeritus Georgia Tech	Opening Remarks for OceanVisions2019
9:45 AM	-	10:00 AM	**Nancy Knowlton** Smithsonian Institution **Emanuele Di Lorenzo** Georgia Tech	The Ocean Visions Group and Joint Initiative
10:00 AM	-	11:00 AM	**Nancy Baron** (COMPASS)	Journalist & Scientist Panel: **Tell Me More: How do you envision ocean solutions for the next generation?** **Dr. Chris Field (Stanford University)** — **Kendra Pierre-Louis (NY Times)** **Dr. A.R. Siders (Harvard University)** — **John Sutter (CNN)** **Dr. Kim Cobb (Georgia Tech)** — **Laura Helmuth (Washington Post)** **Dr. Fanny Douvere (UNESCO)** — **Christopher Joyce (NPR)** **Dr. Sara Cooley (Ocean Conservancy)** — **David Malakoff (Science)**
11:00 AM	-	11:10 AM	Coffee Break	
11:10 AM	-	11:25 AM	**Monika Breuch-Moritz** IOC Vice-Officers, UNESCO, and Past President of Federal Maritime and Hydrographic Agency, Germany	The United Nation Ocean Decade for Science
11:25 AM	-	11:40 AM	**Carter and Olivia Ries** One More Generation www.onemoregeneration.org	Empowering the young generations
11:40 AM	-	12:15 PM	**Jane Lubchenco** **Tethys Award Recipient** Distinguished Professor at Oregon State University, Past Head of NOAA	Georgia Tech **Provost Dr. Raffael Bras** will present Dr. Lubchenco with **Tethys Award** followed by Lecture

Monday, April 1			1:00 PM - 8:00 PM	Caddell Building
1:00 PM	-	1:10 PM	**Session 1** **Chairs**: Mark Merrifield, Robert Nicholls, Emily Grubert, Joel Kostka	Overview and instructions by co-chairs
1:10 PM	-	1:30 PM	**Stefan Aarninkhof** (Keynote)	Nature-based solutions for climate-resilient coastlines
1:30 PM	-	1:50 PM	**Carlos M. Duarte** (Keynote)	The role of Vegetated Coastal Habitats in Climate Change Mitigation and Adaptation of Coastal Social-Ecosystems
1:50 PM	-	2:10 PM	**A.R. Siders** (Keynote)	Social Barriers and Solutions for Living Shorelines
2:10 PM	-	2:20 PM	Q&A	
2:20 PM	-	2:40 PM	Coffee Break	
2:40 PM	-	2:50 PM	Nabir Mamnun	Building Resilience of Ecosystems and Communities to Storm Surges in coastal Bangladesh
2:50 PM	-	3:00 PM	Gustavo Sosa-Nunez	Climate change and coastal wetlands: Adaptation in the Gulf of Mexico
3:00 PM	-	3:10 PM	Catherine Roween Almaden	Meso-level analysis on rice-farmers' adaptive measures for slow onset hazard: the case of saltwater intrusion in the Philippines and Vietnam
3:10 PM	-	3:20 PM	Devendraraj Madhanagopal	Being strong and being vulnerable - Who are the winners and losers of climate adaptation actions at the local levels and why? Insights from the selected fishing villages of coastal Tamil Nadu, India.
3:20 PM	-	3:30 PM	Mohammad Mahmudul Islam	Ten years after a tropical cyclone: What factors contribute to social-ecological resilience in coastal Bangladesh?
3:30 PM	-	3:40 PM	Steven Bograd	Understanding Human and Natural Changes in North Pacific Social-Ecological-Environmental Systems
3:40 PM	-	3:50 PM	Christopher Baillie	Is no net loss achievable? An assessment of the status and restoration of coastal wetlands in United States
3:50 PM	-	4:00 PM	Thomas Okey	LEO Oceans: Local Observer Surveillance of Ocean Changes and Identification of Solutions
4:00 PM	-	4:10 PM	Randall Mathews (Invited)	Smart Sea Level Sensors for Coastal Emergency Planning and Response
4:10 PM	-	4:20 PM	Susanna Lidstrom	Sea-Level Rise in Public Science Writing: History, Science and Reductionism
4:20 PM	-	5:00 PM	Discussion	Q&A and structured conversation
5:30 PM	-	8:00 PM	Icebreaker Reception & Media Mixer	Rooftop gardens of the **Clough Commons Building** on the Georgia Tech Campus (see map). In case of rain, reception will he held in the Ford Environmental Science & Technology Building

Tuesday, April 2			8:00 AM - 12:00 PM	Caddell Building
8:00 AM	-	8:10 AM	**Session 2** **Chairs**: Nancy Knowlton, Kim Cobb, Rob Dunbar, Mark Hay	Overview and instructions by co-chairs
8:10 AM	-	8:30 AM	**Elisabeth Ann Holland** (Keynote)	Building Local to International Resilience in the Pacific Islands
8:30 AM	-	8:50 AM	**Elizabeth Mcleod** (Keynote)	The Scientific Evidence of Hope
8:50 AM	-	9:10 AM	**Sarah Lester** (Keynote)	Dead reefs shining: bright spots in the low coral Caribbean reefs of the Anthropocene
9:10 AM	-	9:20 AM	Q&A	
9:20 AM	-	9:40 AM	Coffee Break	
9:40 AM	-	9:50 AM	Cody Clements	Biodiversity enhances coral growth, survivorship, and resistance to macroalgal invasion on degraded reefs
9:50 AM	-	10:00 AM	Guilherme Longo	Marginal reefs facing global changes: insights from Brazilian reefs
10:00 AM	-	10:10 AM	Becky Twohey (Invited)	Adaptive Reefscapes reduce social and ecological vulnerability and increase adaptive capacity
10:10 AM	-	10:20 AM	Stuart Fulton	Uncertain fishing in a changing world, tales from Mexican fisheries
10:20 AM	-	10:30 AM	Rachel Skubel	Multi-dimensional value of sharks in the South Florida shark fishery socio-ecological system: Implications for policy effectiveness
10:30 AM	-	10:40 AM	Alistair Dove (Invited)	The whale shark: ambassador for the pelagic oceans
10:40 AM	-	10:50 AM	Josheena Naggea	A comparative study of adaptive capacity of Marine Protected Area management in Mauritius
10:50 AM	-	11:00 AM	Smruthi Karthikeyan	Toward predicting the biodegradation rates and ecosystem recovery in coastal marine sediments impacted by oil spills
11:00 AM	-	11:10 AM	Folasade Adeboyejo (Invited)	Land to Sea: Reducing Plastisphere Formation in Mangrove Ecosystem
11:10 AM	-	12:00 PM	Discussion	Q&A and structured conversation

Tuesday, April 2			1:00 PM - 5:00 PM	Caddell Building
1:00 PM	-	1:10 PM	**Session 3** **Chairs**: Sara Cooley, Kirsten Isensee, Frank Stewart, Kostas Konstantinidis	Overview and instructions by co-chairs
1:10 PM	-	1:30 PM	**Leticia Cotrim da Cunha** (Keynote)	The Western South Atlantic Ocean: Fast growing observations on acidification and deoxygenation
1:30 PM	-	1:50 PM	**Curtis Deutsch** (Keynote)	Ocean hypoxia in a warming climate: physical drivers and physiological responses predict patterns of biogeography and mass extinction
1:50 PM	-	2:10 PM	**Jessica Cross** (Keynote)	Ecosystem and Economic Resilience under Ocean Acidification
2:10 PM	-	2:20 PM	Q&A	
2:20 PM	-	2:40 PM	Coffee Break	
2:40 PM	-	2:50 PM	Jessie Turner	From Knowledge to OA Action: Mobilizing Global Leadership to Advance OA Action Plans that Protect Coastal Communities and Livelihoods from a Changing Ocean
2:50 PM	-	3:00 PM	Ziad Khalifa	Novel Nanosensors for Assessment of Heavy Metals in Water Case Study Northern Egyptian Lakes
3:00 PM	-	3:10 PM	Laura Sanchez-Velasco	Larval fish habitats and deoxygenation in the northern limit of the OMZ off Mexico
3:10 PM	-	3:20 PM	Frank Stewart	From Genes to Ecosystems: Microbial Consequences of Ocean Oxygen Loss
3:20 PM	-	3:30 PM	Lydia Kapsenberg	Searching for ocean acidification refugia in variable environments
3:30 PM	-	3:40 PM	David Koweek	Exploring hypoxia alleviation through the use of vertical pipes
3:40 PM	-	3:50 PM	Konstantinos Konstantinidis	Resilience of planktonic open and coastal microbial communities to ocean acidification
3:50 PM	-	4:00 PM	Patricia Castillo-Briceno	Paving the way for ocean acidification outreach through a developing law in a developing country: Ecuadorian experience
4:00 PM	-	4:10 PM	Jan Newton (Invited)	Ocean observations from local to global scales, with applications from science to society
4:10 PM	-	5:00 PM	Discussion	Q&A and structured conversation
6:00 PM	-	9:00 PM	**The Ocean Visions Startups & Solutions Event and Reception at Georgia Aquarium**	Georgia Aquarium, 246 Ivan Allen Jr Blvd NW, Atlanta, GA 30313 (see online program) or table below. Food, Wine and Beer will be served.

Georgia Aquarium Ocean Solutions Event and Reception

Tuesday, April 2			6:00 PM - 9:00 PM	Georgia Aquarium
6:00 PM	-	6:05 PM	**Martin Gray** Chief Marketing Officer and Vice President The Georgia Aquarium	Welcome Remarks
6:05 PM	-	6:20 PM	**Emanuele Di Lorenzo** Professor & Director, Ocean Science & Engineering, Georgia Tech	The Ocean Visions Consortium and Incubator
6:20 PM	-	6:30 PM	**Millicent Wallace Pitts** Chief Executive Officer & Executive Director The Ocean Exchange	The Ocean Visions Startup Competitions
			Ocean Solutions Concept Presentations	
6:30 PM	-	6:45 PM	**Mandy Joye** Athletic Association Professor in Arts and Sciences University of Georgia	Oil Spill Remediation Bacteria
6:45 PM	-	7:00 PM	**Stephen Mayfield** Professor & Director, California Center for Algae Biotechnology, University of California San Diego & Scripps Institution of Oceanography	Algae-based Biodegradable Polymers & Bio-Plastics
7:00 PM	-	7:15 PM	**Chuck Greene** Professor, Department of Earth and Atmospheric Sciences, Cornell University	Marine Algae-Based Solutions to Climate, Energy, and Food Security
7:15 PM	-	7:30 PM	**Kim Cobb** Georgia Power Chair, ADVANCE Professor Director, Global Change Program Georgia Institute of Technology	SMART Sea Level Sensors for Coastal Communities & Cities
7:30 PM	-	7:45 PM	**Doll Avant** CEO, Aquagenuity	Taking on America's Water Crisis
			New Frontiers in Ocean Solutions	
7:45 PM	-	8:05 PM	**Lisa Levin (Keynote)** Distinguished Professor, Past Director of the Center for Marine Biodiversity and Conservation and Oliver Chair, Scripps Institution of Oceanography	Solutions from the Deep Ocean
8:05 PM	-	8:25 PM	**Manu Prakash & PlakntonPlanet Team (Keynote)** Associate Professor, Department of Bioengineering Stanford University	Enabling People to be part of the Ocean Solutions: Planktonplanet and Planktonscope

Wednesday, April 3			8:00 AM - 12:00 PM	Caddell Building
8:00 AM	-	8:10 AM	**Session 4** **Chairs**: Anna Zivian, Fiorenza Micheli, Mary Hallisey	Overview and instructions by co-chairs
8:10 AM	-	8:30 AM	**Fanny Douvere** (Keynote)	Marine Protected Ares In A Changing Climate
8:30 AM	-	8:50 AM	**Grover Fugate** (Keynote)	Untangling the Mess with Marine Spatial Planning
8:50 AM	-	9:10 AM	**Tony Giarrusso** (Keynote)	Georgia Coastal and Marine Planning (GCAMP): A Policy and Mapping Initiative
9:10 AM	-	9:20 AM	Q&A	
9:20 AM	-	9:40 AM	Coffee Break	
9:40 AM	-	9:55 AM	Heather Welch (Invited)	Moving beyond static thinking to manage a dynamic world
9:55 AM	-	10:10 AM	Jameal Samhouri (Invited)	The only constant is change: HABs, crabs, whales, and fisheries in the California Current ecosystem
10:10 AM	-	10:25 AM	Louis Botsford	Projections of early population responses to MPAs for adaptive management of California's MPAs
10:25 AM	-	10:40 AM	Malin Pinsky	Designing climate-smart ocean plans
10:40 AM	-	10:55 AM	Ibukun Jacob Adewumi	Using resilience assessment to understand the dynamics of marine socio-ecological systems in order to inform climate-change-smart marine spatial planning processes
10:55 AM	-	11:10 AM	Vasiliki Chalastani	Reconciling Ecotourism Development and Conservation Outcomes through Marine Spatial Planning for a Saudi Giga-Project in the Red Sea (The Red Sea Project, Vision 2030)
11:10 AM	-	12:00 PM	Discussion	Q&A and structured conversation

Wednesday, April 3			1:00 PM - 5:00 PM	Caddell Building
1:00 PM	-	1:10 PM	**Session 5** **Chairs**: Emily Pidgeon, Chris Field, Matthew Realff, David Koweek	Overview and instructions by co-chairs
1:10 PM	-	1:30 PM	**Catherine Lovelock** (Keynote)	Blue Carbon: A brighter future for coastal wetlands
1:30 PM	-	1:50 PM	**Emily Pidgeon** (Keynote)	Blue Carbon: A transformational tool for marine management and conservation globally
1:50 PM	-	2:10 PM	**James Kairo** (Keynote)	Incorporating blue carbon ecosystems into development and climate change agenda in Africa
2:10 PM	-	2:20 PM	Q&A	
2:20 PM	-	2:40 PM	Coffee Break	
2:40 PM	-	2:55 PM	Amanda Spivak	Putting the horse before the cart: Understanding marsh biogeochemistry is essential for managing sustainable ecosystems in a changing world
2:55 PM	-	3:10 PM	Natalia Erazo (Invited)	Mangroves and microbes, coordinated ecosystem engineers in Coastal Ecuador
3:10 PM	-	3:25 PM	Mbunzama Narcisse	Blue carbon for reducing the impacts of climate change: A DRCongo case study
3:25 PM	-	3:40 PM	Ilan MacAdam-Somer	New solutions to overcome barriers to climate mitigation using seaweed aquaculture
3:40 PM	-	3:55 PM	Ardian Rizal (Invited)	Wave Energy Hot Spots Assessment on the West Coast of Sumatra
3:55 PM	-	4:10 PM	David Koweek	Assessing the acidification buffering potential of aquatic vegetation
4:10 PM	-	5:00 PM	Discussion	Q&A and structured conversation

Wednesday, April 3			5:30 PM - 7:00 PM	ES&T Building
5:30 PM	-	7:00 PM	**Poster Session**	Ford Environmental Science & Technology (ES&T) Building, Main Atrium, on Georgia Tech Campus. 311 Ferst Dr NW, Atlanta, GA 30332 (see map for directions). Refreshment will be served.

Thursday April 4			8:00 AM - 12:00 PM	
8:00 AM	-	8:10 AM	**Session 6** **Chairs**: Annalisa Bracco, Micheal Alexander, William Cheung, Colette Wabnitz	Overview and instructions by co-chairs
8:10 AM	-	8:30 AM	**Patrick Marchesiello** (Keynote)	Coastal erosion of the Mekong delta: from processes to counter measures
8:30 AM	-	8:50 AM	**Robert Nicholls** (Keynote)	An integrated framework to assess plausible future livelihood and poverty changes in deltas: an application to coastal Bangladesh
8:50 AM	-	9:10 AM	**Katherine Mills** (Keynote)	Integrating climate, ecosystem, and human information to understand vulnerability and adaptation strategies for fishing communities
9:10 AM	-	9:20 AM	Q&A	
9:20 AM	-	9:40 AM	Coffee Break	
9:40 AM	-	9:50 AM	Lev Looney	The Relationship between Climate Variability and Wind-Induced Upwelling
9:50 AM	-	10:00 AM	Micheli Duarte de Paula Costa	Similar climate-induced shifts in marine fish larvae and harvested species communities in the Southwestern Atlantic Ocean
10:00 AM	-	10:10 AM	Scott Doney (Invited)	Human impacts on coastal water quality and ecosystem services
10:10 AM	-	10:20 AM	Clarissa Anderson	One model to help them all? Challenges facing harmful algal bloom prediction in the coastal zone
10:20 AM	-	10:30 AM	Jeroen Steenbeek (Invited)	Simulating marine life and change: advancing food web modelling capabilities to analyse plausible global ocean futures
10:30 AM	-	10:40 AM	Becca Selden (Invited)	Adapting to change: fishing communities respond to climate-driven species range shifts
10:40 AM	-	10:50 AM	Jessica Kuonen	How short-term decisions inform long-term understanding: An ocean condition forecast case study
10:50 AM	-	11:00 AM	Marta Coll	Serious gaming as a platform for integrated modelling of cumulative impacts
11:00 AM	-	12:00 PM	Discussion	Q&A and structured conversation

Icebreaker Reception & Marine Media Mixer

OCEAN VISIONS 2019

Rooftop Clough Commons
5:30 PM - 8:00 PM

Exit conference room and turn right. Clough common building is just ahead

Food, Wine, Beer, and Marine Media Mixer

COMPASS

This is a unique opportunity to make new connections, learn what journalists look for in a science story, and seed story ideas. Whether you take the mic or just mingle and meet journalists-and each other-join us for an evening of fun.

Starting at 6:00pm COMPASS will host a fun "Tell me a story"event. Scientists will be invited to "pitch" an aspect of their research in 2 minutes. The journalists will respond: What did they like? What angle might they pursue? What would they want to know more about? Why might a story work for one journalist, but not another?

Tell Me More: How do we envision ocean solutions for the next generation?

OCEAN VISIONS 2019

COMPASS

April 1, 2019, Panel Discussion
10:00 AM - 11:00 AM, Caddell Building

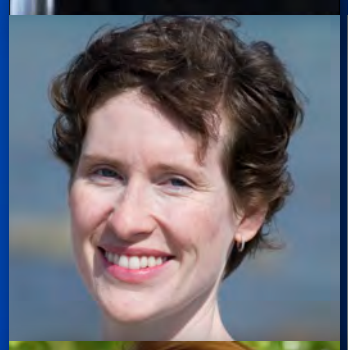
A.R. Siders
Environmental Fellow
Harvard University

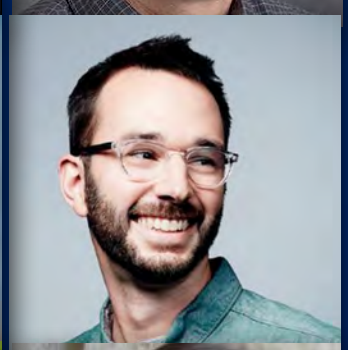
Christopher Joyce
Correspondent,
Science Desk
NPR

Chris Field
Senior Fellow, Melvin and Joan Lane Professor
Director, Woods Institute for the Environment
Stanford University

David Malakoff
Deputy News Editor,
Science Magazine

Sarah Cooley
Director, Ocean Acidification Program, The Ocean Conservancy





John Sutter
Sr. Investigative Reporter
CNN

Kim Cobb
ADVANCE Professor
Director, Global Change Program, Georgia Tech

Kendra Pierre-Louis
Climate Desk
The New York Times

Fanny Douvere
Coordinator, Marine Programme, World Heritage Centre, UNESCO

Laura Helmuth
Health, Science and Environment Editor,
The Washington Post

Tell Me More:
How do we envision ocean solutions for the next generation?

Lead Scientist and Organizer

Emanuele Di Lorenzo
Professor & Director, Program in Ocean Science and Engineering, Georgia Institute of Technology
edl@gatech.edu

Dr. Emanuele Di Lorenzo is Professor and Director of the Program in Ocean Science and Engineering at the Georgia Institute of Technology in Atlanta, USA. His research interests are in the field of multi-scale climate and ocean dynamics (large-scale, regional and coastal), climate impacts on marine ecosystems and social-ecological systems. In his research, Dr. Di Lorenzo attempts to explain the dominant (e.g. low order) dynamics of the ocean and marine ecosystem variability and change by combining available observations with a hierarchy of numerical models (e.g. dynamical and statistical) of ranging complexity. He also is actively involved in efforts, like OceanVisions, that combine science and engineering to enable new solution strategies for addressing emerging problems related to ocean systems.

