BEM-SEERS 2017 Oral Presentation Abstracts

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Restoration of Half Moon Reef in Matagorda Bay, TX: Community Response to Salinity Disturbance

Danielle Aguilar*; Kevin De Santiago; Terence A. Palmer; Jennifer Beseres Pollack

Texas A&M University-Corpus Christi, Department of Life Sciences

In 2014, The Nature Conservancy restored 0.23 km^2 of Half Moon Reef in Matagorda Bay, Texas. Seasonal sampling has occurred since July 2014 to evaluate restoration success in terms of habitat provision for oysters, reef-resident, and reef-associated fauna. Additionally, annual salinity disturbances have provided the opportunity to study faunal community resilience. We used sampling trays containing the same substrates used in reef construction to sample fauna on the restored reef and at adjacent unrestored control sites. We also used a modified epibenthic sled to sample reef-associated fauna at sites near (13 m) and far (200m) from the restored site. Post-restoration, average shell height (mm) has increased for spat (≤ 25 mm), juvenile (26-75 mm) and market-size (≥76 mm) oysters. Following salinity disturbances in 2015 and 2016, species richness and diversity increased in both reef and control areas; average reef-resident faunal biomass (g m^{-2}) also increased whereas faunal biomass at control sites remained similar. Species richness and diversity of reef-associated fauna increased following the 2015 salinity disturbance; the response of reef-associated fauna following the 2016 disturbance is unclear. Overall, the reef has shown resilience to reoccurring low salinity events.

Presenter's email: daguilar4@islander.tamucc.edu

Spatiotemporal analysis of QPX disease in hard clams: Can climate change actually help relief disease pressure?

Dahl, S.; Allam, B.*

School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook

QPX disease has been monitored in Raritan Bay NY since hard clam mortalities were discovered in 2002, resulting in a "long term" data set that includes disease prevalence as well as environmental parameters. Data analysis clearly shows that infection is limited and nearly absent in certain areas of the bay. Temporal variability of infection across the fishery area showed relationships with environmental factors in common with the spatial patterns. Warmer years tend to have lower disease levels across the monitoring stations and the warmest areas of the fishery are typically without QPX infections. Drought and high salinity preceded the reported QPX disease related hard clam mortalities and other years of low precipitation have surges of QPX infections. In parallel, the lowest salinities areas are consistently the least infected. Other parameters (e.g., dissolved oxygen, sediment type, and clam size) were examined and a positive trend of disease prevalence does emerge with clam density. Multiple regression models showed strong relationships between infection and the combination of temperature and salinity conditions. Continued warming trends with predicted intense precipitation events that can drive low estuarine salinity phases may actually provide these hard clams with some relief from QPX disease pressure.

Presenter's Email: Bassem.Allam@stonybrook.edu

Ecological lessons from the rolling stones: Bertness lab adventures on cobblestone beaches

Andrew H. Altieri[1*]; Christine Angelini[2]; Mark D. Bertness[3]; John F. Bruno[4]; Caitlin M. Crain[5]; Andrew D. Irving[6]; Brian R. Silliman[7]; Johan van de Koppel[8]; Bregje K. van Wesenbeeck[9]

[1]Smithsonian Tropical Research Institute, [2]Department of Environmental Engineering Sciences, University of Florida, [3]Department of Ecology and Evolutionary Biology, Brown University, [4]Department of Biology, UNC Chapel Hill, [5]Romberg Tiburon Center, San Francisco State University, [6]School of Medical and Applied Sciences, Central Queensland University, [7]Nicholas School of the Environment, Duke University, [8]Department of Spatial Ecology, Royal Netherlands Institute for Sea Research, [9]Deltares

Mark Bertness may be best recognized for his development of ecological understanding in salt marsh and rocky intertidal ecosystems. However, his research group has also had a "side project" on cobble beaches that was initiated over 30 years ago. In the time since, several generations of undergrad, grad, and postdoctoral students have conducted experimental research with the plant and animal communities that inhabit these unconsolidated cobble shorelines. In the process of developing cobble beaches as a model system for studying species interaction and environmental stress, we have made a number of general discoveries that have elevated our mechanistic understanding of community dynamics and biodiversity. Here, we highlight some key findings on topics including invasive species, long-distance interactions, facilitation, trait-dependent interactions, niche theory, and food web structure.