Panelists

A.R. Siders
Environmental Fellow, Harvard University Center for the Environment
arsiders@fas.harvard.edu

A.R. Siders is an Environmental Fellow at the Harvard University Center for the Environment. Her research focuses on coastal climate change adaptation governance and flood risk management, exploring how institutional and social structures affect decisions around adaptation policies and how those policies affect social justice and risk reduction outcomes. She combines approaches from hazards geography, sociology, law, digital humanities, and computational social science. Siders previously served as a Presidential Management Fellow with the U.S. Navy and Associate Director of the Center for Climate Change Law at Columbia University. She holds a J.D. from Harvard Law School and a Ph.D. from Stanford University.

Chris Field

Senior Fellow, Melvin and Joan Lane Professor for Interdisciplinary Environmental Studies;
Director, Woods Institute for the Environment;
Professor of Earth System Science, of Biology and Senior Fellow, Precourt Institute for Energy; Stanford University
cfield@stanford.edu

Chris Field is the Perry L. McCarty Director of the Stanford Woods Institute for the Environment and the Melvin and Joan Lane Professor for Interdisciplinary Environmental Studies at Stanford University. Prior to his 2016 appointment at the Stanford Woods Institute, Field was a staff member at the Carnegie Institution for Science (1984-2002) and founding director of the Carnegie's Department of Global Ecology (2002-2016). Field's research focuses on climate change, ranging from work on improving climate models to prospects for renewable energy systems and community organizations that can minimize the risk of a tragedy of the commons. He has been deeply involved with national and international-efforts to advance understanding of global ecology and climate change. Field was co-chair of Working Group II of the Intergovernmental Panel on Climate Change (IPCC) (2008-2015), where he led the effort on "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (2012), and "Climate Change 2014: Impacts, Adaptation, and Vulnerability(2014). His widely cited work has earned many recognitions, including election to the US National Academy of Sciences, the Max Planck Research Award, and the Roger Revelle Medal. Field is a member of the Harvard University Board of Overseers, the Board of Directors of World Wildlife Fund (US), and the Board of Trustees of the California Academy of Sciences. He is a fellow of the American Association for the Advancement of Science, the American Geophysical Union, and the Ecological Society of America. He holds a bachelor's degree in biology from Harvard College and a Ph.D. in biology from Stanford.

Fanny Douvere

Coordinator, Marine Programme, World Heritage Centre, UNESCO
F.Douvere@unesco.org

Fanny Douvere is the coordinator of the Marine Programme at UNESCO's World Heritage Centre in Paris, France. Since October 2009, her mission is to ensure the 49 marine sites on UNESCO's World Heritage List are conserved and sustainably managed so future generations can continue to enjoy them. She recently wrote in Nature why not investing in marine World Heritage is a lost opportunity for the oceans. Under her leadership, marine World Heritage transformed into a global network of flagship marine protected areas' managers spanning 37 countries and stretching from the tropics to the poles. Marine areas protected under the World Heritage Convention have more then doubled since she took office. Her day-to-day work includes field missions to evaluate the state of conservation on a wide range of topics, including the critically endangered Vaquita

in Mexico's Gulf of California, the Rampal power plant in the Sundarbans, Bangladesh, and the Great Barrier Reef in Australia. Most recently, she led UNESCO's first global scientific assessment on the impacts of climate change on World Heritage coral reefs and the World Heritage Centre's first analysis on the use of the 1972 World Heritage Convention to establish and conserve marine protected areas in the High Seas. Suggested marine protected areas beyond national jurisdiction that might be of possible Outstanding Universal Value and could thus merit World Heritage protection include the Costa Rica Dome, the Sargasso Sea, the Atlantis Bank, the Lost City Hydrothermal Field, and the White Shark Café. More information is available in the UNESCO publication World Heritage in the High Seas: an Idea Whose Time Has Come.

Kim Cobb

ADVANCE Professor, College of Sciences
Director, Global Change Program, Georgia Institute of Technology
kim.cobb@eas.gatech.edu

Kim Cobb's research uses corals and cave stalagmites to probe the mechanisms of past, present, and future climate change. She received her B.A. from Yale University in 1996, and her Ph.D. in Oceanography from the Scripps Institute of Oceanography in 2002. She spent two years at Caltech in the Department of Geological and Planetary Sciences before joining the faculty at Georgia Tech in 2004. Kim has sailed on multiple oceanographic cruises to the deep tropics and led caving expeditions to the rainforests of Borneo in support of her research. Kim has received numerous awards for her research, most notably a NSF CAREER Award in 2007, and a Presidential Early Career Award for Scientists and Engineers in 2008. She sits on the international CLIVAR Pacific Panel, serves on the Advisory Council for the AAAS Leshner Institute for Public Engagement, and is one of the Lead Authors on the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report. As a mother to four, Kim is a strong advocate for women in science. She is also devoted to the clear and frequent communication of climate change to the public through speaking engagements and social media.

Sarah Cooley

Director, Ocean Acidification Program, The Ocean Conservancy
scooley@oceanconservancy.org

Chemistry has always just made sense to Sarah. Atoms fit together like building blocks, and then they make something new. But spending her life in a laboratory surrounded by bubbling mixtures didn't appeal. She'd rather be on a boat, or maybe, writing a book. One day, Sarah realized that the ocean was full of chemicals, both natural and man-made, and there was still a whole lot left to learn about Earth's final frontier. She went to graduate school to become an ocean carbon cycle expert. Along the way, she learned how to talk to people about science and found she had a knack for making ocean issues clear to all types of people.

After spending several years as an ocean carbon cycle researcher, mostly at Woods Hole Oceanographic Institution on Cape Cod (“the oceanographic institution on the mainland,” to the Jaws fans out there), Sarah wanted a chance to work at the border between science and policy. Instead of doing scientific research and hoping someone would pick it up and use it, she wanted to help bring new science directly into policy that would create action and positive change for the ocean. So she moved to Ocean Conservancy, where she does that work every day. She also gets to write about science and decode its mysteries for people who don’t see the secret logic of chemistry the same way she does.

Journalists

Christopher Joyce

Correspondent, Science Desk, NPR

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Christopher Joyce has been a correspondent and editor at NPR for 26 years. For all but two years, he's worked on the science desk, writing and producing stories on all fields of science, with an emphasis on biology, energy, and environmental sciences. His stories can be heard on all of NPR's news programs, including NPR's “Morning Edition”, “All Things Considered”, and “Weekend Edition”. In addition to his work with the science desk, Chris was the editor and a correspondent for NPR's Radio Expeditions, a documentary program on natural history produced in collaboration with the National Geographic Society. He has also written two popular books on science, “Witnesses from the Grave: The Stories Bones Tell” and “Earthly Goods: Medicine Hunting in the Rainforest,” both published by Little Brown. In his free time, Chris sails a 38-foot Ericson called “Ruby Slipper.”

David Malakoff

Deputy News Editor, Science Magazine

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David Malakoff is a Deputy News Editor specializing in coverage of science policy, energy and the environment. A native of Washington D.C., he has spent more than 25 years reporting on how scientists influence government policy, and how government policy shapes science. In addition to reporting for *Science*, he has worked as an editor and correspondent on NPR’s Science Desk, for *Conservation* Magazine, and as a freelancer for numerous outlets.

John Sutter

Sr. Investigative Reporter, CNN
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@jdsutter

John D. Sutter is an award-winning reporter in CNN's investigative unit, where he focuses primarily on climate change, social justice issues and crowdsourced reporting projects.

He was the creator of the network's "2 degrees" project, which aimed to involve readers in climate change coverage. He led the award-winning CNN Digital series, "Vanishing," which focused on the global extinction crisis. That series was nominated for an EMMY Award and won Editor & Publisher's EPPY Award for best online investigative/enterprise feature story. And he spearheaded CNN's "Change the List" project, which asked the network's digital audience commission story topics in online polls; and involved them in pushing for change.

In 2015, a portfolio of Sutter's work for CNN Digital won the Batten Medal for public service journalism from the American Society of News Editors. His 2012 online documentary on modern slavery in Mauritania won the prestigious Livingston Award for Young Journalists, an award he shared with videographer Edythe McNamee. Sutter's work has been honored by the Online News Association, Investigative Reporters and Editors and the Foreign Press Association, among others. In 2014, he won the Al Neuharth Award for innovation in investigative reporting for an online series on LGBT life in Mississippi. In 2011, he was part of a team that won a Peabody Award for coverage of the Gulf oil spill.

Sutter joined CNN in 2009. Previously, he was a staff writer at The Oklahoman. He earned a bachelor's degree in international studies and journalism from Emory University in 2005.

Kendra Pierre-Louis

Climate Desk, The New York Times
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Kendra Pierre-Louis is New York Times reporter on the Climate Desk where she writes about the intersection of humans and the environment. Previously she was a staff writer for Popular Science. A native of New York City, Kendra holds degrees Cornell University, the SIT Graduate Institute and the Massachusetts Institute of Technology. She counts seeing a polar bear in the wild as one of the best experiences of her life.

Opening Plenary Panel Biographies

Laura Helmuth

Health, Science and Environment Editor, The Washington Post

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Laura Helmuth is the Health, Science, and Environment Editor for The Washington Post. She has been an editor for National Geographic, Slate, Smithsonian, and Science magazines and is the past president of the National Association of Science Writers. She serves on the advisory boards of High Country News, Knowable Magazine and Spectrum and is a council member of the Geological Society of Washington. She has a Ph.D. in cognitive neuroscience from the University of California at Berkeley and attended the U.C. Santa Cruz science writing program.

Moderator

Nancy Baron

Director of Science Outreach, COMPASS

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Nancy Baron is the Director of Science Outreach for COMPASS. Nancy holds workshops around the world for academic, government, and NGO scientists helping them develop core competencies as scientist communicators who want to make their work relevant to journalists, policy makers, and the public. Nancy began her career as a biologist in Banff National Park, spent 6 years as Director of Education at the Vancouver Aquarium, then morphed into journalism. She has won numerous writing awards including the Canadian Science Writers Science in Society and National Magazine awards. An ardent naturalist, she published a popular field guide, The Birds of Coastal British Columbia (Lone Pine Publishing) and a “how to” communications guide book for scientists titled Escape from the Ivory Tower (Island Press). Nancy received the 2013 Peter Benchley Ocean Award for Excellence in the Media for her work at the intersection of science and journalism.

OCEAN VISIONS 2019

Overview & Program's Abstracts

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Part One

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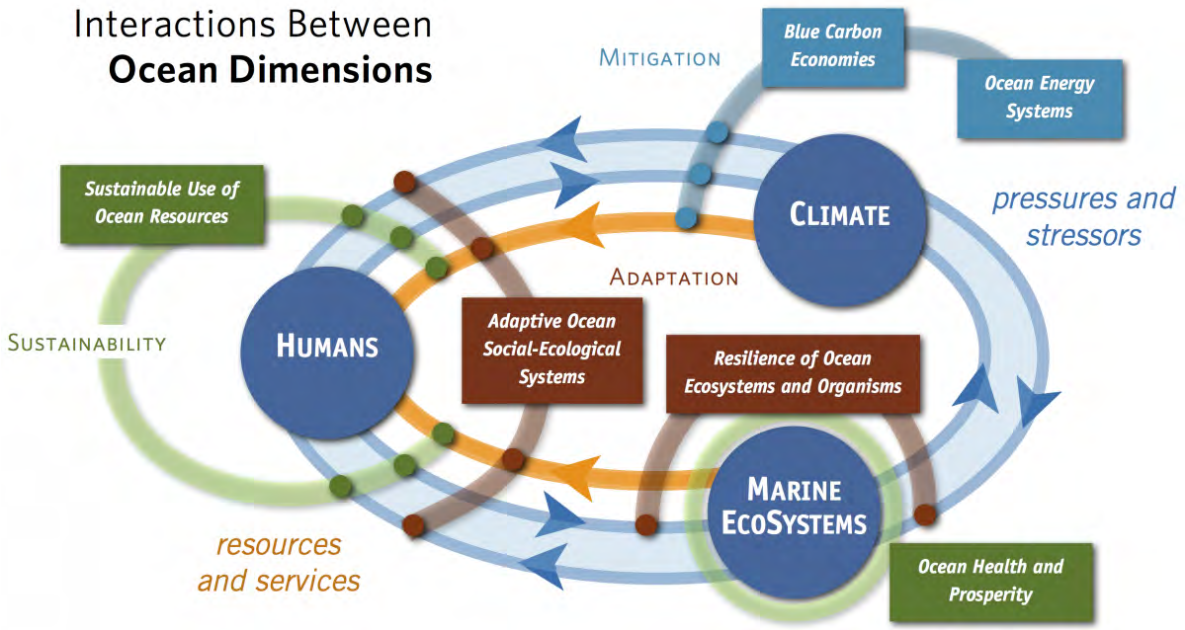
1. Program Introduction

1.1 Overview

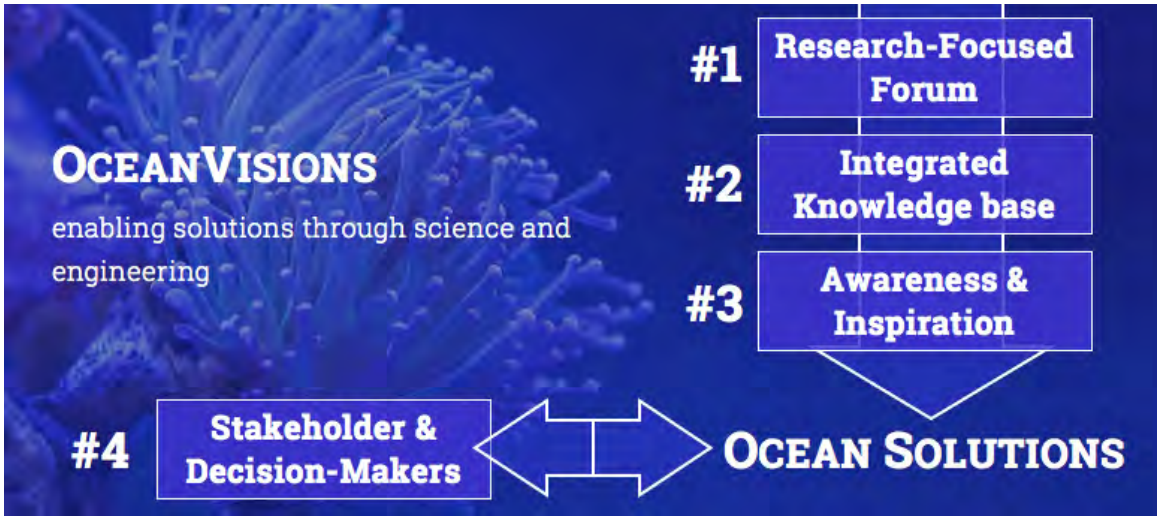


Important advances in our understanding of the ocean systems and in our ability to plan and implement solution strategies come from recognizing the role of the interactions between ocean dimensions (e.g. humans, marine ecosystems, and climate). Each of these dimensions exerts pressures on the other (see blue path in diagram) but also provide resources and services (see orange path in diagram below). The main themes for **OceanVisions2019 – Climate** is on success stories (e.g. case studies) in the areas of adaptation, mitigation, and sustainability. Adaptation dynamics increase the resilience of marine life and human systems to the diverse set of climate impacts (see red shields in diagram under adaptation), mitigation strategies on the other hand aim at

reducing the impact of human activities on climate (e.g. CO2 emissions) (see blue shield in diagram under mitigation). Finally, the goals of sustainability and sustainable development are to ensure that humans interact with the other dimensions of the ocean (e.g. climate and ecological systems) in ways that protect the long-term health of the ocean while maximizing benefits to society and human well-being (see green shields in diagram around the human system under sustainability). The summit will also focus on our current ability to generate integrated understanding and synthesis of the dynamics of exchange at the interface between the human, climate and marine ecosystems dimensions of the ocean.

1.2 Goals

This Ocean Visions initiative aims to **(1) develop a forum where scientists and engineers** can discuss and exchange their research in the context of ocean solutions, **(2) generate an integrated and adaptive knowledge base** of science and engineering that informs ocean solutions, **(3) highlight the natural and social sciences, and engineering that enable ocean solutions** and raise awareness by inspiring younger generation of ocean experts and leaders, and **(4) engage with stakeholders and decision-makers** in order to establish a concrete pathway for translating science and engineering into applications for ocean solutions, and to develop innovative research efforts that build on synergies between academic institutions, NGOs, government and industry.



Diverse examples of ocean solutions include everything from ocean conservation programs that enhance climate resilience/resistance (e.g. reduce local stressors), to strategies that directly aid ecosystems and organisms facing climate change (e.g. assisted evolution or migration), to win-win conservation that also promotes reduced CO2 emissions or CO2 drawdown (e.g. restoring wetlands, plastic waste solutions), to ocean-based energy production systems that replace fossil fuel based energy sources (e.g. ocean wind power), to reduced energy demands via increased ocean-related efficiency (e.g. ship designs), to innovative developments of sustainable ocean-reliant communities, infrastructures and food production systems.

1.3 Tethys Award and Lecture

The Tethys award is designed to raise awareness of a growing movement focused on ocean solutions and optimism (#OceanOptimism). Recipients of this award are selected from a diverse set of individuals that have contributed to, promoted to, enabled or raised awareness in the ocean solutions space – broadly defined. These individuals are meant to represent role models that inspire the new

generations of ocean experts and leaders. Examples include scientists, engineers, policy makers from all sectors, private and public figures, leaders and young innovators. The award does not have an associated monetary prize, but it comes with an invitation to deliver the Tethys Lecture at the Ocean Visions summits.

The first recipient of the Ocean Tethys Award 2019 is Dr. Jane Lubchenco. She is going to deliver the Tethys Lecture at the OceanVisions2019 opening ceremony on April 1, 2019.

Jane Lubchenco - 2019

Dr. Lubchenco is a world renowned environmental scientist who has deep experience in the worlds of science, academia, and government. She is a champion of science and of the stronger engagement of scientists with society. She was the Under Secretary of Commerce for Oceans and Atmosphere and the Administrator of the National Oceanic and Atmospheric Administration (NOAA) from 2009-2013. Nominated by President Obama in December 2008 as part of his "Science Dream Team," she is a marine ecologist and environmental scientist by training, with expertise in oceans, climate change, and interactions between the environment and human well-being. To introduce her to his Senate colleagues for her confirmation hearing, Senator Ron Wyden called Lubchenco 'the bionic woman of good science.'

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2. Oral Presentations

2.1 Session Introduction

SESSION I - Adaptive Social-Ecological Systems: Coastal Climate Change

Co-Chairs: Mark Merrifield (Scripps), Robert Nicholls (Southampton University), Emily Grubert (Stanford University), Joel Kostka (Georgia Tech)

Monday, April 1, 2019 -- 1:00 PM - 5:00 PM

This session will focus on advances in living shorelines that enable coastal communities to address, and develop management strategies and tools for issues associated with climate variability and change, in particular the physical, biological, chemical and human dimensions of sea level rise and increasing extreme events (e.g. marine heatwaves, hurricanes). The goal of the session is to explore the role of living shorelines, what they can practically and reliably deliver, how decision-makers and coastal communities see them, and the coastal science and engineering research required to support their development.

Keynote Speakers

A.R. Siders is an Environmental Fellow at the Harvard University Center for the Environment

Stefan Aarninkhof is a Professor of Coastal Engineering at Delft University of Technology, The Netherlands

Carlos M. Duarte Is Professor and Tarek Ahmed Juffali Research Chair in Red Sea Ecology at the King Abdullah University of Science and Technology (KAUST)

SESSION II - Resilience of Coastal Ecosystems: Tropical Oceans and Coral Reefs

Co-Chairs: Nancy Knowlton (Smithsonian), Kim Cobb (Georgia Tech), Rob Dunbar (Stanford), Mark Hay (Georgia Tech)

Tuesday, April 2, 2019 -- 8:00 AM-12:00 PM

This session will focus on the natural and social sciences and engineering that enable innovative approaches in the conservation of tropical ecosystems, their biodiversity and the services they provide to coastal human communities. The goal of this session is to identify a set of promising and potentially scalable case studies in both research and management that lead to more resilient ecosystems.

Keynote Speakers

Elizabeth Holland is a Professor of Climate Change, Pacific Center for Environment and Sustainable Development, University of the South Pacific, Suva

Lizzie Mcleod is the Nature Conservancy's Climate Adaptation Scientist for the Asia Pacific region and the Science Lead for the Reef Resilience Network

Sarah Lester is an Assistant Professor in the Department of Geography at Florida State University

SESSION III - Protecting Ocean Health: Ocean Acidification and Hypoxia

Co-Chairs: Sara Cooley (Ocean Conservancy), Kirsten Isensee (IOC-UNESCO), Frank Stewart (Georgia Tech), Kostas Konstantinidis (Georgia Tech)

Tuesday, April 2, 2019 -- 1:00 PM - 5:00 PM

This session will highlight advances in science and engineering that enable innovative strategies for understanding, managing, and predicting the rising threats associated with ocean acidification and deoxygenation. These include expanding and improving observation systems and research, exploring submerged aquatic vegetation as a management tool, advancing modeling to identify drivers of acidification and deoxygenation (and potential hotspots), and exploring impacts to water quality. The goal of this session is to identify case studies that inform near-term and long-term strategies for dealing with the challenges associated with ocean acidification and deoxygenation now and in the future.

Keynote Speakers

Jessica Cross is a Research Associate at the NOAA Pacific Marine Environmental Laboratory

Curtis Deutsch is an associate professor in the School of Oceanography at the University of Washington in Seattle

Leticia Cotrim da Cunha is Assistant Professor in Chemical Oceanography at Rio de Janeiro State University (UERJ - Brazil)

SESSION IV - Sustainability of Ocean Resources: Marine Spatial Planning

Co-Chairs: Anna Zivian (Ocean Conservancy), Fiorenza Micheli (Stanford), Mary Hallisey (Georgia Tech)
Wednesday, April 3, 2019 -- 8:00 AM - 12:00 PM

This session aims at identifying case studies where science and engineering are enabling sustainable and scalable approaches in the spatial planning of marine resources such as marine protected areas and aquaculture farms. The goal of this session is to build on existing case studies to identify areas of critical knowledge gaps, modeling approaches that can optimize planning, and strategies for informing actionable policies.

Keynote Speakers

Grover Fugate is Executive Director of the Rhode Island Coastal Resources Management Council (CRMC)

Fanny Douvere is the coordinator of the Marine Programme at UNESCO's World Heritage Centre in Paris, France

Tony Giarrusso is a Associate Director of the Center for Spatial Planning Analytics and Visualization at the Georgia Institute of Technology in Atlanta

SESSION V - Mitigation: Scalable strategies for Blue Carbon

Co-Chairs: Emily Pidgeon (Conservation International), Chris Field (Stanford), Matthew Realff (Georgia Tech), David Koweek (Carnegie)

Wednesday, April 3, 2019 -- 1:00 PM - 5:00 PM

This session will focus on the importance of the ocean to mitigating climate change and the science and engineering challenges necessary to realize the full potential of ocean solutions to climate change and ocean acidification. The role of seagrasses, mangroves and coastal wetlands as organic carbon sinks and stores is increasingly recognized in climate mitigation policy and related mechanisms. Science is needed, however, if other ocean processes and ecosystems are to be similarly included in blue carbon accounting. Ocean vegetation also takes up dissolved CO2 in the oceans which increases the pH, potentially providing a buffer against ocean acidification. However, both science and policy gaps need to be addressed before such processes can be integrated into implementable plans for climate action. Finally, the oceans have the potential to mitigate climate change by providing numerous sources of CO2-free energy (waves, tides, open-ocean wind, hydrothermal) and technology is emerging to harness this potential. This session will highlight success stories that show how integration of science, policy, and engineering can lead to ocean-based climate mitigation solutions, and will identify the immediate opportunities for ocean carbon-climate innovation.

Keynote Speakers

Catherine Lovelock is a Professor in the School of Biological Sciences, University of Queensland

James Gitundu Kairo is a Professor of Oceanography and Hydrography at the University of Nairobi in Kenya

Emily Pidgeon is the Senior Director of Conservation International's Strategic Marine Initiatives

SESSION VI - Integrated Modelling of Human and Climate Impacts on Ocean Systems

Co-Chairs: Annalisa Bracco (Georgia Tech), Micheal Alexander (UCAR), William Cheung (UBC), Colette Wabnitz (UBC)

Thursday, April 4, 2019 -- 7:30 AM - 11:30 AM

This session will highlight innovative approaches, especially those using quantitative methods, that enable an integrated understanding of the interactions between climate, ecosystems and dependent human communities for the purposes of evaluating, predicting and managing the impacts of climate and human

pressures on ocean systems. We welcome presentations spanning natural and social sciences. Potential topics include climate variability and change, ecosystem prediction/projections, risk assessments, sustainable fisheries, protected species conservation, spatial management, fishery economics, and challenges confronting social-ecological systems. A goal of this session is to identify common challenges faced when synthesizing our understanding of the complex dynamics of ocean systems for decision-support information to managers and policy makers, and pathways forward.

Keynote Speakers

Patrick Marchesiello is a Senior Researcher at Institut de Recherche pour le Développement, LEGOS, Toulouse

Robert Nicholls is a of Coastal Engineering within Engineering and the Environment at the University of Southampton

Katherine Mills is a Research Scientist at the Gulf of Maine Research Institute in Portland, Maine

2.2 Sessions

2.2.1 Adaptive Social-Ecological Systems: Coastal Climate Change

S11: Nature-based solutions for climate-resilient coastlines

KEYNOTE PRESENTATION
Stefan Aarninkhof
Delft University of Technology

Highly-developed, densely populated shorelines are facing the increasing risk of climate-induced accelerated sea level rise. Large-scale sand nourishments, such as the Dutch Sand Engine project, are increasingly deployed as a sustainable measure for climate adaptation. The sand nourishments reinforce the shoreline in a natural way, thus increasing the safety of the hinterland against flooding. But at the same time, the seaward extension of the shoreline offers unprecedented opportunities for other services like nature development, recreation, housing and drinking water supply. Being very flexible in the amount and pace of sediment supply, the method easily allows for adaptation to uncertainties in future sea level rise.

Though often proved to be successful, nature-based solutions are not commonly applied yet in coastal management practice. This can be attributed to the limited predictability of their yearly to decadal evolution (owing to the complex interplay of morphological and ecological processes), but lack of societal support for the implementation of innovative climate adaptation measures also plays a role. Full-scale demonstration projects, together with high-profile, multidisciplinary research sites are needed to overcome these challenges. Considering their global scale and the diversity of coastal environments involved, we advocate an open-access, network approach to generate the knowledge

needed: an International Coastline Observatories Network.

S12: The role of Vegetated Coastal Habitats in Climate Change Mitigation and Adaptation of Coastal Social-Ecosystems

KEYNOTE PRESENTATION

Carlos M. Duarte
King Abdullah University of Science and Engineering (KAUST)

Vegetated coastal habitats, including seagrass meadows, mangrove forests, salt marshes and kelp and other macroalgal-dominated habitats, are highly productive ecosystems that deliver globally significant services despite occupying about 0.2 to 0.5 % of the global ocean. They have, however, declined steeply due to multiple anthrpogenic pressues so that their current extent represents about half of the area they occupied prior to human perturbation. Here I will discuss the role vegetated coastal habitats play in the adaptation of coastal social-ecological systems to climate change, and how rebuilding these ecosystems under a living shorelines concept will help mitigate and adapt to climate change while delivering multiple additional benefits.

S13: Social Barriers and Solutions for Living Shorelines

KEYNOTE PRESENTATION

A.R. Siders
Harvard University

Climate change challenges our social and institutional systems not just because the scale of the change is unprecedented but because it requires an acknowledgement that the future will not look like the past. Traditional governance systems have been designed to maintain the status quo, to prioritize stability and predictability. In light of continually changing environment, nowhere as obvious as the coasts, our social, institutional, and regulatory systems need to become more adaptive. Living shorelines are one way to pursue adaptive coasts, but there are strong social and institutional barriers to the use of living shorelines. Among these are lack of public awareness of the benefits of living shorelines, a perceived lack of evidence and successful examples, regulatory requirements, and funding constraints. None of these challenges are insurmountable. Solving them, however, may require significant coordination and cooperation that raises the question: how serious are we about coastal resilience?

S14: Building Resilience of Ecosystems and Communities to Storm Surges in coastal Bangladesh

Nabir Mamnun
Network on Climate Change, Bangladesh, Dhaka, Bangladesh

Storm surges associated with severe tropical cyclones are among the world's most devastating and destructive natural hazards. They pose serious threats to the coastal communities of Bangladesh. Densely populated low-lying coastal ecosystems of the country face the impacts of storm surges and other coastal disasters. Nonetheless, Bangladesh has made progress towards building resilient to the impacts of storm surges and is an example of social and ecological interactions in coastal region for building resilience to storm surges. This study presents different approaches that communities adopt to build resilience, while placing ecosystems at the center of adaptation initiatives. A literature review, and interviews and focus groups discussions with a wide variety of stakeholders were conducted in the south-west coastal region of Bangladesh. The findings of the study present case studies on resilience efforts to cyclones and storm surges taken by different stakeholders. It was found that the trust between government and non-government organizations, community

leaders, and civil society is high. As a consequence evacuation warnings are generally followed and communities are well prepared. We also illustrate different approaches of ecosystem based adaptation efforts in the social and ecological systems towards more to improve adaptation to storm surge impacts in changing climate.

S15: Climate change and coastal wetlands: Adaptation in the Gulf of Mexico

Gustavo Sosa-Nunez
Instituto Mora

Mexico was the first developing country to create a legal, institutional and programmatic framework to deal with climate change. The protection, conservation and restauration of coastal wetlands is considered in such framework, as these ecosystems are relevant in a country with access to two oceans. However, there is no clear definition as to who is responsible of bringing these actions forward. This does not mean that projects to approach this issue have not been developed. Funded by the Global Environmental Fund, the National Institution for Ecology and Climate Change developed and implemented the Adaptation to Climate Change Impacts on the Coastal Wetlands in the Gulf of Mexico project. Focusing on three sites, and with an ecosystem-based adaptation approach, this project aimed at reducing vulnerability of local communities to climate change, through conserving and sustainably managing environmental services, and ecological planning. Lasting from 2011 to 2016, this project also entailed the installation and operation of mareographs and meteorological equipment; as well as the organization of workshops with local NGOs, academia, the private sector, and federal, state, and local governmental institutions, besides local communities. With this context, this project represents a successful story about adaptation, where potential improvements and follow-up strategies could be recommended.

S16: Meso-level analysis on rice-farmers' adaptive measures for slow onset hazard: the case of saltwater intrusion in the Philippines and Vietnam

Catherine Roween Almaden
XAVIER UNIVERSITY - ATENEO DE CAGAYAN

This study examined the factors influencing rural rice-farmers choice of adaptation measures for slow-onset hazard brought about by saltwater intrusion in selected rice-farm communities in the Philippines and Vietnam. Specifically, this study determined the influence of social, economic and institutional factors as well as farmers perception and level of awareness on climate related events on the choice of adaptation measures to address saltwater intrusion. The study classified adaptation measures into specific categories and developed a multi-criteria assessment tool on adaptation measures. This led to the development of a measure-based adaptation index (MAI) which addressed a number of shortcomings of previous studies and captured the variation in adaptation measures implemented by the rice farmers in terms of the number of adaptation measures implemented by the rice-farmers, feasibility of implementing the measures and the extent to which they are applied. Econometric approach was applied to determine the factors influencing rice-farmers choice of adaptation measures. The results indicated that adaptation takes place at different levels based on the propensity to adapt, the variety and diversity of adoption of various measures, and the feasibility of the various measures. The results also underscored that socio-economic and institutional factors significantly influence rice-farmers choice of adaptation measures to saltwater intrusion. The study is suggestive of important innovative interventions and policy implications crucial in the optimization of the current adaptation measures employed and the potential adoption of new measures.

S17: Being strong and being vulnerable - Who are the winners and losers of climate adaptation actions at the local levels and why? Insights from the selected fishing villages of coastal Tamil Nadu, India.

Devendraraj Madhanagopal
Indian Institute of Technology Bombay

Coromandel coastal zones of Tamil Nadu, India has the long history of vulnerability to climate change and extremes and coastal disasters. The 2004 Indian Ocean Tsunami disaster had devastating impacts on the marine fishers of this region. Evidence highlight that the changing climate and the long-term indirect effects of the Tsunami disaster further exacerbate the livelihoods vulnerability of the small-scale fishers, who reside along this coastal stretch under multiple dimensions. Also, these small-scale fishers have the long history of marginalization, which entangled with their livelihoods and in turn it reflects in their socioeconomic, political and institutional setups. Given this background, this paper critically analyzes the multiple marginalization and strengths of the marine fishing communities of this region and discusses its relevance with their adaptation actions to climate change at the local levels. Drawing qualitative empirical evidence, I discuss that the socioeconomic factors and political power tacitly decide the strengths and vulnerability of the marine fishers in adapting to climate change at the local levels. I also argue that the changing shorelines over the decades and its projected impacts on the marine fishing community indirectly divide the fishing community into two types from their localized adaptation actions to climate change Winners and Losers of climate change.

S18: Ten years after a tropical cyclone: What factors contribute to social-ecological resilience in coastal Bangladesh?

Mohammad Mahmudul Islam
Sylhet Agricultural University

The coastal zone of Bangladesh is vulnerable to frequent exposure to tropical cyclones. In 2009 the south-west coast of Bangladesh was devastated by a tropical cyclone Aila that caused profound negative impacts on livelihood assets, standing crops, coastal ecosystem services and environment. Using the Sundarbans mangrove region as an illustrative case study example, the study assessed, to what extent, the responses of the government, NGOs, donor organization and community themselves contributed to social-ecological resilience in the region. The findings indicated the cyclone inflicted enormous damage to the natural environment and community livelihoods, however a number strategies such as a moratorium on forest resources extraction to allow mangrove regeneration, facilitation of protective plantation on and in frontal or back side of the flood control Drainage (FCD) structure/ dam to build bio-shield, investment in long-term capacity building of the communities, wider social safety-net program as a buffer against crises, a vibrant NGO sectors for building an effective partnership for disaster risk reduction helped for recovery of social-ecological system of the region. Though challenges are enormous, however a closer look into successful strategies reflects the viability of science (both social and natural) and engineering towards making coastal social-ecological system in Bangladesh more resilient.

S19: Understanding Human and Natural Changes in North Pacific Social-Ecological-Environmental Systems

Steven Bograd
NOAA Southwest Fisheries Science Center

Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosys-

tems (FUTURE) is the flagship integrative Scientific Program undertaken by the member nations and affiliates of the North Pacific Marine Science Organization (PICES). One of the principal goals of FUTURE is to develop a framework for investigating interactions across disciplinary dimensions and scales in order to most effectively address common interests and problems across the North Pacific. These interactions are complex and nonlinear, occur across a range of spatial and temporal scales, and can complicate management approaches to shared problems. Here we present a Social-Ecological-Environmental Systems (SEES) framework to coordinate marine science within PICES, and demonstrate the application of this framework by looking at four case studies: (a) species alteration in the western North Pacific; (b) ecosystem impacts of an extreme heat wave in the eastern North Pacific; (c) jellyfish blooms in the western North Pacific; and (d) basin-scale warming and species distributional shifts. An effective and comprehensive SEES approach is necessary to maintain resilient ecosystems within a changing climate. PICES provides the structure required to address the multi-national, inter-disciplinary issues we face in the North Pacific.

S110: Is no net loss achievable? An assessment of the status and restoration of coastal wetlands in United States

Christopher Baillie
UNC Institute of Marine Science/ECU

Coastal ecosystems are under pressure from anthropogenic stressors, including development, pollution, and climate change, resulting in significant losses of coastal habitats globally. Modern conservation policies and efforts are often implemented with the intent of reducing and even halting habitat loss and degradation. However, losses already incurred will require habitat restoration, if critical ecosystem functions and services are to be recovered. Given the long history of wetland loss and conservation and mitigation efforts in the United States, including the 1989 No Net Loss (NNL) policy, U.S. wetland restoration practices are an ideal case study for better understanding the role of restoration in habitat conservation. We sought to address two questions with this study: (1) How have coastal wetlands changed since the implementation of NNL? (2) How do restoration efforts (non-mitigation) compare to the amount of wetland loss or gain in the U.S.? First, we calculated palustrine and estuarine wetland change from 1996 to 2010 in U.S. coastal shoreline counties using data from NOAA's Coastal Change Analysis Program. We then synthesized available data on Federally funded palustrine and estuarine wetland restoration in coastal shoreline counties. Since 1996, U.S. coastal shoreline counties have lost 139,552 acres of estuarine wetlands (2.5%, 9,303 acres per year) and 336,493 acres of palustrine wetlands (1%, 22,433 acres/yr). From 2006 to 2015, Federal agencies have funded the restoration of 211,942 acres of estuarine wetlands (21,184 acres/yr) and 154,153 acres of palustrine wetlands (15,415 acres/yr) in coastal shoreline counties. While these results suggest recent estuarine wetland restoration efforts may offset estuarine wetland losses, palustrine wetland restoration has not kept pace with wetland loss. Further, we found that wetland losses and restoration efforts were often not aligned, resulting in local and regional winners and losers. We also currently lack the monitoring data necessary to evaluate the effectiveness of restoration efforts at restoring wetland functions and services. Although significant progress has been made, further conservation and restoration efforts are necessary to achieve no net loss.

S111: LEO Oceans: Local Observer Surveillance of Ocean Changes and Identification of Solutions

Thomas Okey
Ocean Integrity Research and University of Victoria

The Local Environmental Observer (LEO) Network (leonetwork.org) is a global community of

citizens and experts documenting unusual environmental change, understanding those changes, and finding solutions. It features a growing online database of quality-assured observations that can be queried topically, geographically, and temporally. Observations integrate local, indigenous, and scientific knowledge systems, and they become published collaborative posts with attribution. First-person LEO Network observations naturally concentrate along coastlines. Implementation of LEO Oceans, based on the LEO Network, is a U.N. voluntary commitment on ocean action (#21889). The commitment objective is to rapidly establish an effective local-knowledge-based global oceans surveillance system for detecting, measuring, understanding environmental change across scales, and to enable the development of scale-relevant solutions such as social-ecological adaptation actions. LEO observations are topically organized, and link with, powerful resources related to the topics of each observation. We aim to link observations of unusual environmental change with relevant adaptation and mitigation solutions through dedicated linkages to resources such as those provided by cakex.org for adaptation solutions, Drawdown.org for mitigation solutions, and other ocean-relevant solution resources. LEO Oceans is the primary platform and network for local documentation of changes in ocean social-ecological systems, and for exploring both local and global solutions.

S112: Smart Sea Level Sensors for Coastal Emergency Planning and Response

Randall Mathews
Emergency Management Chatham County, Georgia

Coastal flooding represents a growing threat to the City of Savannah and adjoining areas in Chatham County, which are home to diverse communities rich with cultural heritage and thriving economies. Recent brushes with Hurricane Matthew in 2016 and Hurricane Irma in 2017 saw storm surges of 7+ feet at the county's only two tide gauges, shutting down county schools and businesses for days. During these extreme weather events, strong winds interacted with an extremely intricate network of coastal rivers, tributaries, and marshlands to create a complex pattern of flooding that varied by 2-4ft over a distance of several miles. The Smart Sea Level Sensor Project aims to install a large network of 50-100 internet-enabled water level sensors across flood-vulnerable Chatham County, via a working partnership between officials from the Chatham Emergency Management Agency (CEMA) and the City of Savannah, together with a diverse team of scientists and engineers from Georgia Tech. The sensor network will span a wide range of tributary sizes, orientation, and building densities. The data collection will be complemented by a suite of modeling tools to inform flood risk and vulnerability, including a high-resolution coastal ocean model as well as an integrated hydrological model to capture surface runoff during high precipitation events. Taken together, the framework enables the assessment of short- and long-term coastal flooding risk and vulnerability that are required to inform planning for flood mitigation strategies in Chatham County and other coastal communities across the southeastern US.