Presenter's Email: andrewaltieri808@gmail.com

MPAs did not mitigate coral reef phase shifts in Belize caused by disease and warming

Alves, C.[*1]; Locklear, Z.[1], McField, M.[2]; Bruno, J.[3]

[1] Curriculum for the Environment and Ecology, University of North Carolina at Chapel Hill; [2] Smithsonian Marine Station, Fort Pierce, Florida, [3] Department of Biology, University of North Carolina at Chapel Hill

Coral cover has declined on many Caribbean reefs due to disease and ocean warming. Other invertebrates and macroalgae have replaced corals as the most dominant taxa and the remaining coral are nearly all weedy species, negatively altering reef ecosystem functioning. The primary management response to this global phenomenon has been the design and implementation of Marine Protected Areas (MPAs), many of which are too small and not well enforced. A recent 16-site, 4-year study (Cox et al. 2017) found that the establishment of MPAs did not restore coral reef communities in Belize. We expanded this work by analyzing a 20-year time series of benthic video transects across the Belizean Barrier Reef (BBR). Roughly half the sites were in MPAs or no-take marine reserves. From 1999 to 2016, absolute coral cover declined from 23% to 16%, while macroalgal cover increased from 16% to 45%. These findings are concordant with a large majority of studies focusing on the effectiveness of MPAs in mitigating coral loss. Since the shift to algal dominance is common regardless of MPA presence, we recommend both local and global efforts to mitigate these impacts – including increased efforts to enforce MPAs and decreasing global carbon emissions.

Presenter's Email: calves06@live.unc.edu

Reef fish assemblage biogeography of the Florida Reef Tract

Cory A. Ames*[1]; Steven G. Smith[2]; Brian K. Walker[1]; David W. Kerstetter[1]

[1]Department of Marine and Environmental Sciences, Nova Southeastern University; [2]Rosenstiel School of Marine & Atmospheric Science, University of Miami

Understanding the biogeography of reef fish assemblages is paramount to reef conservation, management, and conducting appropriate population survey designs. Reef fish assemblages are a multispecies complex of reef-associated fish and are shaped by multiple environmental and biological factors (e.g. temperature, depth, topography, benthic habitat), which determine the species constituents residing in an area. Assemblages typically change latitudinally where the number of families, genera, and/or densities of species specific to warmer climates decrease poleward into colder climate regimes. The Florida Reef Tract (FRT) extends for 595 km from the Dry Tortugas in the south-west to Martin County in the north, crossing a sub-tropical to temperate climate transition.

This study investigates the biogeography of reef fish assemblages throughout the FRT to determine if they correspond to previous regional delineations primarily based on coastal geomorphology. Multivariate density analyses show that depth, habitat, relief, and region are major factors in determining the assemblages. Three main assemblage regions were evident: Dry Tortugas (DT), Florida Keys (FK), and Southeast mainland (SE). FK did not show further regional separation. SE assemblages split into seven groups corresponding to depth, habitat, relief and the latitudinal transition.

Presenter's Email: ca1126@nova.edu

Disentangling physical and biological effects of the invasive slipper limpet by the use of biological trait analysis

Androuin, T.*[1]; Vallée, V.[2]; Dubois, S. F.[1]; Carlier, A.[1]

[1] Department of Coastal Benthic Ecology, IFREMER (Brest, France), [2] Department of Haliotic Biodiversity, IFREMER (Cayenne, France)