S113: Sea-Level Rise in Public Science Writing: History, Science and Reductionism

Susanna Lidstrom
KTH Royal Institute of Technology (Scripps Institution of Oceanography)

Sea-level rise is a dramatic effect of climate change, with profound implications for societies around the world. In the past few years, a rush of literary non-fiction books have appeared that aim to explain the threat of rising seas to the public. This paper critiques how sea-level rise is framed in many of those books, on two accounts. First, anthropogenic sea-level change is frequently framed by accounts of natural variations of sea level in earth history, focusing on geological rather than societal processes. Second, single and sudden floods are often used to exemplify sea-level rise

in ways that draw attention away from incremental environmental change in favour of fast-paced but de-contextualised events. The paper argues that both these frames de-politicise sea-level rise and may steer public understanding and discussion away from relevant social, cultural, and ethical considerations. As examples of climate reductionism, these depictions may obstruct rather than facilitate appropriate negotiations in response to predicted sea-level rise.

2.2.2 Resilience of Coastal Ecosystems: Tropical Oceans and Coral Reefs

S214: Building Local to International Resilience in the Pacific Islands

KEYNOTE PRESENTATION
Elisabeth Ann Holland
University of the South Pacific

Resilience requires solutions founded on local participatory actions reinforced by international leadership and diplomacy to compel climate and ocean action. Across 15 Pacific Island countries and territories: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of the Marshall Islands, Samoa, Solomon Islands, Timor Leste, Tonga, Tuvalu, and Vanuatu, efforts are underway to combine locally managed climate change adaptation networks with locally managed marine networks to build climate resilient development pathways. The efforts combine indigenous and local knowledge with climate and ocean science to implement actions that support both community resilience and ocean stewardship. In a study of 4 villages along Fiji's Coral Coast, mangrove restoration demonstrably supported climate resilient development, to provide economic livelihoods, support provision of ecosystem services and to support 21 targets of 14 Sustainable Development Goals (SDGs), 20% of the SDG targets and an overall 14 out of the 17 Sustainable Development Goals, from poverty eradication to climate change resilience. In parallel, Pacific Leaders have led the way to implementing the Paris Agreement with Fiji leading the UN Conference on Oceans and COP23 in 2017 resulting in an ocean pathway to ensure that oceans have a role in the UNFCCC.

S215: The Scientific Evidence of Hope

KEYNOTE PRESENTATION
Elizabeth Mcleod
The Nature Conservancy

Climate change is causing unprecedented changes in our world's oceans. The ability of local management efforts to protect corals has been challenged in the face of recent back to back coral bleaching events. Despite the scope and magnitude of climate impacts, new advances in technology, local actions, and global commitment provide hope for the future of coral reefs ecosystems. While the most urgent action to protect corals is the immediate reduction on carbon dioxide emissions, there are a number of steps that can be taken to provide corals a window of opportunity. This presentation will explore these steps and discuss the evidence for their efficacy in a changing world.

S216: Dead reefs shining: bright spots in the low coral Caribbean reefs of the Anthropocene

KEYNOTE PRESENTATION
Sarah Lester
Florida State University

Dramatic coral loss has transformed Caribbean reefs into degraded, but novel ecosystems. Most

previous studies and management efforts have focused on documenting coral loss and its consequences rather than examining the range of ecological outcomes on reefs with low coral cover. Here we evaluate key ecological functions and ecosystem services of 328 Caribbean reefs varying in coral cover. Surprisingly, we found high variability in some ecological outcomes on low-coral reefs. While some functions (coral recruitment, reef accretion) are are more strongly correlated with coral cover, others such as herbivorous fish biomass and fishery value show no relationship to live coral cover. Sites with high herbivorous fish biomass and fishery value are as likely or more likely to be lower-coral vs. higher-coral cover reefs. Coral should be protected and restored where possible, but contemporary science and management should seek to understand and foster high-functioning bright spots among the degraded Caribbean reefs of the Anthropocene.

S217: Biodiversity enhances coral growth, survivorship, and resistance to macroalgal invasion on degraded reefs

Cody Clements
Georgia Institute of Technology

Coral reefs are declining dramatically and losing species richness, but the impact of declining biodiversity on coral well-being remains inadequately understood. To assess how diversity affects coral performance, we manipulated coral species richness in experimental plots on a degraded reef. We made monocultures of three common Indo-Pacific corals and compared these with polycultures containing all three species. Intraspecific differences in coral growth and tissue mortality between monocultures and polycultures were assessed after 4 and 16 months, as was total plot colonization by benthic macroalgae after 16 months. Corals exhibited up to 190% greater growth and 40% less tissue mortality when grown in polyculture compared to monoculture, while macroalgal biomass in polyculture was comparable to or less than monospecific plots. Coral growth in polyculture was also greater than (4 months) or equal to (16 months) growth in the most productive monoculture, suggesting that both selection and complementarity effects may be contributing to enhanced coral community performance. Our findings highlight the positive role of biodiversity in the function of coral reefs and suggest that loss of coral species richness may trigger a negative feedback that causes further ecosystem decline.

S218: Marginal reefs facing global changes: insights from Brazilian reefs

Guilherme Longo
Federal University of Rio Grande do Norte (UFRN - Brazil)

Global changes are affecting reef ecosystems worldwide by warming and acidifying the oceans, and by increasing the frequency and intensity of extreme events. Corals are running out of options as areas that have not yet experienced massive bleaching are likely to experience bleaching soon. Still, most studies on the impacts of global changes on corals and reefs are leaving an important part of the story out of the map: the marginal reefs. We are assessing the potential impacts of climate changes on Brazilian reefs by integrating multiple approaches including: historical ecology; scientific monitoring; predictive models; mesocosm experiments and citizen-science. We found that: Brazilian reefs have lost coral cover and large fish over time; the main reef-building corals may be resilient to bleaching caused by extreme events; global changes will directly affect food web dynamics and interactions among species; ocean warming may reduce the territorial behavior of damselfishes impacting ecosystem functioning; and that citizen science may be an excellent tool to expand monitoring efforts. If we aim to advance our understanding on the impacts of climate change on reef ecosystems, we need to strengthen the studies on marginal reefs, which can be used as surrogates of the future of diverse reefs.

S219: Adaptive Reefscapes reduce social and ecological vulnerability and increase adaptive capacity

Becky Twohey
Coral Reef Alliance

Coral reefs are in crisis due to a combination of global climate change and local stressors. If we are to have functional reef ecosystems in the future, they will need to adapt through evolutionary and ecological processes. We report on new scientific research that shows how management actions can facilitate adaptation and reduce both social and ecological vulnerability. Our approach, called Adaptive Reefscapes, is to create networks of healthy reefs that are diverse, connected and large. The network design principles are built on portfolio theory in such a way as to minimize risk and maximize chance of advantageous genetic adaptation after environmental shocks, a process known as evolutionary rescue. Importantly, our approach is scalable because it builds upon existing conservation efforts that match local conditions and align with human-centered needs that can be replicated throughout a region. Here, we will share both the scientific basis of Adaptive Reefscapes as well as how those principles are being applied in the MesoAmerican Region by managers who are reducing socio-ecological vulnerability and increasing socio-ecological adaptive capacity.

S220: Uncertain fishing in a changing world, tales from Mexican fisheries

Stuart Fulton
Comunidad y Biodiversidad

Fishers make daily decisions about where and when to fish. Climate change is creating uncertainty, with changes to species distributions, extreme weather and the creation of new social conflicts. When climate uncertainty is combined with other factors of global change such as international politics, markets, technological advances, and more recently in Mexico, organized crime and the use of social media, are considered, Mexico's fisheries are in a severe state of flux. From 20 years of anecdotes from Mexico's Pacific, Gulf of California and Caribbean coastlines we highlight the rapidly changing problems that fishers face, and how the speed at which they react far outpaces the government's efforts to regulate. Fishers have always been adaptable, following seasons and switching from one fishery to another. Some of their decisions are good and promote resource sustainability and social benefits, whilst others are not. For example, to compensate for decreased income from high value commercial invertebrates, fishers are catching more fish, with increasingly less sustainable gear. Fishers are also excellent citizen scientists acting as early-warning systems to changing coastal conditions, and they will survive in a changing world, independently of national and international policy making for fisheries and climate change.

S221: Multi-dimensional value of sharks in the South Florida shark fishery socio-ecological system: Implications for policy effectiveness

Rachel Skubel
University of Miami

Historical overfishing of sharks in South Florida has necessitated policy interventions to restore populations to sustainable levels. The number of commercial shark fishers in South Florida has dropped starkly, and in some communities has ended entirely, and recreational fishers are subjected to regulations on what, where, when, and how much they can catch. Despite increases in some shark populations attributed to these regulations, there have been stakeholder conflicts over shark conservation policy arising from recent increases in recreational shark fishing alongside other beach and ocean-goers. Here, we characterize attempts by policy-makers to balance the needs of

ocean-users with ecosystem health, considering that similar community structures and relationships observed at present, and roadblocks to policy effectiveness, may continue to be significant in future efforts for socio-ecological resilience. We applied ethnographic methods including participant observation and interviews, to examine the role of relational values in the policy lifecycle, with a specific focus on public feedback and stakeholder meetings. These values provide a conceptual framing for how fishers react to changes in their access to sharks, how stakeholder groups relate to one another, and how the respective values of actors at each stage of the lifecycle can ultimately influence policy effectiveness.

S222: The whale shark: ambassador for the pelagic oceans

Alistair Dove
Georgia Aquarium

One way to engage the public in solving ocean challenges in an intrinsically positive fashion is through the cultivation of ambassador species: animals towards which people are positively disposed, and through whose lives they can understand and relate to scientific concepts or conservation issues. The maintenance of whale sharks in the collection at Georgia Aquarium has afforded just such an opportunity, and the species is an ideal candidate for the ambassador approach; it is big, harmless, unusual, intriguing, cosmopolitan and charismatic, all ideal ambassador properties. Since 2005 the team at the aquarium and their academic partners have explored many aspects of biology and ocean conservation, often using the whale shark as a vehicle to help people understand the scale and risks of particular threats. Bringing these science and conservation stories back to the aquarium and weaving them into the exhibit narrative and communications program has helped millions of guests to relate to ocean science and conservation in new ways. As you work on science and conservation challenges in the future, consider cultivating partnerships with public aquariums and using the ambassador species approach so that your ocean science and conservation efforts remain relevant, relatable and engaging to the public.

S223: A comparative study of adaptive capacity of Marine Protected Area management in Mauritius

Josheena Naggea
Stanford University

This research aims to evaluate the adaptive capacity of the Marine Protected Area (MPA) management agencies of four Western Indian Ocean (WIO) nations: Kenya, Tanzania, Seychelles and Mauritius. A new program, called the Strategic Adaptive Management (SAM) approach by SMART Seas Africa, has been developed to train MPA managers in the WIO to use a proactive, science-based approach for adaptive management. So far, SAM has been implemented in Kenya (since 2009), Tanzania (since 2013) and Seychelles (since 2016) and has had numerous positive impacts. Through a series of surveys and interviews with MPA managers across all four countries, our study aims to compare managers skills, proactiveness, sense of place and, connectedness to nature. The results will be used to identify gaps in management and provide recommendations for non-SAM countries like Mauritius, where MPA management is mostly top-down.

S224: Toward predicting the biodegradation rates and ecosystem recovery in coastal marine sediments impacted by oil spills

Smruthi Karthikeyan
Georgia Institute of Technology

Although petroleum hydrocarbons discharged from the Deepwater Horizon (DWH) blowout were shown to have pronounced impacts on indigenous microbial communities in the Gulf of Mexico, effects on coastal ecosystems remain comparatively understudied owing to the stochasticity and complexity of ecosystem processes as well as the lack of appropriate model microorganisms for studying the fate of oil in beach sands.

By performing mesocosm incubations with advection chambers that closely simulate the beach sand environment, including oxygen and water transport phenomena, we show that the microbial community structure undergoes reproducible succession patterns during oil biodegradation under different conditions. In particular, early responders to oil contamination, likely degrading aliphatic hydrocarbons, were replaced after three months by populations capable of aromatic hydrocarbon decomposition that represented both previously known as well as novel taxa. Among the latter, we noted a population that is highly abundant in oiled sediments of coastal marine ecosystems across the world, often comprising 30% of the total community, and virtually absent in uncontaminated or recovered sediments or seawater. This population may be useful as biomarker for enhanced oil decomposition activity. We also noted a dramatic reduction in the abundances of several autotrophic archaeal populations in oiled samples that could serve as biomarkers of oil toxicity. Most of these patterns were also observed in field samples from the Pensacola public beach (Florida, US) after the DWH spill. We will discuss how these patterns can be used to identify the phase (e.g., early, mid, late) of oil biodegradation and the limiting factors for microbial activity during in-situ bioremediation efforts.

S225: Land to Sea: Reducing Plastisphere Formation in Mangrove Ecosystem

Folasade Adeboyejo
EcoHub Initiative

Coastal states in the tropics are leading the chart as major contributors of mismanaged plastics of 5 -13 million tonnes entering the ocean. High population, consumption pattern and poor waste management are contributing factors making tropical marine ecosystems witness leap in degradation from plastic pollution. The mangrove ecosystem might be the worst hit coastal ecosystem due to its unique positioning; receiving plastic exported by river, ocean and branching networks of its prop root. Thereby creating new sink zones for plastics with estimates unknown. Although, plastic fishing is a removal solution and an alternative source of living for fishermen along Lagos lagoon due to declined fisheries resources, it is contributing to mangrove deforestation in this region. Communities associated with mangrove ecosystem are often underserved making waste management a challenge. Household waste are major contributors to CO2 emission are burnt indiscriminately, dumped in open surface and water bodies where it constitute marine litter. In a bid to develop preventive solution that reduce marine litter, improve mangrove ecosystem health and conservation, EcoHub Initiative is championing community led recycling in underserved coastal communities. This is built on the pedestals of plastic bank, a social innovation that aids last mile plastic separation and upcycling with zero CO2 emissions. We are a hybrid, youth-led organization working to distribute the plastic banks to coastal communities based on hydrodynamics, modelling of plastic transportation pattern, and knowledge of source and sink zones.

2.2.3 Protecting Ocean Health: Ocean Acidification and Hypoxia

S326: The Western South Atlantic Ocean: Fast growing observations on acidification and deoxygenation

KEYNOTE PRESENTATION

Leticia Cotrim da Cunha

Faculdade de Oceanografia, Universidade do Estado do Rio de Janeiro

Recently, Kerr et al. (2016) assessed the state of the art on ocean acidification and its impacts, as well as the risk of coastal eutrophication to deoxygenation and increased seawater acidity through respiration along the western south Atlantic Ocean (WSAO) coast and margin. Major gaps were identified, namely the lack of regional long-term coastal an open ocean observations and analytical capacity, and the use of modeling tools to evaluate the impacts. The region comprises a large latitudinal range, and consequently has a number of key marine ecosystem types such as mangroves, warm water coral reefs, salt marshes and carbonate shelves, providing food and ensuring socioeconomic activities (tourism, fisheries, aquaculture) to the population.

Observational and organism-oriented studies on ocean acidification (OA) and related impacts has been peer-review published since the last above-cited assessment, along with the kick-off of long-term ecosystem comprehensive studies, thus creating a considerable amount of new data. The launching of a regional Latin American OA scientific network (LAOCA) in 2015 has certainly contributed to a better integration of scientists and capacity building across the region.

In this study we assess and review the recent improvements in ecosystem observations and process/organism studies across the WSAO, and suggest new scientific efforts to cover knowledge gaps.

S327: Ocean hypoxia in a warming climate: physical drivers and physiological responses predict patterns of biogeography and mass extinction

KEYNOTE PRESENTATION

Curtis Deutsch
University of Washington

Rising temperatures and declining oxygen are among the most robust observations of global ocean change, and are projected to accelerate this century in concert with anthropogenic climate warming.The impact of these trends are linked through the physiology of marine organisms, which increases metabolic oxygen demand in warmer water that supplies less of this essential gas. I will present emerging analyses that quantify the physiological basis for variation of temperature-dependent hypoxia tolerance in diverse marine species, and reveal its critical role in shaping the biogeography of animal life in the sea and its changes in response to climate change.Examples will include decadal variability in the California Current and the global patterns of extinction risk in the largest mass extinction in Earth's history.These analyses imply that solutions to the conservation of marine biodiversity must include mitigation of anthropogenic climate warming.

S328: Ecosystem and Economic Resilience under Ocean Acidification

KEYNOTE PRESENTATION

Jessica Cross
National Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory

Concern about ocean acidification as a scientific issue and a marine resource management concern has grown rapidly over the last decade, as the present and likely future impacts of this global ocean change have come into focus. According to the Intergovernmental Panel on Climate Change (IPCC), ocean pH has dropped by about 0.1 units since the start of the Industrial Revolution, corresponding to about a 30% increase in acidity. The resulting chemical changes could have significant consequences for many marine ecosystems and marine ecosystem services. Experts are concerned that OA will cause cumulative ecosystem level shifts that put human communities and resources at risk damaging commercial fisheries, eroding food security, and driving cultural losses.

Furthermore, future projections indicate that the duration, intensity, and extent of acidification events and their impacts are likely to increase as anthropogenic carbon dioxide continues to build up. Recently, the international community has responded by developing decision support and risk mitigation strategies for a variety of economic sectors that could be impacted by ocean acidification. Here, we will discuss OA observations and forecasts, adaptation strategies, and resilience building, and reflect on best practices for initiating efficient, lasting, sustainable responses to ocean acidification risks.

S329: From Knowledge to OA Action: Mobilizing Global Leadership to Advance OA Action Plans that Protect Coastal Communities and Livelihoods from a Changing Ocean

Jessie Turner
International Alliance to Combat Ocean Acidification

In 2016, the West Coast governments of British Columbia, Washington, Oregon, and California launched the International Alliance to Combat Ocean Acidification (OA Alliance), an international network of governments and organizations that together address ocean acidification and other threats from changing ocean conditions.

The OA Alliance was established in direct response to the impact of ocean acidification to oyster hatchery production that was felt across the West Coast, and to motivate governments to proactively respond to impacts of ocean acidification on coastal communities and livelihoods.

Together the OA Alliance is: 1) Supporting governments to take meaningful actions to address changing ocean conditions; 2) Pushing for inclusion of strong ocean protection provisions in international climate agreements and other relevant frameworks; and 3) Creating a coalition of governments and partners elevate the visibility and importance of OA in public discourse and policy development.

OA Alliance members are working together to elevate the issue of ocean acidification and develop OA Action Plans that contain practicable, implementable steps to mitigate causes, to adapt to unavoidable change and to build resiliency in marine ecosystems and the coastal communities impacted by changing ocean conditions. The OA Action Plan toolkit provides members with examples and suggestions on a strategic process for getting started on the creation OA Action Plans.

S330: Novel Nanosensors for Assessment of Heavy Metals in Water Case Study Northern Egyptian Lakes

Ziad Khalifa
British University in Egypt

Northern Egyptian lakes have an economic importance in terms of fish production that amounts more than 75% of total fish production in Egypt. Contamination of its water with heavy metal ions causes great problem for human beings. The trace of these ions are very toxic and can exert direct impact on human body resulting in several diseases. Therefore, there is a remarkable demand to detect heavy metal ions in a fast, sensitive, and selective way. Conducting polymers based nanotechnology overcomes these challenges and endows the sensing platform a better performance. Poly (1,8-diaminonaphthalene/glassy carbon) doped with silver (Ag) nanoparticles modified electrodes is a sensor capable of detecting trace amounts of Pb+2, Cd+2 and Cu+2 heavy metal ions in both natural and sea water. Further, the cadmium ions bind strongly to the sensing surface than other ions and due to this the sensor is highly sensitive for Cd2+ ions. The sensor's performance is best for the low concentrations of heavy metal ions and its sensitivity decreases with the increasing concentration of heavy metal ions.

S331: Larval fish habitats and deoxygenation in the northern limit of the OMZ off Mexico

Laura Sanchez-Velasco
Instituto PolitÈcnico Nacional - Centro Interdisciplinario de Ciencias Marinas

The aim of the study was to determine the present state of deoxygenation in the OMZ off Mexico and to detect its effects on larval fish habitats, considering the larvae sensitivity to decreased dissolved oxygen. A series of cruises (2000 to 2016, including a warm event) suggested vertical expansion of suboxic layer (< 4.4 μmol/kg). This layer has risen 100 m at 19.5 ^{o}N off Cabo Corrientes and 50 m at 25 ^{o}N in the mouth of the Gulf of California. The larval habitat distribution was related to the geographical variability of dissolved oxygen detected during cruises made between these latitudes. One recurrent larval habitat was located throughout the water column off Cabo Corrientes between 4.4 and 220 μmol/kg with Bregmaceros bathymaster as indicator species. The second recurrent habitat was located between the oxycline (> 44 μmol/kg) and the surface near the Gulf, represented by Benthosema panamense. During the warm event of 2015-2016, a tropical larval fish habitat (Auxis spp.) appeared to modify the larval habitat distributions. Results indicate differential response of the fish larvae to the dissolved oxygen concentrations and to the interannual events, showing some species have a resilience to the present stage of deoxygenation.

S332: From Genes to Ecosystems: Microbial Consequences of Ocean Oxygen Loss

Frank Stewart
Georgia Institute of Technology

Marine oxygen minimum zones (OMZs) support complex microbial assemblages with major roles in ocean biogeochemistry. The integration of genomic analyses with coupled biogeochemical measurements is enhancing our understanding of OMZ microorganisms, revealing a richness of metabolic processes structured along the vertical redox gradient and previously unrecognized linkages between elemental cycles. Recent work by our lab has identified novel clades of OMZ bacteria mediating anaerobic methane and sulfide oxidation coupled to denitrification, as well as previously unrecognized adaptations to anaerobic metabolism by the world's most abundant bacterium. This talk highlights these and other OMZ processes in relationship to key environmental drivers, including water column chemistry and the microscale partitioning of communities between particle-associated and free-living microniches. Coupled omic-biogeochemistry studies are necessary for understanding how oxygen concentration constrains microbial diversity and activity, and consequently for predicting how ocean de-oxygenation will affect chemical cycles and ecosystem structure under global climate change.

S333: Searching for ocean acidification refugia in variable environments

Lydia Kapsenberg
CSIC Institute of Marine Biology, Barcelona

Over the last few years, oceanographic observations of pH variability have inspired the idea that ocean acidification (OA) refugia exist. To evaluate the importance of natural pH variability on OA impacts, we reviewed all studies that incorporate variability into their assessment of biological responses. More than 50 publications matched the search criteria. Studies were divided into two broad categories: (1) direct effects of variable carbonate chemistry, or, (2) the influence of environmental history. For direct exposures, the majority of observed biological responses were insensitive to pH variability, with no trends of positive or negative effects across species or biological processes. For environmental history studies, 70% of observed biological responses of non-photosynthesizing calcifiers showed a reduction in OA sensitivity when the organisms came

from a variable pH environment. These results indicate that (1) temporary increases in pH are unlikely to mitigate OA, (2) locations of intense variability may facilitate adaptation to OA for non-photosynthesizing calcifiers, and (3) only areas of substantial and persistent high mean pH, regardless of temporal variability, have the potential to serve as true OA refugia. As such, local OA management strategies are highly dependent on local carbonate chemistry dynamics and the biological process of interest.

S334: Exploring hypoxia alleviation through the use of vertical pipes

David Koweek
Carnegie Institution for Science

Low dissolved oxygen, or hypoxia, remains a persistent ecological and biogeochemical problem in coastal ecosystems due to high rates of nutrient input and water column stratification. Much attention has been paid to the role of nutrient input reductions to the coastal zone as a form of reducing the drivers of hypoxia. However, more direct measures of oxygenating hypoxic waters are also needed. We present some initial results of an investigation into the role that large floating pipes may play in enhancing vertical mixing and thus alleviating hypoxia. We use simple energy modeling to show that downwelling is generally more energy-efficient for oxygenating water bodies than are various forms of aeration, such as fountains and bubble diffusers. We use more sophisticated models to show how large floating pipes may induce circulation cells that expand the footprint of impact beyond the pipe diameter alone. Finally, we present some results from a recent field experiment where we installed a large floating pipe in a reservoir in northern California and used pumps to induce downwelling. We share lessons learned from the experiment and discuss the challenges that arise from trying to quantify the effect of downwelling in a naturally dynamic system. Overall, we argue enhanced vertical mixing from floating pipes may be a scalable approach for addressing coastal hypoxia and deserves further investigation.

S335: Resilience of planktonic open and coastal microbial communities to ocean acidification

Konstantinos Konstantinidis
Georgia Institute of Technology

It remains unclear how marine microorganisms will adapt to ocean acidification (OA), i.e., increase in seawater pH, which is caused by increasing atmospheric carbon dioxide (CO2) concentrations, and how much their activities will be affected. Further, coastal microorganisms often experience greater natural variation in pH, temperature and other stressors due to perturbations such as tropical hurricanes, compared to their open water counterparts and thus, the former may be better adapted to OA. However, this hypothesis awaits experimental testing.

To assess the effects of OA, we have obtained RNA and DNA sequence data from mesocosm incubations (10L) performed under ambient (control) vs. conditions of small changes in pH (0.3 units) and temperature (3^oC), mimicking the expected level of change of the climate in the next couple decades. Our results showed that all the coastal incubations had distinct transcriptional profiles from the open ocean incubations, an observation that highlights the distinct responsiveness of the coastal versus the pelagic communities. Somehow surprisingly, however, we did not detect any significantly differentially expressed functional categories between the control and acidified incubations for either coastal or open ocean water mesocosms. In contrast, the warmed mesocosms showed significantly different gene expression levels for at least 5 functional categories in the coastal incubations (urea subunits and decomposition, ammonia assimilation, DNA repair and serine biosynthesis). These results revealed that a relatively small change in pH (e.g., 0.3 units)

does not substantially affect microbial community gene expression and activity, and a differential response of coastal vs. open ocean communities.

S336: Paving the way for ocean acidification outreach through a developing law in a developing country: Ecuadorian experience

Patricia Castillo-Briceno
ULEAM University

Equatorial ecosystems are expected to face levels of ocean acidification that by 2050 would drive loss of several species in countries that host numerous biodiversity hot spots. Moreover, it is an increasing risk for developing countries, where marine related productive activities -such as fisheries and aquaculture- are part of their strategies for socio-economic development, and that have a lag in local research on ocean acidification. That is the case of Ecuador, and therefore actions to encourage the study of this problem are urgently required. In 2014, we initiated a research program on ocean acidification and equatorial biome to be developed in Ecuador, and focusing in native marine species that are relevant for food sovereignty. A crucial part to start our scientific work was a continuous going beyond the experiments to outreach and back to the lab, thus involving public decision makers and production stakeholders in: environmental, coastal, law making, aquaculture, science management and higher education sectors. These interactions allowed us to integrate other elements to refine our research projects to be meaningful for the local and national context, as well as to be regional and internally articulated. And moreover, it generated the conditions to include the topic of ocean acidification and its relevance for the country sustainability during the construction of the National Environmental Law, approved in 2017. This achievement is currently returning an increasing commitment of research institutions, universities and decision making sectors to incorporate ocean acidification subject in their activities, and to develop collaborative experiments, recognizing the need of further research to prevent and mitigate its impact in species relevant for food sovereignty and biodiversity.

S337: Ocean observations from local to global scales, with applications from science to society

Jan Newton
University of Washington

The change in ocean properties projected from warming, hypoxia, and ocean acidification deserves all our attention yet most people on the planet are not ocean literate. Ocean observing systems seek to increase the availability and usability of ocean data and information. On local scales, the states of Washington and Oregon with our NOAA partners and NANOOS (part of U.S. IOOS) have worked with shellfish growers to provide pH and aragonite saturation state monitoring at hatcheries (www.nanoos.org). Further, socializing access to buoy observations offshore of growing areas and modeled forecasts on weekly and seasonal timescales has made a difference in shellfish growing practices. Enhancement of this work from Alaska to California has yielded a network where local growers can check the data and scientists can assess how drivers of variation change with latitude and location (www.ipacoa.org). On a global scale, over 540 scientists from 84 countries have come together to form the Global Ocean Acidification Observing Network, GOA-ON, www.goa-on.org, a collaborative international approach to document the status and progress of ocean acidification in open-ocean, coastal, and estuarine environments, to understand its impacts on marine ecosystems, and to provide biogeochemical data necessary to optimize forecast modeling. Collaboration, partnerships, integration, and transdisciplinary sharing have been the keys to success in all of this work.

2.2.4 Sustainability of Ocean Resources: Marine Spatial Planning

S438: Marine Protected Ares In A Changing Climate

KEYNOTE PRESENTATION
Fanny Douvere
UNESCO - World Heritage Centre

Today, 49 marine protected areas across 37 countries have received the highest international recognition for conservation, e.g., UNESCO World Heritage status. Sites are part of a global collection of iconic places that reflect humanities most unique places on Earth. They stretch from the tropics to the poles and include Australia's Great Barrier Reef, the Galapagos Islands in Ecuador, or the Sundarbans in Bangladesh, among other. Yet despite their status, they are not immune to the challenges the oceans face. Working daily across 49 flagship marine protected areas confirms clearly that local management is no longer enough. This presentation will draw on a decade-long experience, illustrate how climate change is rapidly changing Earths' most iconic ecosystems and discuss how most current management practices are not up to the challenge to adapt to the change.

S439: Untangling the Mess with Marine Spatial Planning

KEYNOTE PRESENTATION
Grover Fugate
Coastal Resources Management Council

In 2010, the Rhode Island Coastal Resources Management Council (CRMC) adopted the Ocean Special Area Management Plan (Ocean SAMP), as a comprehensive set of regulations outlining Rhode Island's process for ensuring the management and protection of its ocean resources and activities, going offshore 30 miles into the Outer Continental Shelf waters. The plan gave the state a comprehensive regulatory plan for its ocean waters that reflects exceptional science, rigorous yet flexible policies, and extensive public participation, a plan that would give Rhode Islanders a significant role in determining how the state's offshore waters should be developed, or simply be left alone. The project seemed daunting. In two years a short time frame, as coastal and ocean planning goes, we would try as fully as possible to understand how the ocean waters off of Rhode Island are already being used by people and wildlife, develop regulations to minimize conflict between uses, determine where offshore renewable energy should be sited and managed, and gain public approval and buy-in for the process and its future goals.

S440: Georgia Coastal and Marine Planning (GCAMP): A Policy and Mapping Initiative

KEYNOTE PRESENTATION
Tony Giarrusso
Center for Spatial Planning Analytics and Visualization - Georgia Tech

Georgia's coastal and offshore resources face increasing pressure from a variety of factors, including onshore development, increasing population, demand for offshore fossil fuels, and climate change. In order to better plan for and manage these impacts, the DNR Coastal Resources Division and Georgia Tech teamed up to create the Georgia Coastal and Marine Planner, an innovate GIS based decision making tool. This session will explore how GCAMP can assist a variety of stakeholders in navigating the complex technical and policy considerations of coastal and marine planning and development in Georgia.

S441: Moving beyond static thinking to manage a dynamic world

Heather Welch
NOAA Southwest Fisheries Science Center / UC Santa Cruz Institute of Marine Sciences

Managing for economic and ecological sustainability in marine fisheries often requires novel approaches. Here we present a real-time approach termed dynamic ocean management that is aligned with ocean features in space and time. The most common spatial management approaches use large-scale seasonal closures to minimize risk to protect mobile predators. Here we discuss the history, present state, and future of dynamic ocean management, focusing on both voluntary and mandatory tools and exploring the barriers and bridges towards their implementation. Data on top predators are often sparse and collected using multiple platforms thus synthesizing across data types can provide a more holistic understanding than a single data source alone. Dynamic ocean management approaches have been developed in collaboration with stakeholders and managers to minimize ship strike risk for blue whales in the California Current and to minimize bycatch while maintaining target catch in a pelagic swordfish fishery. These tools use habitat models, real-time satellite data, combined with risk weightings to produce maps of integrated risk and opportunity. These tools should be added to existing static approaches as they are built to adapt to anomalous ocean conditions such as recent marine heatwaves and also inherently serve as a climate-ready management approach.

S442: The only constant is change: HABs, crabs, whales, and fisheries in the California Current ecosystem

Jameal Samhouri
NOAA

In some ways marine conservation has never been more successful. Threatened species of mammals in particular have benefited enormously from strong legislation mandating their recoveries. While this increase in population size is desirable from a conservation perspective, it can have unintended consequences for human activities such as shipping and fishing that operate in the same ocean waters. This presentation will provide an overview of the dramatic increase in whale entanglements in fishing gear in the California Current ecosystem over the last 5 years, and the unprecedented, ecosystem-based science and management efforts marshalled in response. We explore the potential for stakeholder-generated, spatial management measures to reduce both the ecological vulnerability of whales to entanglement and the social vulnerability of fisheries to forced, coastwide closures. These trade-off and scenario analyses are laying the foundation for forecasts of whale and fishing activity, and oceanographic conditions, that will enable managers to anticipate conflicts rather react to them after it is too late.

S443: Projections of early population responses to MPAs for adaptive management of California's MPAs

Louis Botsford
University of California, Davis

Planning for adaptive management of MPAs requires projection of early, transient populations responses to implementation. We have projected the trajectories of 19 nearshore species, based on life history information. The response variables were the increases in abundance and biomass due to the filling in of the age distribution previously truncated by fishing, a precursor to most other MPA benefits. Biomass increased by a factor ranging from 1.1 to 7, and depended critically on local fishing mortality rate, F. We tested a new method of estimating local F to determine the

dependence of precision on amount of sampling. Managers need to plan when a confident decision can be made regarding the efficacy of the MPA. To assess the decision-making ability vs. time, we calculated Receiver Operating Characteristics (ROC) for deciding whether the noisy observed data represented the expected biomass or no effect. These indicated that for most species the time at which a confident decision could be made would 10 y or greater. These results have been used by California Department of Fish and Wildlife to choose indicator species and to plan the decision making in their Action Plan for Marine Protected Area Monitoring.

S444: Designing climate-smart ocean plans

Malin Pinsky
Rutgers University

Multi-sector ocean planning is increasingly used as a tool to mitigate conflicts over space in the sea, but key questions include whether and to what extent static ocean plans are robust to dynamic climate change. Here, we use more than 20,000 projections for 658 marine animals around the North American coast to show that one third of species may be replaced within existing Marine Protected Areas (MPAs) by the end of the century. However, we also identify practical solutions. Networks of protected areas were exposed to half as much turnover, and preparing for species redistribution, even within static multi-sector ocean planning, produced meaningful reductions in climate exposure without requiring substantial tradeoffs for other ocean users. While climate change will severely disrupt many human activities, we find a strong benefit to proactively planning for long-term ocean change, even in the face of substantial uncertainty.

S445: Using resilience assessment to understand the dynamics of marine socio-ecological systems in order to inform climate-change-smart marine spatial planning processes

Ibukun Jacob Adewumi
Whitaker Institute of Innovation and Societal Change, National University of Ireland, Galway

The concept of resilience has gained widespread popularity over the past few decades. As Climate Change (CC) advances, there is an increasing need to develop tools that can provide guidance on how to enhance management and governance of the marine spaces. Invariably, coastal and marine management issues are not just ecological or social issues, but have multiple integrated elements which require the need to make resilience thinking central. Marine/Maritime Spatial Planning (MSP) is becoming apparently and increasingly used as a veritable forward looking tool for managing coastal and marine uses, resources and activities for stable/maximum long and short-term social-economical and environmental gains. However In the face of accelerated CC, today's marine spatial plans need to take into cognizance socio-ecological systems, in which cultural, political, social, economic, ecological, technological, and other components interact in the marine and coastal domain. This paper therefore takes a mixed-method research approach, using the seven principles for building resilience in social-ecological systems highlighted in the 2015 book Principles for Building Resilience: Sustaining Ecosystem Services in Social- Ecological Systems published by the Cambridge University Press ; and the EcoAdapt (2017) actions on how climate-informed Coastal and Marine Spatial Planning can be done as framework to systematically evaluate if the dynamics of change in social-ecological systems for climate change were taken into consideration in the planning processes of four selected marine spatial plans in Europe, North America, and other parts of the world respectively. These evaluations revealed that most of the plans only assume insights from complex adaptive systems and does not consider general system-wide CC resilience in actions and policies taken to address issues. This paper therefore concluded by providing range of recommendations on integrating key concepts of resilience to provide an

alternative way of thinking about CC in the different stages of marine spatial planning process.

S446: Reconciling Ecotourism Development and Conservation Outcomes through Marine Spatial Planning for a Saudi Giga-Project in the Red Sea (The Red Sea Project, Vision 2030)

Vasiliki Chalastani
Laboratory of Harbor Works, Department of Water Resources and Environmental Engineering, School of Civil Engineering, National Technical University of Athens (NTUA), Zografou 15780, Greece

The Red Sea Project is a 28,000 km2 giga-project that will develop a sustainable luxury tourism destination on the west coast of the Kingdom of Saudi Arabia. The destination incorporates the Al Wajh lagoon, a pristine 2,081 km2 area that includes 92 islands with valuable habitats (coral reefs, seagrass and mangroves) and species of global conservation importance. The Red Sea Development Company, the master planner for the Project, has committed to achieve a net-positive impact on biodiversity while developing the site for sustainable tourism. This requires reaching conservation outcomes superior to those of a business as usual scenario for an undeveloped site. We applied Marine Spatial Planning to optimize the conservation of the Al Wajh lagoon in the presence of development, after carefully optimizing this to remove impacts. We tested five conservation scenarios (excluding and including development) using software designed to optimize zoning of the site to meet the prescribed conservation targets. We succeeded in creating a three-layer conservation zoning that achieved, in the presence of development, the same demanding conservation outcomes as those possible in the business as usual scenario. Subsequently, we designed additional actions to remove existing pressures and generate net positive conservation outcomes. The results demonstrate that careful design and planning allow coastal development to enhance, rather than jeopardize, conservation.

2.2.5 Mitigation: Scalable strategies for Blue Carbon

S547: Blue Carbon: A brighter future for coastal wetlands

KEYNOTE PRESENTATION
Catherine Lovelock
The University of Queensland

Coastal wetlands provide ecosystem services that support coastal communities, being particularly important for fisheries, coastal protection, and provding timber and other products. Coastal wetlands also sequester organic carbon in their biomass and soils, which has been called Blue Carbon. Blue Carbon describes both the carbon sequestered in marine ecosystems as well as management strategies that simultaneously achieve conservation of these ecosystems while reducing greenhouse gas emissions. This transformative thinking has been received enthusiatically by governments and communities, stimulating the identification of opportunities for retoration of coastal Blue Carbon ecosystems as well as ambitious targets for restoration. To discover pathways for the successful scaling-up of Blue Carbon I outline progress in the development of Blue Carbon in Australia and in other nations. A range of innovations in science, including global, national and local distributions of soil and biomass carbon, quantification of greenhouse gas emissions from degraded coastal wetlands and models of the impacts of sea level rise have supported adoption of Blue Carbon, but innovative policies, linkages to existing policies, engagement with multiple levels of government, industry and communities have had critical influences on the process.

S548: Blue Carbon: A transformational tool for marine management and conservation globally

KEYNOTE PRESENTATION
Emily Pidgeon
Conservation International

Coastal blue carbon carbon stored in mangroves, seagrasses and tidal marshes is developing rapidly as a tool for sustainable management and conservation of these ecosystems. Foundational to this was the explicit reference recognizing the mitigation value of coastal and ocean ecosystems within the 2015 Paris Climate Agreement. Consequently, a growing number of governments are integrating blue carbon conservation into climate change commitments and strategies, including through National Greenhouse Gas accounting and Nationally Determined Contributions (NDCs) to achieving the Paris Agreement targets. Simultaneously, carbon financing is being piloted to support mangrove conservation activities in multiple locations and climate mitigation value is increasing a motivation for domestic wetlands conservation and restoration. To fully achieve the potential of Blue Carbon to support and accelerate conservation of coastal and marine ecosystems, however, science is needed to fully describe carbon dynamics in terms that are applicable to policy and management. For example, stability of these ecosystems to factors such as sealevel rise is needed to address questions of risk in carbon financing. Clear descriptions of the carbon flux and longterm storage associated with other ocean-based ecosystems, such as kelp, is needed before these ecosystems can be included in Blue Carbon related conservation policy and activities.