Crepidula fornicata is an invasive ecosystem engineer which spreads in Europe during the XXs. This species can modify its habitat by the presence of its own shell (autogenic engineering) and/or by its biological activity, e.g. the biodeposition of large amount of pseudo-faeces (allogenic engineering). Here, we have tested the effect of *Crepidula* on the associated benthic communities both considering structural and functional diversity and by distinguishing the auto/allogenic engineering effect. Diversity changes were studied along a gradient of *Crepidula* biomass considering two aspects: dead and alive *Crepidula*. The structural diversity assessed by common indexes (species Richness, Shannon and Pielou index) didn't show any significant trend along the gradient, only the macrofaunal abundance increased significantly. The functional diversity was described through the use of biological traits analysis. The results suggest the formation of 4 distinct functional groups, mostly described by the trophic mode, mobility, size and organic matter affinity. Frequencies analysis of these groups along the same *Crepidula* gradient showed different pattern and trajectory depending on functional groups. Our work highlights that changes regarding functional diversity could be greater than the ones affecting structural diversity and that the functional groups respond differently depending on physical/biological engineering effect.

Presenter's Email: thibault.androuin@ifremer.fr

The Top-Down Effects of Mark Bertness on Marine Ecology and His Facilitation of My Career in Environmental Engineering

Christine Angelini*[1]

[1]Environmental Engineering Sciences, University of Florida, Gainesville, FL 32611

To kick off this special session, I will present an overview of Mark Bertness' major contributions to ecology as well as a brief reflection on how his work and mentorship continue to shape my career. From his earliest studies of carnivorous gastropods on Western Washington's rocky shores to his recent work on the runaway collapse of New England salt marshes, Mark has been dedicated to understanding the natural history of marine communities and experimentally challenging the paradigms that have long-defined our field. With his students, he adopted marshes, rocky shores, and, most recently, coastal dunes as a playground and a proving ground for ecological theory, bringing to light the importance of positive interactions, stress gradients, and human activities in regulating community organization. I will share a highlight reel of his career as an ecologist and share how Mark's ideas have inspired elements of my own work and how his sustained mentorship has helped me succeed in breaking into the field of Environmental Engineering. Through his intellectual contributions and diehard dedication to training and mentoring students, Mark continues to profoundly and positively influence our field.

Presenter's Email: c.angelini@ufl.edu

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Bob Paine's Contribution to Paleobiology

Aronson, Richard B.*[1]

[1]Dept. of Biological Sciences, Florida Institute of Technology, Melbourne, FL 32901

Bob Paine began his graduate career studying fossils. Although he left paleontology for marine ecology, his early ideas about the central role of consumers permeated the emerging field of paleobiology. Paine's conceptual framework made it possible to view the Phanerozoic history of benthic communities through the lens of ecology, driven by the progressive addition of trophic levels. The emergence of novel, shell-crushing predators during the Mesozoic era restructured nearshore-benthic communities. Those changes, which transcended the mass-extinction event at the end of the Cretaceous period, were amplified by the accelerated diversification of predators in the Cenozoic era. The deep sea is the low-predation redoubt of outmoded, Paleozoic taxa. Modern predators are currently excluded from coastal environments in Antarctica because the water is too cold, and as a result the benthic communities have become functionally archaic. Climate change may be reversing that trend by allowing predators to return, with cascading consequences predicted from Paine's work.

Presenter's Email: raronson@fit.edu

Climate Change, Novel Predators, and Community Reorganization in Antarctica

Aronson, R. B.*[1]; Smith, K. E.[2]; Steffel, B. V.[1]; McClintock, J. B.[3]

[1]Dept. of Biological Sciences, Florida Institute of Technology, [2]College of Life and Environmental Sciences, University of Exeter, UK, [3] Department of Biology, University of Alabama at Birmingham