S549: Incorporating blue carbon ecosystems into development and climate change agenda in Africa

KEYNOTE PRESENTATION
James Kairo
Kenya Marine and Fisheries Research Institute

Blue carbon describes the carbon storage potential of vegetated coastal ecosystems, including tidal marshes, mangrove forests, and seagrass meadows. Although they occupy less than 0.5% of the world's ocean surface area, these coastal ecosystems are estimated to bury nearly 70% of the carbon sequestered in the world oceans. However, blue carbon ecosystems, are being degraded globally at an alarming rate of 1-7% per year, which is significantly higher than the global loss of tropical forests, estimated at 0.5% per year. When degraded, these critical ecosystems not only halt to take up carbon, but also release the already stored carbon back to the atmosphere leading to global warming impacts. This paper focus on how countries around the world are restoring and protecting mangroves to meet their development and climate change agenda. In eastern Africa, there are 1.1million hactares of mangroves distributed amongst the 11 countries of the region. These forests provide goods and services that are of ecological, economic, and environmental value to the people. Over-harvesting of mangrove wood products, conversion pressure, and pollutions effects are the factors responsible for the 25% loss and degradation of mangroves in eastern Africa over the last two decades. Although countries in the region have emissions estimates under Paris Agreement; and emissions reductions strategies in their agriculture and forests sector (AFOLU), most of these interventions do not include mangrove forests, despite their high carbon sequestration rates and the multiple ecosystem services they provide. Progress of restoring and protecting mangroves in Kenya through carbon financing and prospects of incorporating blue carbon ecosystems in nationally determined contributions (NDCs) will be discussed.

S550: Putting the horse before the cart: Understanding marsh biogeochemistry is essential for managing sustainable ecosystems in a changing world

Amanda Spivak
Department of Marine Sciences, University of Georgia, Athens, GA, USA

Salt marshes occupy narrow slivers of coastlines and have some of the fastest areal soil carbon accumulation rates in the world. Developing large scale marsh carbon budgets and implementing management solutions is complicated by spatial heterogeneity in soil carbon stocks. Some of this heterogeneity is due to the presence of naturally occurring ponds on the marsh platform. Accelerations in sea-level rise have catalyzed pond expansion in some ecosystems and even contributed to drowning. Our data suggest that pond deepening occurs primarily though decomposition and that expansion reduces both marsh ecosystem productivity and soil carbon storage. Certain hydrological management actions that promote pond draining and infilling have the potential to restore lost soil carbon. However, management decisions often involve tradeoffs; actions that optimize one ecosystem service may negatively affect another. An example of this balancing act is the installation of parallel grid ditches in 90% of New England marshes during the 1920s - 1940s. Ditches reduced pond density but had other unintended and long term consequences for marsh sustainability and ecosystem service delivery. Such tradeoffs highlight the need to better understand marsh biogeochemistry as a driver of spatial heterogeneity and develop integrated biogeochemical and geomorphic models to identify effective management solutions.

S551: Mangroves and microbes, coordinated ecosystem engineers in Coastal Ecuador

Natalia Erazo
Scripps Institution of Oceanography

Mangrove forests occupy a large portion of the world's tropical and subtropical coastlines, but land use changes and eutrophication have caused degradation and loss of mangrove habitat. Within mangrove-dominated estuaries, water column microbes are essential to many important ecosystem processes such as carbon and nutrient cycling, and may contribute to the health of the overall mangrove ecosystem. However, the bacterial response to land use change is poorly understood. In this study, we used 16S and 18S rRNA gene analysis, nutrient concentrations, C and N isotopes, and acoustic Doppler current profiling (ADCP) data to evaluate the impact of mangrove land use change on near-shore biogeochemical and hydrodynamic processes in northern coastal Ecuador. Changes in microbial community structure and nutrient concentration were associated with gradients in salinity and land use. Samples in close proximity to active shrimp aquaculture were high in NH4+ and PO43-, showed low diversity, and were dominated by Gammaproteobacteria. Bacterial communities near intact mangrove forest showed high diversity and were dominated by Alphaproteobacteria, Actinobcateria, and Gammaproteobacteria, with lower levels of dissolved inorganic nutrients. The hydrodynamic processes also played a role in structuring the microbial community with higher abundance of Alphaprotebacteria during flood currents and Gammaproteobacteria during ebb currents. These results highlight the sensitivity of the estuarine-mangrove microbial community, and their ecosystem functions, to land use changes . We will present a detailed analysis of the principle drivers of microbial community structure and the implications for ecosystem health and climate mitigation services.

S552: Blue carbon for reducing the impacts of climate change: A DRCongo case study

Mbunzama Narcisse
DRCONGO Sustainable Ocean Research Center

Coastal ecosystems are currently being promoted for their role in carbon sequestration and storage. Among others, they include mangrove swamps, salt marshes and seagrass beds, which are commonly referred to as blue carbon ecosystems. Besides their role in sequestering and storing carbon, the ecosystems have seminal roles in maintaining human well-being and biodiversity, and perform a widerange of ecological functions. With regard to blue carbon ecosystems, DRCongo has a large mangrove coverage. However, global mangrove coverage has steadily shrunk in recent decades due to land use changes and coastal developments. It has been suggested that the degree of loss involved isprobably similar to, or greater than that of tropical forests. The loss of mangrove-based ecosystemshas been widely recognised and is regarded as being of common concern

Protection of blue carbon ecosystems is necessary. In international climate change agreements, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, the capacity of blue carbon ecosystems to sequester carbon has been acknowledged. However, blue carbon ecosystems and activities related to preserving them have not yet been incorporated into legal instruments designed to mitigate climate change.

S553: New solutions to overcome barriers to climate mitigation using seaweed aquaculture

Ilan MacAdam-Somer
Bren School of Environmental Science & Management

Despite more than a decade of interest and investment in understanding the contribution of seaweed aquaculture to blue carbon, seaweed farming as a carbon offset strategy remains an interesting but largely unimplemented idea. We explore the costs, benefits, and unanticipated consequences of seaweed farming in a generalizable life cycle assessment and techno-economic analysis. We consider multiple species, oceanographic conditions, and different farm systems to maximize carbon sequestration potential, while minimizing environmental and economic risks. We then identify and propose solutions to market barriers preventing implementation and scalability of the most promising combinations of species, locations, and farm-types by using the calculated cost of carbon savings. Ultimately, we find that there is substantial suitable habitat for seaweed farming, and if grown in ideal conditions, a one-hectare farm would have a carbon break-even point of 10 years. Although substantial area would need to be converted for farms to completely offset carbon emissions (e.g. approximately 60,000 km2 and 20 years to offset California's emissions), we highlight the potential to utilize identified market opportunities to scale seaweed farming to achieve climate mitigation targets.

S554: Wave Energy Hot Spots Assessment on the West Coast of Sumatra

Ardian Rizal
Bandung Institute of Technology

In the last past few decades, the demand for energy consumption is rapidly increasing and ocean wave energy potential exploration starts to emerge interest to substitute fossil based fuel. In this study, WW3 spectrum wave model was driven to simulate significant wave height span for 25 years from 1991 to 2015 on the west coast of Sumatra. The wave energy was estimated and the annual and seasonal average calculation were determined. The annual average of wave energy shows there are some noticeable hot spots at certain area with the value up to 50 kW/m. Furthermore, these hotspot occurrences site has a similar pattern with the average seasonal calculation. In addition, there is a similar pattern between significant wave height and wave energy associated with the tropical monsoon with the value of wave energy reaches the peak in JJA at 80 kW/m and the lowest value occur in MAM at 10 kW/m. Another parameter of wave energy sites selection statistic were

considered such as OHI, WEDI, and COV calculation. These statistic shows to give an insight into some potential points that is prospective as ocean wave energy harvesting.

2.2.6 Integrated Modelling of Human and Climate Impacts on Ocean Systems

S655: Coastal erosion of the Mekong delta: from processes to countermeasures

KEYNOTE PRESENTATION
Patrick Marchesiello
Institut de Recherche pour le DÈveloppement

The Lower Mekong Delta Coastal Zone (LMDCZ) is emblematic of the coastal erosion problem in tropical delta regions. It has been generated by very large sedimentary fluxes reaching the ocean, but modulated also by waves and currents, which, in combination, redistribute the river intake to the southwest. This process has formed the southern tip of Vietnam for the last 3500 years. But now, in addition to natural forces, the LMDCZ is affected by local human activity, including reduction of river fluxes due to damming and sand mining, and reduction of protective coastal mangroves in favor of agriculture and aquaculture. Relative sea level rise is also a major challenge, although global warming is a minor factor in the current situation when compared with land subsidence due to groundwater extraction. Here, we present the findings of a European-Vietnamese project with the dual objectives of: 1) better assessing the hierarchy of causality for observed erosion patterns; and 2) proposing engineering solutions at two specific sites. A discussion on various aspects of coastal science is proposed based on questions that emerged from the project, e.g., what are the paradigms needed for understanding coastal erosion and protection measures in delta coastal zones? How do we handle the gap between science and civil engineering as researchers?

S656: An integrated framework to assess plausible future livelihood and poverty changes in deltas: an application to coastal Bangladesh

KEYNOTE PRESENTATION
Robert Nicholls
University of Southampton

Deltas represent one of the most densely populated and dynamic areas in the world. In coastal Bangladesh, livelihoods, food security and poverty are strongly dependent on natural resources affected by multiple factors including climate variability and change, upstream river flow modifications, fishing in the Bay of Bengal, and engineering interventions such as dikes/polders. Dry season saline water intrusion and natural disasters (e.g. river floods and cyclones) constrain land use and livelihood opportunities of the coastal population. An integrated framework and an integrated assessment model – the Delta Dynamic Integrated Emulator Model or DIEM has been developed which allows analysis of the possible changes by linking physical processes (e.g. river flows, nutrients), with productivity (e.g. fish, rice), social processes (e.g. access, property rights, migration) and governance/management (e.g. fisheries, agriculture, water and land use management). DIEM has been developed in a participatory manner and is designed to provide science-based evidence to delta planning over timescales of multiple decades. This presentation describes the model framework and aims to illustrate the cause-effect relationship in-between changes of the hydro-environment and the livelihoods and poverty of the coastal population of Bangladesh.

S657: Integrating climate, ecosystem, and human information to understand vulnerability and adaptation strategies for fishing communities

KEYNOTE PRESENTATION

Katherine Mills
Gulf of Maine Research Institute

Globally, climate change is affecting marine ecosystems, fish populations, fisheries, and fishing communities. At local scales, climate impacts emerge in distinct ways depending on the nature and rate of ecosystem change, patterns of dependence on marine resources, and adaptation capacity and choices. For the rapidly-warming Northeast U.S. Shelf, we bring these factors together using climate projections, species distribution models and vulnerability assessments, as well as social indicators and economic models. These integrated models enable us to evaluate the social-ecological vulnerability of 75 fishing communities between Maine and Virginia to species changes that are expected to occur under future climate scenarios. Results of this assessment provide insights into relative vulnerability among communities and key risks to specific ports. In four pilot communities, we incorporate the projected species changes into economic models of the fishing sector and regional economy to quantify the impacts and to assess the potential for specific adaptation strategies to buffer these impacts. Interviews with fishermen and municipal officials enable us to evaluate factors that facilitate or constrain adoption of specific strategies. Ultimately, this information provides a foundation for decision-making and climate adaptation planning at community and regional scales.

S658: The Relationship between Climate Variability and Wind-Induced Upwelling

Lev Looney
University of South Carolina

Upwelling ecosystems are some of the most biologically productive ecosystems in the world's oceans. Economically, upwelling systems account for roughly 20% of the global fish catch, yet compose less than 1% of ocean areas. Coastal upwelling is primarily driven by wind. The intensity, seasonality, and location of upwelling-favorable winds are critical factors influencing ecosystem processes. Anomalies in these winds can have devastating economic impacts and have been associated with different modes of natural variability. Here, we used cyclostationary EOFs to investigate how different climatic fluctuations might influence these winds in different regions. We compare our results with those of earlier researchers who have taken different analytical approaches. An advantage of our technique is the ability to look at the spatio-temporal anomalies in winds throughout the seasonal cycle. In general, our findings are consistent with previous analyses, but this approach offers new perspectives. In the North Pacific, both ENSO events and lower-frequency atmospheric variability are correlated with modifications in upwelling. Our study suggests that climatic variability results in alterations of the seasonal cycle, intensity, and location of winds. Understanding the relationships between climate processes and upwelling-favorable winds is crucial to accurately forecast the responses of these important economic and biological communities with an ever-changing climate.

S659: Similar climate-induced shifts in marine fish larvae and harvested species communities in the Southwestern Atlantic Ocean

Micheli Duarte de Paula Costa
The University of Queensland

The Southwestern Atlantic Ocean continental shelf is among the six richest marine biodiversity regions in the Southern Hemisphere. As this shelf is one of the fastest warming hotspots in the

ocean, there is likely to be profound effects of climate change on species distributions in the future. We investigated climate-induced changes in fish larvae and harvested fish species in the Southwestern Atlantic Ocean using the Gradient Forest approach, a community-based modelling technique. This approach uses information on all species simultaneously, rather than typical species distribution approaches that treat each species independently. We had two primary questions: how might climate change affect the distribution, abundance and composition of fish larvae communities; and will populations of harvested fish species follow the same trends? Using two climate change scenarios (RCP 4.5 and 8.5), we found that both communities of fish larvae and harvested species are likely to be displaced southwards. Greater changes in community composition are projected in the southern portion of the study area for both fish larvae and harvested species communities. There are few studies investigating the impact of climate change on fish larvae and their adults, and this is the first study predicting climate change influences focused on biological communities in the Southwestern Atlantic Ocean. The impacts predicted highlights the need for policies to mitigate environmental and economic effects. By modelling the response of different species to environmental predictors simultaneously, community modelling approaches such as Gradient Forest provide more robust projections of distribution changes.

S660: Human impacts on coastal water quality and ecosystem services

Scott Doney
University of Virginia

Human activities are negatively affecting coastal marine ecosystems across a range of scales from local nutrient pollution, overfishing, and habitat destruction to global-scale climate change and ocean acidification. Examples of human impacts on coastal water quality and fisheries will be shown for the U.S. Northeast based on data synthesis and modeling studies.

S661: One model to help them all? Challenges facing harmful algal bloom prediction in the coastal zone

Clarissa Anderson
Scripps Institution of Oceanography

With the explosion of myriad modeling and remote sensing techniques to estimate the extent and timing of harmful algal blooms, we are now faced with assessing the successes and failures associated with reducing complex biology into a relatively constrained state-space. The practical matter of mitigating the impacts of harmful algal blooms with an early warning system is complicated by the spatial and temporal discontinuities associated with the multiple scales of variability inherent in available model and earth observation data products. The impacts are widespread across these many scales and affect nearshore aquaculture, public health, and offshore fish and mammal populations. Regional modeling efforts have been successful at reaching stakeholders from a variety of these sectors but fail to be a comprehensive mitigation tool for the full suite of vulnerable systems. In this talk, I will address the lessons learned from an operational harmful algal bloom forecasting system in coastal California and efforts to extend the reach of the model to predict higher trophic level impacts in nearshore environments. With the introduction of the California Harmful Algae Risk Mapping (C-HARM) System, coastal conditions conducive to toxic algae can be monitored in real-time. This kind of advanced warning has proven valuable to marine mammal resource managers given the tight connection between offshore toxins and animal stranding events. Where C-HARM provides less information is in major inlets such as the San Francisco Bay-Estuary and Humboldt Bay. The latter is the site of some of the highest commercial oyster production in the nation and is very rarely affected by toxin bioaccumulation even when the coastal region is

experiencing a major bloom event. While this breakdown in the model-observation relationship is in part due to the limitations of C-HARM's spatial resolution, there are also knowledge gaps when translating in-water properties to shellfish toxicity, particularly in semi-enclosed systems. Using a combination of particle tracking simulations and paired measurements of shellfish and water toxin levels, we show the potential for toxic particles to enter the bay from the coastal boundary and, in fact, lead to some of the highest toxin levels on record in an area rarely affected by commercial shellfish closures. I will end with how the use of mechanistic approaches could enhance forecasting systems while at the same time offer a powerful research tool for understanding the dynamical changes that lead to harmful algal blooms in the coastal zone.

S662: Simulating marine life and change: advancing food web modelling capabilities to analyse plausible global ocean futures

Jeroen Steenbeek
Institute of Marine Science (ICM-CSIC)

There has been considerable effort to predict the impact of climate change and anthropogenic activities on the biophysical environment and marine resources at regional and global scales. To further our understanding of how changes in the environment and marine resources will affect marine ecosystems, there is a need for global integrated assessments. We improved a previously developed spatial-temporal ecosystem model of the global ocean (EcoOcean), spanning food web dynamics from primary producers to top predators, and including worldwide fisheries. We re-calibrated EcoOcean and enhanced its ability to reproduce spatial-temporal ecosystem dynamics by linking species productivity and distributions to main environmental conditions in flux under climate change (e.g. primary production, sea surface temperature, salinity, ice cover), accounting for varying species compositions of functional groups in time and space. The updated modelling platform was used to model past and future scenarios of climate change and fisheries, considering intrinsic input parameter uncertainty and alternative input drivers using standardized outputs from Earth-system models (ESM) and contrasting emission scenarios (RCPs) for historical (1950-2005) and future (2006-2100) periods. Standardized ecological indicators were used to compare changes in marine structure and functioning between scenarios. Comparing results from alternative environmental and management scenarios allowed evaluating how climate-driven responses differed. The study sets the baseline to further develop global ocean analyses and contribute to the quantification of cumulative effects assessment of multiple stressors and plausible ocean-based solutions to global change.

S663: Adapting to change: fishing communities respond to climate-driven species range shifts

Becca Selden
Rutgers University

Shifts in species distributions driven by warming oceans have the potential to disrupt the provision of ecosystem services to coastal communities. We coupled information on species distributions with fishing records to quantify the vulnerability and response of fishing communities to climate-driven shifts. Shifts in spatial distribution can both intensify or offset changes in stock biomass, suggesting that fishing communities can experience different trends in fishing potential even during shared climate and fishing conditions. Likewise, fishing communities varied widely in their exposure to shifting species distributions and in their response to changing availability. Fishers following shifts in target species was rare, and limited to large vessels specializing on high value species. Instead, fishers continued to target traditional fishing grounds, exploiting newly available species

where possible. While the majority of fishing communities respond opportunistically to changes in availability, management and economic factors can delay or decouple landings from availability. We conclude that the greatest insights about human responses to shifting distributions of fishery species will come from fully coupled social-ecological analyses of global change, and this approach will be required for climate-ready fisheries management.

S664: How short-term decisions inform long-term understanding: An ocean condition forecast case study

Jessica Kuonen
Oregon State University

A powerful way to bridge science and application in support of sustainable fisheries and coastal economies is to understand how information about the environment is produced, distributed, consumed, and interpreted for short-term decisions. This case study explores how to add value to regional ocean condition forecast information by bringing awareness to the processes that govern decision-making and outcomes within the system. A modified mental models research approach is applied to examine differences and similarities in perceptions of risk and comfort with uncertainty between two interdependent communities, the ocean data provider and end user, and how these perceptions impact accessibility and usefulness of data products. In this study, data providers are academic and agency scientists from institutions that make decisions regarding what ocean condition forecast information to provide to pubic end-users and how to present that information. End users are members of the Oregon commercial fishing community that use ocean forecast information to make decisions in sea-going operations. Comparisons reveal key differences and similarities related to the nature of each profession that impact perceptions of scale in time and space, and the ways that cumulative and intersecting risks and uncertainties act as key drivers in decision-making. Implications highlight the value of working directly with marine operations end users to optimize ocean forecast delivery tools and demonstrates how these interactions can identify the specific ocean conditions of interest to marine operators with regard to long-term climate change research. The research also suggests potential ways to structure cooperation and strengthen relationships between forecasters (short-and long-term) and end-users. Results also have implications for improving collaboration and communication in other areas of marine research that link natural and social science, longer-term climate forecasts, and decision-making.

S665: Serious gaming as a platform for integrated modelling of cumulative impacts

Marta Coll
Ecopath International Initiative

The capabilities of the Ecopath with Ecosim (EwE) food web modelling approach greatly expanded in the past few years to address the interplays between ecosystem dynamics, climate change, and anthropogenic activities. Critically, the introduction of dynamic niche modelling and the capability to incorporate the output of virtually any external model have given EwE an edge to address cumulative impacts onto marine ecosystems and sustainable fisheries. In an effort to synthesize scientific model results to a wider audience, we have integrated EwE and its spatial module, Ecospace, into the Maritime Spatial Planning (MSP) Challenge, a Decision Support Tool (DST) intended for educating policy makers and stakeholders through serious gaming. In the MSP Challenge, game players try to achieve planning goals through the management of a shared marine space. The inclusion of the EwE food web model provides MSP players with realistic short- and long-term ecosystem effects of human exploitation, protection, and climate variability in a 3D game environment. Especially this forecasting component is a key critical aspect for informing policy

advice missing from most DSTs. The EwE - MSP integration is a new way to disseminate scientific advice to those policy arenas where it is direly needed.

3. Posters

3.0.1 Adaptive Social-Ecological Systems: Coastal Climate Change

S170: Coastal and marine ecosystems in a changing climate: the case of Zambia

Joseph Tembo
Ministry of General Education: Copperbelt University

This study presents an analysis of the existing and projected links between climate change and coastal and marine ecosystems in Zambia. Literature indicates that the projected climatic-induced disturbances increased temperature and enhanced extreme weather events are likely to exacerbate more pressures on coastal and marine ecosystems, such as fisheries, beaches and coral reefs. In responding to the projected changes, Zambian government is undertaking a number of initiatives. Likewise, with the adoption of the Water Resource Management Act (WRMA) No. 21 of 2011 strategy shows a number of WRMA related conservation programmes and projects along the coast and provides significant baseline information for developing more adaptation strategies for both people and ecosystems. The study recommends on several aspects: the need to undertake socio-ecological and governance studies in understanding how governance structures influence implementation of WRMA initiatives lessons from forestry and wildlife sectors could be useful. The need to undertake empirical studies to investigate carbon stocking capacity of coastal and marine ecosystems to provide baseline information for Zambia to venture into blue carbon initiatives. Lastly, there is a need for enhanced political will that might make it easier the avoidance of donor dependence on financial and technical supports for WRMA projects implementation.

S171: Volunteer Marine Environmental Management as a type of adaptation to Climate change in Coastal Communities in Lagos, South-Western, Nigeria

Oyeronke Adegbile
Nigerian Institute for Oceanography and Marine Research Victoria Island Lagos Nigeria

A sea turtle rescue and release project launched through Volunteerism in 2009 in Communities

along the Lagos coastline in Southwestern Nigeria metamorphosized into beach Cleanup campaigns and international coastal beach cleanups in 2016 in Coastal communities in Lagos in partnership with the Ocean conservan cy and the movement has been growing into several other areas including recycling/upcycling partnership and temperature changes research. The combination of the awareness, beach Clean-up, recycling and research is aiding climate change adaptation in Coastal Communities in Lagos in terms of coastal resources protection, circular/blue economy and ocean conservation (i.e. sea turtle protection, reduced plastic pollution, cleaner beaches and waterways) and are discussed in details using pictures and graphics. Also the preliminary findings from the plastic thermal pollution research is discussed in this Paper and has shown that it's necessary to carry out further investigation to determine the extent of the plastic thermal pollution in the sea turtle nesting beaches in Lagos, Nigeria.

S172: Ecological, genetic, and social impacts of mangrove expansion in subtropical ecosystems

Manuel Lerdau
University of Virginia

In subtropical regions around the Globe, shifts in vegetation patterns are occurring at the boundaries of where salt marshes and mangroves species coexist. The ecotone occurs as a dynamic stable state between salt marsh grasses and forbs and mangrove woody vegetation. The vegetation composition is controlled by climate and disturbance events. Recently this ecotone has been receiving more attention as mangrove species have expanded their range polewards and replaced salt marsh species in some areas at a rapid rate, as well as salt marshes experiencing large die-off events and landscape level habitat loss. This shift poleward of mangrove vegetation and loss of salt marsh habitat could have lasting effects on ecosystem services provided by coastal habitats such as coastal protection, erosion prevention, nutrient cycling, fisheries maintenance, and rates of carbon sequestration: all of which also influence local and regional economies. These expansions also have potentially large impacts on the genetics, ecology, and evolution of mangroves and their ecosystems.

S173: Adapting ocean spaces for conservation and climate change adaptation

Wanjohi Kabukuru
Indian Ocean Observatory

More than two dozen communities in the Western Indian Ocean are adapting ocean spaces for conservation and climate change adaptation. Through community managed marine parks these communities create no-take marine parks to aid in fish spawning and species reintroduction not to mention promote healthy oceans. This unique model has seen communities seeking carbon credits and promoting mangroves and coral reefs restoration. The inimitable model is fast catching up from Kenya all the way to Madagascar and is supporting government and NGOs marine conservation efforts. The most interesting aspect is seeing these initiatives helping communities cost sharing in environmental benefits. A remarkable payments for ecological services scheme.

S174: Harnessing marine micro-climates for climate adaptation

C. Brock Woodson
University of Georgia

Marine micro-climates can provide spatial refuges (safe spaces) or local adaptation that may be

harnessed to improve marine conservation and management. We analyze multiyear data sets within two fishing cooperatives in Baja California, Mexico, to quantify small-scale ocean variability, describe the degree to which this variability affects the abundance of species, and discuss the potential for marine micro-climates to improve climate adaptation.We find that variation in ocean conditions and species abundances at scales of a few kilometers is striking and robust to large-scale climate forcing. Marine micro-climates into fisheries management and conservation efforts can improve ecosystem sustainability by allowing local adaptation and maintenance of spatial refuges in the face of climate change.

S175: Virtual Reality to increase people awareness of climate change impact on coastal flooding

Tina Korani
San Jose State University

Coastal cities are exposed to rising risk of flooding from sea level rise, increasing storm intensity and local subsidence. Climate change is expected to double coastal flooding within the next decade but some areas could experience floods 100 times stronger. People living in at-risk areas often ignore the impact of climate change on floods intensity and frequency. In this research, we are exploring the usage of Virtual Reality (VR) as a tool to better reach people living in coastal cities and better explain them the impact of climate change on their community. A virtual exploration of the coast in which people can be immersed in a flood, experience its intensity, and visualize the underlying mechanics that created these flooding conditions. We use a combination of GIS data and photogrammetry techniques to create a virtual environment in which people can recognize real locations in their neighborhood and then apply a water texture in Unity3D to create the flood levels desired. The user will be able to select different scenario (historical, 2035 SLR, 2050 SLR) so he can easily compare the different scenario. Information on the model used and its meaning will be provided interactively so the user is also understanding the reason of this change. A survey will be conducted before and after the experience in order to assess how effective this experience was to inform people on how future climate is impacted flooding in their city.

3.0.2 Resilience of Coastal Ecosystems: Tropical Oceans and Coral Reefs

S276: Development of 3D models to evaluate the role of coral reef complexity to shoreline impacts in Kiribati

Heather Summers
University of British Columbia

Coral reefs support a complex ecology and provide a natural, physical barrier from waves thereby protecting coastal communities from shoreline erosion and inundation. The three-dimensional structure of living coral communities provides frictional resistance as waves and currents pass over the reef. However, degradation of coral reefs due to climate change and local human stressors may alter wave attenuation, posing serious challenges for low-lying coastal regions threatened by sea-level rise. For example, many outer reef sites around Tarawa Atoll, the capital of the Republic of Kiribati, have shifted towards weedy, temperature-tolerant coral species which feature low structural complexity.

For this study, we surveyed outer reefs and reef flats in Kiribati to assess reef structural complexity and to determine the ability of the extant reefs to attenuate wave energy and protect shorelines from erosion and flooding. High resolution, three-dimensional topographic reconstructions of reef structure as well as reef flat morphology measurements were developed to study the structural

complexity and used to estimate wave energy reaching shorelines at 16 reef sites around Tarawa and its less populated neighbor Abaiang Atoll. The findings provide insight into possible trade-offs between reef resilience to climate change and shoreline protection as well as the relative vulnerability of different Kiribati shorelines to sea-level rise.

S277: In-situ metabolic measurements reveal complex recovery on a bleached reef

Manoela Romano de Orte
Carnegie Institution for Science

Increases in seawater temperature are increasing the intensity and frequency of coral bleaching events. Lizard Island, located at the northern part of the Great Barrier Reef, experienced massive bleaching events in 2016 and 2017 with nearly 90% of the reefs impacted by bleaching which led to widespread coral mortality. The degradation of corals leds to shifts in the dominant benthic biota on the reefs, from reef-building to non-reef-building communities such as turf algae. To study the influence of those shifts on metabolism we deployed two Coral In-Situ Metabolic and Energetics (CISME) instruments concurrently at the healthy (coral covered) and degraded (algal) parts of mounding coral colonies and calcification rates were compared on light and dark scenarios. The coral- and algal-covered reefs showed similar positive calcification rates during the day. However, nighttime respiration on the surfaces covered by turf algae drove carbonate dissolution. It is not clear whether the dissolving carbonate is from calcifying organisms living in the algal turf or whether it is the underlying coral substrate. The surprising result of daytime positive net calcification on a dead coral skeletal surface suggests a more complex balance between calcification and dissolution than previously assumed.

S278: Contributions of Sediment Mineralogy to the Resilience of Seagrass Beds

Andrew Stancil
Florida Atlantic University

Seagrass provides numerous ecosystem services in tropical regions, including habitat provisioning for juvenile fish, sequestration of nutrients to mitigate coastal eutrophication, and prevention of shore erosion through wave attenuation. In recent years, seagrass decline has been driven globally by increasing external pressures such as ocean acidification and warming water temperatures. Seagrass restoration is difficult, and the few successful efforts have tended to focus on alleviating stressors instead of basic replanting activities. Few restoration projects, however, consider the role of sediment minerology in lieu of other primary factors such as light and nutrients. However, the production of toxic sulfides fueled by organic carbon deposition has been demonstrated to control seagrass growth and expansion. We present results demonstrating that natural distributions of reactive iron offer sediments a level of resilience by titrating sulfides from solution, and in turn, rescuing seagrass. Overall, by constraining the acceptable natural concentrations or optimal amendments of reactive iron required for healthy sediments, these findings provide valuable insights into scalable strategies for restoration management.

S279: Molecular phylogeny of Symbiodinium spp. within selected soft coral genera in the Red Sea, Egypt

Hadeer Ismail
Marine biologist at Faculty of Science, Port Said University, Egypt

Soft corals (Octocorallia: Alcyonacea) represent the most abundant and species-rich order of octocorals in Indo-Pacific coral reefs and many are zooxanthellate. The symbiosis between zooxanthellae (Symbiodinium) and corals is in dynamic equilibrium and remains subjected to constant regulation in response to changes in environmental conditions. Phylogenetic clades and diversity of Symbiodinium within soft coral hosts were investigated using the analysis of nuclear gene sequence at the internal transcribed spacer ITS2 and chloroplast gene sequence variation at the ribosomal large subunit 23S Domain V. A total of twenty-nine soft coral samples of the genera Sinularia, Sarcophyton, Lobophytum, Xenia and Nephthea were collected from two sites, Lighthouse in the Gulf of Aqaba and Marsa Egla in the northern Red Sea during summer 2015 at three depths; (0-5m), (5-10m) and (10-15m). The results revealed that three subclades of Symbiodinium were detected within soft coral hosts; C1 was found within three genera Sinularia, Sarcophyton and Xenia, C3 found in Lobophytum and A3 in Nephthea. There was no change of clades reported in response to bathymetric fluctuation. The recorded subclades showed slight difference between soft corals of the same species collected from different localities.

S280: Coral dominated marine protected areas enhance coral chemical defense against a thermally regulated bleaching pathogen

Deanna Beatty
Georgia Institute of Technology

Coral reefs are in precipitous decline due to thermally induced bleaching and disease. We investigated the effects of no-take coral dominated marine protected areas (MPAs) versus algal dominated fished areas on coral microbial communities and chemical defense against the thermally regulated bleaching pathogen Vibrio coralliilyticus. We also reciprocally transplanted corals between these spatially paired MPAs and fished areas to experimentally evaluate effects on coral chemical defense and microbiomes. For an ecologically sensitive acroporid species, MPAs enhanced chemical defense and this effect became more pronounced under elevated temperatures. In contrast, chemical defenses were not altered by reef state for an ecologically hardy poritid coral or for a weedy pocilloporid coral. Acropora millepora that originated from or were transplanted into MPAs exhibited 46% and 36% increase, respectively, in inhibition of V. coralliilyticus relative to those that originated from or were transplanted into algal-dominated fished areas. A. millepora also exhibited reef of origin effects on their microbial communities, notably by persistently higher relative abundances of Vibrionaceae among individuals that originated from algal-dominated fished areas. These data suggest that for some important reef building but bleaching susceptible species, such acroporids, algal-dominated reefs may suppress coral chemical defense toward Vibrio bleaching pathogens and allow for blooms of Vibrio bacteria that persist within the coral.

S281: Larval Connectivity and Restoration of Diadema antillarum in Bahamian Reefs

Veronica Lucchese
Rosenstiel School of Marine and Atmospheric Science at the University of Miami

A keystone species, Diadema antillarum is an urchin species endemic to the tropical coral reefs of the Atlantic Ocean. D. antillarum populations indicate reef and ocean health. Unfortunately, climate change combined with the 1980's mass urchin mortality episode has led to a severe decline in the Bahamian reefs Diadema population. Efforts by the Bahamian government to restore D. antillarum populations require a deep understanding of urchin larval connectivity in the Atlantic reef system. Using Matlab, this project aims to model larval connectivity of Bahamian and surrounding

reefs using ocean condition parameters (i.e. currents, temperature, salinity, etc.) along with larval parameters (i.e. survivorship, competency, and mortality rates). Understanding larval connectivity will elucidate larval Diadema population dynamics. With this information, we will illuminate critical Bahamian reef areas where restoration efforts, such as transplanting Diadema, should be concentrated.

3.0.3 Protecting Ocean Health: Ocean Acidification and Hypoxia

S382: Blue holes as hotspots of ocean deoxygenation and acidification

Jordon Beckler
FAU Harbor Branch Oceanographic Institute

Blue holes are phenomenal bathymetric features in shallow carbonate platforms easily recognized and most often associated with well known reef systems in, for example, the Bahama Banks, the Yucatan Peninsula, and the Great Barrier Reef. While no blue hole is exactly the same, they generally display much different geochemistries than their surrounding environments, particularly with respect to oxygen and alkalinity. Because fine-scale features such as blue holes are mostly missed on bathymetric surveys, it is likely that many remain to be discovered. For example, on the West Florida Shelf in the Gulf of Mexico, over 20 submarine-sink blue holes have been explored in waters ranging between 15 and 150 m in depth. Surprisingly, few researchers are aware of their existence, despite potential connectivity to the Floridan Aquifer. Indeed, preliminary geochemical exploration has revealed they serve as deposition centers of fine-grained sediments hosting high anaerobic respiration rates and appear to be a source of acidification. We present the first results of a new exploration project that hopes to shed light on the potential impacts of blue holes both regionally and globally with respect to ocean acidification and hypoxia.

S383: Using open-source electronics to expand experimental capacity for climate change research

Natalie Low
Hopkins Marine Station, Stanford University

One important aspect of being able to understand, predict, and manage the ecological impacts of climate change on marine ecosystems is having good empirical data on how organisms respond to climate stresses like temperature, ocean acidification, and hypoxia. Obtaining such data requires experimentally simulating realistic changes in environmental conditions, including patterns of variability and multiple physiological stresses. However, the control systems that can run such experiments tend to be expensive, which restricts these important experiments to a limited number of research institutions and investigators. There has been a rise in the use of low-cost, open-source electronics platforms that are designed for accessibility to students and people without a formal electronics engineering or programming background. These platforms are highly customizable and supported by large online user communities and extensive hardware components and software libraries. We present a low-cost, open-source control system for multiple-stressor climate change experiments, built on the open-source Arduino hardware and software prototyping platform. This system is being used to expand the capacity for key climate change experiments at marine research stations in California and Mexico. We also discuss the development of resources and workshops to build researchers skillsets for effective implementation of the system.

S384: Sensitivity of the grooved carpet shell clam (Ruditapes decussatus) to ocean acidification

Merna Awad
University of Port Said

Ruditapes decussatus, which is known as, the grooved carpet shell clam, is considered to be one of the most popular bivalves in the Mediterranean coastal sites. The current study intents to examine the effect of different levels of acidification on this calcifying bivalves. Juvenile clams (avg. total weight, TW= 2.28 $\pm$ 0.28 g) were incubated at four different CO2 concentrations enriched seawater, 420 ppm (ambient control), 550, 750 and 1050 ppm, which IPCC represent these projected atmospheric CO2 concentrations scenarios for the year 2100. The studied antioxidant enzymatic activities [catalase (CAT) showed an increase recorded at 550 ppm group (23 $\pm$ 2.1 μmol min-1 mg prot-1) compared with the control group 420 ppm which had CAT percentage of (22 $\pm$ 1.9). For lipid peroxidation [malondialdehyde (MDA)] an increase was observed in the clams exposed to 1050ppm (0.23 $\pm$ 0.050 nmol TBARS mg prot-1), while control recorded (0.2 $\pm$ 0.020). Moreover, the clams studied at 1050 ppm showed average decrease in the shell dry weight (0.98 $\pm$ 0.11) where control group were (1.04 $\pm$ 0.14). Calcification analysis was determined using XRD and was confirmed by the results of the Scanning Electron microscope which highlighted a trend towards obvious superficially physical sensitivity to acidification. Furthermore, shell shape analysis results showed periostracum distortion in the clam shell as pCO2 concentration increased at 1050 ppm.

S385: Using Novel Spectrophotometric Determination of CO2 Dissociation Constant, K2, To Improve CO2 System Calculations

Katelyn Schockman
University of South Florida, College of Marine Science

Over-determination of the carbonate system (measurement of three or more system variables) can be used to compare measured and calculated values for carbonate system parameters (pH, total alkalinity (TA), total dissolved inorganic carbon (DIC), carbon dioxide fugacity (fCO2)). This process has previously uncovered errors of up to 30% between measured and calculated values. A significant portion of these errors come from uncertainty in CO2 system dissociation constants, K1 and K2. These constants, which relate the relative concentrations of CO2, HCO3- and CO32- to pH, have approximate uncertainties of 2% and 5% respectively, thereby limiting quantitative descriptions of the marine CO2 system. In order to address this problem, a novel spectrophotometric procedure was developed to improve the accuracy of K2 over a salinity and temperature range relevant to marine conditions.

K2 values determined using this new spectrophotometric procedure, along with the K1 values of Lueker et al. (2000), were used to examine agreement between calculated and measured TA, DIC and pH on the three Gulf of Mexico and East Coast Carbon Cruise (GOMECC) expeditions. Using new K2 values obtained in my laboratory work, improved agreement between calculated and measured carbon parameters was observed relative to calculations using previous K2 parameterizations.

S386: Development of oceanographic instruments to study the adaptation of corals to physicochemical changes in the water column.

Cristian Mariano Hincapie Lopera
universidad de antioquia

The coral ecosystems are of great importance, since they protect the coast against erosion and are habitat for many species (Approximately $\frac{1}{4}$ of the marine species). therefore is important to study the influence that the physical-chemical changes of the ocean, these can be attributed to climate change and anthropic actions, where a minimum variability in temperature and pH can significantly affect the conservation of these. From here, comes the importance of determining the behavior of the variables that are directly involved with the possibility of producing coral bleaching and the erosion of these by the acidification of the ocean. For this, devices are designed and built with the capacity to study some of the most important variables that influence the propagation of coral bleaching and deterioration, understanding the temporal behavior of corals. This device can measure such changes in temperature and pH throughout the sea column, with a chain of strategically placed sensors, as well as the incidence of UV rays. It has a storage and transmission system through a mobile network that transfers the data to an online server for pre-visualization in a telemetric manner.