Low temperatures have historically prevented durophagous (skeleton-crushing) predators from playing a significant role in benthic communities on the Antarctic shelf, facilitating the evolution of a benthic fauna poorly defended against durophagy. Now, rapid warming of the Southern Ocean threatens to restructure those shelf-communities by allowing predatory king crabs to invade. The lithodid *Paralomis birsteini*, currently living in viable populations on the continental slope off the western Antarctic Peninsula, could potentially expand to the shelf, where temperatures are no longer prohibitively low. We analyzed the diet of *Paralomis* and compared the distributions of prey in slope environments within two study sites supporting different lithodid densities. Three commonly eaten, eurybathic taxa—ophiuroids, echinoids, and gastropods—were negatively associated with *Paralomis* off Marguerite Bay, where the mean lithodid density was 4.28 ind·1000 m^{-2} (range 3.44–5.01 ind·1000 m^{-2}) at 1100–1500 m depth, but not off Anvers Island, where the mean was 2.06 ind·1000 m^{-2} (range 0.66–3.27 ind·1000 m^{-2}) in the same depth-range. Where present in sufficient densities, predatory lithodids appear to be affecting the distribution of benthic invertebrates on the slope. Climate-driven expansion of the environmental range of *Paralomis* could reduce populations of endemic prey-species on the Antarctic shelf.

Presenter's Email: raronson@fit.edu

Spatial Variability in a Salt Marsh Consumer

Atkins, R. L.*; Osenberg, C. W.

Odum School of Ecology, 140 East Green Street, Athens, GA 30602, USA

Southeastern US salt marshes are some of the most productive ecosystems in the world. Within these marshes, the marsh periwinkle, *Littoraria irrorata,* is a dominant grazer of saltmarsh cordgrass, *Spartina alterniflora.* At high densities, *Littoraria* can denude expansive swaths of cordgrass, destroying associated ecosystem services. My previous research in a Georgia saltmarsh has demonstrated that both small and large *Littoraria* can shift the *Littoraria-Spartina* interaction from beneficial (+) at low densities, to deleterious (-) at high densities, and that changes in consumer interaction strength with pant biomass can be predicted based upon the total metabolic

demands of the consumer population (i.e., as determined by both size-structure and density). However, factors driving *Littoraria* size structure,density, and spatial distribution within and among salt marshes, and how these population characteristics relate to aboveground *Spartina* productivity, have yet to be explored. Initially, I've quantified spatial variation in *Littoraria* populations and *Littoraria-Spartina* interactions in salt marshes spanning Florida to Virginia. I expect that changes in temperature (related to latitude) will lead to variation in consumer mean body size and population biomass; however, site-specific variation in predator abundance and *Littoraria* recruitment may affect the strength of this temperature-size relationship, how *Littoraria* are spatially arranged among *Spartina* stalks, and the resulting *Littoraria-Spartina* interaction.

Presenter's Email: Atkinsr@uga.edu

Invasion dynamics: interactions between the European Green Crab *Carcinus maenas* and the Asian Shore Crab *Hemigrapsus sanguineus*

Baillie, Christopher[1*], Grabowski, Jonathan[1]

[1] Marine Science Center, Northeastern University, 430 Nahant Road, Nahant, MA 01908, USA

The negative effects of invasive species on endemic organisms have been the focus of much theoretical and empirical research; however, appreciably less attention has been devoted to predator-prey and competitive interactions between invasive species even though many systems have been invaded by multiple taxa from overlapping guilds. The recent expansion of Asian Shore Crab, *Hemigrapsus sanguineus*, populations into the rocky intertidal of New England presents an opportunity to investigate the degree to which this recent invader interacts with the more established invasive European Green Crab, *Carcinus maenas*. We conducted a field experiment to investigate the effects of adult crab identity (conspecific or heterospecific) and density on recruitment of juvenile *H. sanguineus* and *C. maenas*. Contrary to previous findings, we found that *H. sanguineus* recruitment decreased in the presence of both adult *H. sanguineus* and *C. maenas*. Meanwhile, *C. maenas* recruitment was unaffected by the presence of adult conspecifics and increased in the presence of adult hetereospecifics. Additionally, regardless of adult crab presence, identity or density, we found a significant negative correlation between the densities of *H. sanguineus* and *C. maenas* recruits. While early studies hypothesized that *H. sanguineus* would replace *C. maenas*, our findings suggest interaction dynamics may exist that result in the persistence of *C. maenas* in low intertidal and subtidal rocky habitats.