S387: Effects of ocean acidification and temperature on the regeneration capacity of the ragworm Hediste diversicolor (O.F. M¸ller, 1776)

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Global warming and elevated level of atmospheric CO2 resulted changes in seawater conditions especially ocean acidification (OA). OA resulting mainly from the global warming and elevated level of CO2 in the atmosphere. The impact of OA poses a serious threat to marine species worldwide, including the deep sea to coastal estuaries. Polychaetes are the class of segmented worms that highly abundant in estuarine areas. They are facing wide range of environmental pollutants and coping with stress situations. Until recently, very less is known regarding the effect of OA and elevated temperatures on the marine organism, especially on marine polychaetes. Here, we undertook investigation of the changes in temperature (15 ^{o}C and 25 ^{o}C) and pH (8.1, 7.5 and 7.0) on the behavior, feeding rate, capacity of tissue regeneration as well as mortality rate of the coastal polychaetes (ragworm Hediste diversicolor) under controlled laboratory conditions during a period of 28 days. The results showed that the organisms exposed to the high level of acidic conditions of pH 7.5 and 7.0 and elevated temperature 25 ^{o}C noticed with a slower tissue regeneration capacity, higher mortality rate, lower feeding rate and slower burrowing rate than that of the ambient conditions. Based on the future oceanic climatic conditions some physiological changes were observed in this ragworm. Our study highlighted the adverse effect of future OA and global warming on the marine polychaete, results clearly show the physiological changes of H. diversicolor. These findings seem to have marine ecological consequence, because polychaetes established links between producers and consumer in the marine food chain.

S388: Effects of the Northeast Pacific Marine Heatwave on the Nearshore Ecosystem of the Olympic Coast, Washington

Julie Ann Koehlinger
Olympic Coast National Marine Sanctuary

The Olympic Coast National Marine Sanctuary is located in the northeast Pacific Ocean and off the northwest coast of Washington. Using spring to fall water temperature records from sanctuary moorings, we constructed a climatology of this nearshore environment and examined temperature anomalies during the 2013-14 northeast Pacific marine heat wave and 2015 El Niño event. Our

analysis focused on assessing the spatial and temporal extent of these anomalies. We found significant positive temperature anomalies with durations of 10-20 days and greater variability than observations recorded with offshore moorings and satellite sea surface temperatures. We also examined the influence of winds and currents and their relationship to water temperature at the mooring sites. These results also showed strong correlations with wind and current observations in this upwelling driven system. Understanding the potential effects of extreme events on nearshore ecosystems is vital to understanding climate change adaptation.

S389: Effects of future climate change on coral health: a temperate/tropical contrast

Nicole Johnston
Georgia Institute of Technology

Corals, many of which live on tropical reefs at the top of their thermal limit, are predicted to exhibit reduced health and survival in response to global climate change. Adaptation and/or acclimation strategies that would mitigate the negative consequences for coral reefs have been suggested, including the theory that tropical corals could survive by shifting their range towards traditionally temperate habitats as the Earth warms. The feasibility of this strategy is unknown. Here, two conspecific coral species, Oculina arbuscula and O. difussa, were collected from North Carolina, USA and Florida, USA respectively. The two species' growth, bleaching, and survival when exposed to predicted future temperature and acidification levels was evaluated over nine weeks. Over the course of the experiment, O. arbuscula (North Carolina) exhibited significantly higher survival and growth rates and lower bleaching rates than O. diffusa (Florida). However, these differences were no longer significant at week nine when both species were negatively affected by high temperature and carbon dioxide levels versus ambient levels. These results suggest that species from temperate environments may be more resistant to climate change over shorter-time scales.

3.0.4 Sustainability of Ocean Resources: Marine Spatial Planning

S490: Spatial Planning of Marine Aquaculture Under Climate Decadal Variability: A Case Study for Mussel Farms in California

Jade Sainz
UCSB

The growth of marine aquaculture over the 21st century is a promising venture for food security because of its potential to fulfill the seafood deficit in the future. However, to maximize the use of marine space and its resources, the spatial planning of marine aquaculture needs to consider the regimes of climate variability in the oceanic environment, which are characterized by large-amplitude interannual to decadal fluctuations. It is common to see aquaculture spatial planning schemes that do not take variability into consideration. This assumption may be critical for management and for the expansion of marine aquaculture, because projects require investments of capital and need to be profitable to establish and thrive. We analyze the effect of climate variability on the profitability of hypothetical mussel aquaculture systems in the Southern California Bight. Using historical environmental data from 1981 to 2008, we simulate mussel production and estimate the Net Present Value as an economic indicator of profitability. We find that productivity of the farms exhibit a strong coherent behavior with marketed decadal fluctuations that are connected to climate of the North Pacific Basin. This decadal variability has a strong impact on profitability both temporally and spatially. Depending on the trend of the decadal regimes in mussel productivity

and the location of the farms, cost recovery for a given farm may exceed the 5-10 year horizon. These results suggest that climate variability should be taken into consideration by managers and investors on decision making to maximize profitability.

S491: Climate mitigation and adaptation in the deep ocean - planning for the next century

Lisa Levin
Scripps Institution of Oceanography

The deep ocean (>200 m) plays a large role in climate mitigation, removing heat and CO2 from the atmosphere in ways that alter the temperature, circulation, dissolved oxygen, carbonate system, and food supply in deep waters. These stressors interact with each other and with other ocean parameters such as light and nutrients to modify ocean life. The consequences for deep-sea marine ecosystems and their ecological functions and services are likely to be substantial. These changes will intersect with physical, chemical and biological disturbance imposed by increasingly deeper extraction of oil and gas, living resources and seabed minerals. Continental margins, seamounts and potentially nodule covered abyssal plains may be most affected. This presentation will discuss how climate stress interacting with human disturbance may act to reduce ecosystem resilience, alter times and trajectories for recovery from disturbance, or impose new (non-analog) conditions and generate novel ecosystems. Today environmental management of deep-ocean ecosystems and resources requires a amore integrated, ecosystem-based framework that incorporates climate change into decision-making, a form of climate adaptation. Applications include spatial planning and conservation (including the designation of protected areas), baseline observation and monitoring strategies, and environmental impact assessment (including the evaluation of cumulative impacts).

S492: Bridging Monitoring and Solutions-Based Thinking: Lessons from CalCOFI for Understanding and Adapting to Marine Climate Change Impacts

Natalya Gallo
Scripps Institution of Oceanography, UCSD & NOAA Southwest Fisheries Science Center

Multidisciplinary, integrated ocean observing programs provide critical data for monitoring the effects of climate change on marine ecosystems. California Cooperative Oceanic Fisheries Investigations (CalCOFI) samples along the US West Coast and is one of the world's longest-running and most comprehensive time-series, with hydrographic and biological data collected since 1949. The pairing of ecological and physical measurements across this long time-series is like a Keeling Curve for the ocean and informs our understanding of how the California Current marine ecosystem responds to climate variability. However, challenges remain in connecting the data collected from long-term monitoring programs with the needs of stakeholders concerned with climate change adaptation (i.e. resource managers, policy makers, and the public), including for the fisheries and aquaculture sectors. We use the CalCOFI program as a case study to ask: how can long-term ocean observing programs inform ecosystem based management efforts and create data flows that meet the needs of stakeholders working on climate change adaptation? Addressing this question and identifying solutions requires working across sectors and recognizing stakeholder needs. Lessons learned from CalCOFI can inform other regional monitoring programs around the world, including those done at a smaller scale in developing countries.

S493: Shrimps in Space: Charting Contentious Spatialities between Commercial Fishing and Spaceport Industries

Ian Rossiter
University of Georgia

This research project examines the socioeconomic and broader environmental impacts of the proposed Spaceport Camden through an investigation of perceived marine spatial competition between the spaceport and shrimpers on the coast of Georgia, USA. The current development proposition threatens to undermine the local fishing industry by excluding boat traffic during temporary waterway closures, and altering valuable marsh habitat crucially linked to healthy Georgia fisheries. Standard environmental impact statement procedures utilize a top-down approach calling for assessment from outside experts and provide a limited outlet for local stakeholder input. Although political ecologist have widely documented environmental and economic marginalization in fishing cultures, current literature provides little insight into how spaceport facilities and operations may impact coastal zone management and local fishing practices. This project cogenerates quantitative and qualitative data with Coastal Georgia shrimpers through participatory mapping and semi-structured interviews to examine the potential spatial relationships between shrimpers and Spaceport Camden and assess potential conflicts of interest between the proposed spaceport and established local shrimping industry. In doing so, this research challenges normative protocols of environmental assessment and coastal resource management, particularly with regard to the perceived placelessness of Georgia seascapes and the disenfranchisement of local fishing industries on the Georgia Coast.

3.0.5 Mitigation: Scalable strategies for Blue Carbon

S594: Blue Economy of Bangladesh and Poverty Alleviation

Mohammad Jamil Khan
Dhaka Bar Association

Bangladesh is a poor country. It has many kind of socio-economic problems. In order to eradicate those problems ocean has an important role in our economy. A vast area of ocean is remaining unexplored. Various scientific and economic knowledge developments on sea has ushered a new era which made us optimistic to explore blue economy. Many basic needs and resources of our country may be generated from this vast area of seas or from Bay of Bengal. The economic activities includes agriculture, fishing, biodiversity, exploring mineral resources, tourism, shipping and generating electricity from there. On the other hand protecting our sea from pollution is another side of our blue economy.

3.0.6 Integrated Modelling of Human and Climate Impacts on Ocean Systems

S695: Reactive transport modeling to reveal the underlying electron transfer mechanism of anaerobic oxidation of methane

Xiaojia He
University of Georgia

Anaerobic oxidation of methane (AOM) acts as a significant sink for methane that plays an important role in global carbon cycle and impacts global warming. AOM in marine sediments is primarily coupled to sulfate reduction. Proposed syntrophic interactions between the archaeal and bacterial cells mediating AOM include electron transfer through (1) the exchange of H2 or small organic

molecules, (2) the delivery of disulfide from methane oxidizing archaea to bacteria for disproportionation, and (3) direct interspecies electron transfer. Our reactive transport models simulated activities across a range of aggregate sizes and archaeal and bacterial cell arrangements. Comparison of model results to measured AOM rates and intra-aggregate activity patterns determined by FISH-nanoSIMS shows that rates for mechanism (1) were limited by the build-up of metabolites, while mechanisms (2) and (3) yielded cell specific rates and archaeal activity distributions that were consistent with observations from single cell resolved FISH-nanoSIMS analyses. The novel integration of both intra-aggregate and environmental data provided powerful constraints on the model results, but the similarities in model outcomes for mechanisms (2) and (3) highlight the need for additional observational data (e.g. genomic or physiological) on electron transfer and metabolic functioning of these globally important methanotrophic consortia.

S696: Redefining Risk in Data-Poor Approaches and Its Implications for Five Global Studies

Betsy Mansfield
Stanford University

The Productivity Susceptibility Analysis (PSA) is an extremely popular method to rapidly assess species risk to fishing activities in data-poor fisheries, which is critically important in the face of climate change. To date, little attention has been given to how number, weighting, or scaling of attributes may affect the classification of target stocks in one of the three vulnerability categories. Here we show that the probability of a stock to be classified in the intermediate vulnerability class increases with the number of attributes used to characterize productivity and/or susceptibility. We present a novel and statistically robust method to define risk, where threshold values between the three vulnerability classes are adjusted depending upon the number of attributes used in the assessment. To understand differences in the two methods, we recalculate species risk from five previous PSA studies. We outline fisheries and species groups whose vulnerability class changes with respect to previous assessments and show that this new method is more conservative in resolving risk, as the chance for a species to be being classified as highly vulnerable does not decrease with the number of attributes to characterize it.

S697: Temporal Trends in Marine Llitter at Three Stations of the HAUSGARTEN Observatory in the Arctic Deep Sea

Karla Parga Martinez
Institute Alfred Wegener

Litter is found in all ocean compartments, from the sea surface to the seafloor. Despite of its final fate remains unclear, it is thought that the deep seafloor represents a major sink even in regions as secluded as the Arctic Ocean. Here, we assessed the temporal and spatial variability of seafloor litter over a latitudinal gradient at the HAUSGARTEN observatory. Photographic surveys of the northernmost (N3), central and southernmost stations were analyzed to determine litter density, composition, size and litter-fauna interactions. Indicators of maritime traffic and summer sea ice extent were examined as potential sources. Between 2002 and 2017, litter density increased over time with peaks in 2011 and 2014. The overall composition was plastics (45%) but at N3 glass became dominant (41%). Small-sized items accounted for 63% and litter was often observed entangled with sponges or colonized by anemones. Litter densities correlated with maritime traffic but not with sea ice. Again, N3 differed and a reversed trend was noticed, which could mean that sea ice may act as barrier and a mean of transportation. Regardless of the source, it is clear that the

current waste management systems are insufficient such that fragile Arctic ecosystems are subject to increasing plastic pollution.

S698: The impact of temperature on growth rates of demersal fish species in the Scottish waters

Idongesit Ikpewe
University of Aberdeen

Temperature, along with food availability, is often regarded as a major determinant of ectothermic growth. The temperature-size rule (TSR) predicts that an increase in temperature results in faster growth and a smaller asymptotic (maximum) length. There is empirical support for the TSR in ectotherms, including in several commercial fish species. Sea temperatures to the West of Scotland have risen by approximately 1^oC over the past three decades. The present study investigated whether changes in the growth rates and asymptotic lengths of haddock (Melanogrammus aeglefinus), cod (Gadus morhua), whiting (Merlangius merlangus) and Norway pout (Trisopterus esmarkii) were consistent with the TSR. For each species, a Von Bertalanffy growth function (VBGF) was fit on a cohort-by-cohort basis from 1985-2010. Only one species, haddock, had an asymptotic length (L) which was significantly, and negatively, correlated with temperature, while the growth rate (K) was positively correlated. Over the study period a 28% decrease in the L of haddock was associated with a temperature increase of 1^oC. Correlations between temperature and VBGF parameters were not significant for whiting, Norway pout or cod. These results are consistent with those in the adjacent North Sea, previously published, but also updated here. Reasons why haddock are unique in this regard are discussed.

S699: Multiscale flow interactions and ecological impacts of the 2010 oil spill in the Gulf of Mexico

Annalisa Bracco
Georgia Tech

This talk will present an overview of recent studies of physical and biogeochemical interactions across mesoscale and submesoscale flows focusing on the Gulf of Mexico. I will describe the physical mechanisms responsible for the patterns of oil dispersion at the ocean surface and near the ocean bottom in the aftermath of the 2010 Deepwater Horizon oil spilusing models and observations, and will provide examples of how multiscale flows impact the dispersion of tracers and the marine ecosystem. Furthermore, I will discuss implications of large anthropogenic disturbances and interactions between physical and biogeochemical fields on time scales from hours to millenia.

S6100: The Response of the Northwest Atlantic Ocean to Climate Change: Experiments with a high solution model

Michael Alexander
NOAA/Earth System Research Laboratory

ROMS, a high-resolution regional ocean model, was used to study how climate change affects the northwest Atlantic Ocean. A control (CTRL) simulation was conducted for the recent past (1976-2005), and simulations with additional forcing obtained from three different global climate models (GCMs), were conducted to represent the future (2070-2099) applying the RCP8.5 scenario. The climate change response was obtained from the difference between the CTRL and each of the

three future simulations.

All three experiments indicated large increases in sea surface temperatures (SSTs) over most of the domain except off the eastern US seaboard due to a reduction in strength of the Gulf Stream. There are also substantial differences in the response, including a southward shift of the Gulf Stream in one simulation and a slight northward shift in the other two, with corresponding changes in eddy activity. The depth of maximum warming varied among the three simulations, resulting in differences in the bottom temperature response in coastal regions, including the Gulf of Maine and the west Florida Shelf. The surface salinity decreased (increased) in the northern (southern) part of the domain in all three experiments, but in one, the freshening extended much further south in ROMS than in the GCM that provided the large-scale forcing, likely due to changes in transport by the well resolved coastal currents.

3.0.7 General

G0101: Seasonal transboundary movement of cape hake (Merluccius capensis) across the western coast of southern Africa

Veronica Kapula
University of Namibia

This study was conducted to investigate the patterns of genetic differentiation of Cape hake (Merluccius capensis) across Southern Africa. Six sampling sites were chosen based on latitude and their relative position regarding known oceanographic breaks, Northern Namibia(NN),Central Namibia(CN),Southern Namibia(SN),Orange River(NWC),Central West Coast (CWC) and Southern West Coast(SWC).Molecular characterisation of 503 individuals belonging to M ,capensis was performed using eight microsatellite markers within the control region of the mitochondrial DNA(mtDNA),to assess the genetic diversity and also to determine the population structure. The results showed the overall FST of both seasons (FST = 0.160 of summer and winter FST = 0.112) showing high genetic differentiation that were statistically significant different from zero ($p<0.05$). The pairwise FST analysis revealed that the genetic break between the northern and southern stocks across Southern Africa was not constant throughout the year as population distribution clines revealed differential seasonal movement. However, paired t-tests assessing statistical significance between population composition of summer and winter months were not statistically significant, suggesting that observed migration levels were low. The study concluded that southern individuals migrate to the northern Benguela region in the winter while the northern individuals migrate to southern in summer. The assessment of the temporal and spatial genetic structure of M. capensis will help the management and assessment of mixed fisheries and the results of genetic population structure also help to estimate the distribution of populations in mixed catches and seasonal migration patterns.

G0102: Marine vertebrate biodiversity and distribution within the central California Current using environmental DNA (eDNA) metabarcoding and ecosystem surveys

Collin Closek
Stanford University

Biodiversity of pelagic marine vertebrates is threatened by climate change and human impacts. Development of new biodiversity assessment tools and combining them with traditional methods is essential for characterizing baseline patterns and monitoring changes. Assessments of pelagic vertebrate distribution and diversity are generally conducted using net trawls (e.g., fish) and visual surveys to assess air-breathing vertebrate (e.g., marine mammals). Environmental DNA (eDNA) metabarcoding can also assess vertebrate occurrence, however few studies have evaluated

vertebrate biodiversity in the marine environment through eDNA from seawater or compared synoptic patterns with traditional methods. This study uses an eDNA metabarcoding approach to target the mitochondrial 12S rRNA gene to characterize vertebrate diversity and distribution within the upwelling ecosystem off central California, and overlaps with several National Marine Sanctuaries. Biological replicate eDNA samples were collected at 10, 40, and 80m during the 2016 and 2017 Rockfish Recruitment and Ecosystem Assessment Survey. In total, we examined eDNA sequences from 134 small volume (1 L) environmental water samples. Overall, the diversity and distribution patterns reflected known spatial organization patterns in species occurrence and community structure (e.g., cross-shelf and alongshore patterns). In both years, Sebastes (rockfish), Merluccius (hake), Citharichthys (sanddab), and Engraulis (anchovy) were identified across the majority of the stations through eDNA, while other taxa indicated specific habitat associations in deep and shallow locations. However, the marine vertebrate community identified by eDNA in 2016 was significantly different from the 2017 community and more marine mammals were identified in 2017. Taxa identified through eDNA partially overlapped with trawl assessments, but more taxa were identified by eDNA overall. The study informs how eDNA diversity assessments could assist both traditional biodiversity observation and monitoring as well as benefit fishery management programs.

G0103: Modeling fisheries connectivity networks to understand and advance adaptive capacity in marine social-ecological systems

Mary Fisher
University of Washington

Fished populations can be connected not only ecologically, but also by the individuals or vessels which harvest them. Characterizing these fisheries connectivity networks contributes to our understanding of the capacity of coastal communities to adapt to climate change. Our research is the first to explicitly model the sensitivity of these networks to a significant perturbation, and examine differential adaptive responses. We use landings data to characterize fisheries connectivity networks during and after the extensive 2015 harmful algal bloom along the US West Coast that caused extensive closures in the Dungeness crab fishery. These impacted connectivity networks were compared against pre-2015 baselines, both coast-wide and at the level of individual port groups. By correlating network changes within each port group with community-level socioeconomic impacts, interactions between network characteristics and community vulnerability can be explored. These results can be used to shape management strategies that promote the adaptive capacity of US West Coast fisheries. This is especially important as harmful algal blooms are expected to increase in frequency and intensity as climate change advances. Our research also creates a framework for future studies on the feedbacks between fisheries connectivity networks and the resilience of marine social-ecological systems in the face of environmental change.