Presenter's Email: Baillie.c@husky.neu.edu

Historical decline of coral growth rates over the last century varies by reef zone in Belize

Justin H. Baumann*[1], Travis Courtney[2], JP Rippe[1], Hannah Aichelman[3], Justin B. Ries4, Karl D. Castillo[1]

[1] University of North Carolina at Chapel Hill, Department of Marine Sciences; [2] Scripps Institution of Oceanography, University of California San Diego; [3] Old Dominion University, Department of Biological Sciences; [4] Northeastern University, Department of Marine and Environmental Sciences

Coral reefs are experiencing global scale decline due to a combination of indirect and direct anthropogenic impacts. However, corals from contrasting environmental regimes have exhibited differential responses to stress due to local adaptation. We collected over 100 cores of the resilient massive reef-building corals *Siderastrea siderea* and *Pseudodiploria strigosa* from paired inshore and offshore sites across a latitudinal gradient on the Belize Mesoamerican Barrier Reef System (MBRS) to examine trends in coral growth rates. Skeletal extension rates for *S. siderea* declined significantly over the past century in nearshore corals, but were relatively stable in back-reef and fore-reef conspecifics. In *P. strigosa*, extension rates decreased over the past 50 years in nearshore corals but remained stable within the fore-reef. Calcification rates mirrored extension rates in *S. siderea* but did not differ over time or between reef zone in *P. strigosa*. Additionally, nearshore corals exhibited faster extension and calcification rates than fore-reef corals for both species. Overall, our results suggest that there has previously

been a benefit to residing in nearshore environments, but over the last century this has dissipated as extension and calcification rates between nearshore and fore-reef corals have converged.

Presenter's Email: baumannj@live.unc.edu

Toxicity comparison of the shoreline cleaners Accell Clean and PES-51 in two life stages of the grass shrimp, *Palaemonetes pugio*

Sarah E. Baxter[1]*; Marie E. DeLorenzo[2]; Peter B. Key[2]; Michael H. Fulton[2]; Barbara Beckingham[3]

[1]College of Charleston, Department of Environmental Studies; [2]National Oceanic and Atmospheric Administration, National Ocean Service, Center for Coastal Environmental Health and Biomolecular Research; [3]College of Charleston, Department of Geology and Environmental Geosciences

Each year, oil spills and other anthropogenic sources contribute to a significant amount of crude and refined oil coastal pollution. Shoreline cleaners are used to remove oil from solid surfaces such as rocky shorelines and beaches. Two life stages of the estuarine grass shrimp, Palaemonetes pugio, were tested with two shoreline cleaners, Accell Clean and PES-51, alone and in combination with crude oil using Chemically Enhanced Water Accommodated Fractions (CEWAFs). The toxicities of the treatments to both life stages were compared using standard 96-h LC50 bioassays. When tested alone, toxicity of the two shoreline cleaners was relatively similar. When tested in mixture oil as CEWAFs; however, Accell Clean resulted in significantly greater hydrocarbon concentrations in the water column and significantly greater toxicity than PES-51. Larval grass shrimp were significantly more sensitive to the Accell Clean-CEWAF than adult shrimp. Sublethal effects were evaluated, including biomarkers of cellular stress (glutathione and lipid peroxidation) in adult shrimp, and developmental metrics (time to post-larval stage, number of molts, growth and molting hormone levels) in larval shrimp. This study is the first to evaluate the toxicity of Accell Clean and PES-51 in grass shrimp and will support future oil spill response decisions.

Presenter's Email: baxterse@gmail.com

Towards a better understanding of coral settlement, survivorship, & microbiomes on coral-dominated and seaweed-dominated reefs

Deanna Beatty*; Cody Clements; Frank Stewart; Mark Hay

Georgia Institute of Technology, School of Biology

Differences in microbial communities between algal- versus coral-dominated reefs are hypothesized to suppress coral recovery on degraded reefs. We compared microbiomes and larval and juvenile survival of the coral *Pocillopora damicornis* between a no-take marine protected area (MPA) dominated by corals and an adjacent non-MPA dominated by seaweeds. When held in MPA or non-MPA water, mortality of larvae from MPA adults was 6% while mortality for non-MPA larvae was 34% and 74% in MPA and non-MPA water, respectively. When out-planted to the field, mortality of juvenile corals was much higher in the non-MPA than in the MPA and was driven by immediate proximity to macroalgae rather than general MPA/non-MPA differences. Despite large differences in survivorship, microbial community structure did not differ between the MPA and non-MPA corals, although microbiomes differed between adults and larvae, with larval microbiomes being more diverse. However, the coral pathogen *Vibrio shilonii* and Vibrionaceae in general were significantly more common in non-MPA than MPA corals. We also found greater microbiome variability among adult corals from the non-MPA compared to adults from the MPA. Understanding the impacts of microbes on marine species may require a deeper understanding of species-level function rather than assessments of community composition alone.

Presenter's Email: dbeatty3@gatech.edu

Role of the marine pulmonate snail *Melampus bidentatus* in Atlantic Canadian salt marshes

Beck, A. D.*; Barbeau, M. A.

Department of Biology, University of New Brunswick

The marine pulmonate snail *Melampus bidentatus* occurs in salt marshes along eastern North America. Its detritivorous activities contribute to processing of tough marsh grasses like *Spartina* spp., and thus nutrient cycling. It is typically the most abundant invertebrate present in the high marsh zone, based on USA studies. However, there is little information about the snail in eastern Canada (where winter disturbances are substantial). During summers 2015 and 2016, we sampled 3 salt marshes in the region to determine the spatial distribution, density and population structure of *M. bidentatus* snails. In contrast to USA studies, *M. bidentatus* adults and juveniles in Canadian marshes occupied both the high and low marsh zones. Egg masses were also found throughout the marsh, and were laid between mid-June to mid-July. A cage experiment was conducted in 2016 to determine the effect of snail presence on growth of *Spartina* plants and of marine fungi on dying plants. We suspect that regions with more winter disturbance (and consequently less ecological complexity) may allow a species to become more dominant in certain ecological roles, such as in nutrient cycling (for our study species).

Presenter's Email: i011e@unb.ca

Unravelling the effects of the cryptic pathogen *Paramikrocytos canceri* on the brown crab *Cancer pagurus* in the UK

Behringer, D.*[1,2]; Bateman, K.[3]; Vance, T.[4]; Bass, D.[3,5]; Ross, S.[3]; Avant, J.[3]; Stentiford, G.[3]

[1]Fisheries and Aquatic Sciences, University of Florida (USA); [2]Emerging Pathogens Institute, University of Florida (USA); [3] Centre for Environmental, Fisheries and Aquaculture Science (UK); [4] Plymouth Marine Laboratory (UK); [5] British Museum of Natural History (UK)

It is increasingly apparent that pathogens and parasites have important ecological roles that impact their host populations and the broader communities in which they live. However, determining the role they play is not always a simple task and such is the case for the pathogen *Paramikrocytos canceri*, which infects the juvenile edible crab *Cancer pagurus*. Prior research has shown that prevalence of infection can reach 80% in some sites, but how the pathogen affects crab biology or ecology is largely unknown. Infected crabs are not overtly affected by the pathogen but they have been shown to excrete the parasite into surrounding waters via their urine. Preliminary studies have shown that larger juvenile and adult crabs, which live offshore of the infected intertidal juvenile population, do not appear infected. To begin unravelling this mystery we conducted a series of experiments to test: 1) if infection intensity is related to the quantity of pathogen shed into the water column, 2) if intensity of infection affects physiological condition (haemolymph protein), 3) if infection intensity affects competition for available shelter, and 4) if high infection prevalence is habitat specific and limited to the intertidal region.

Presenter's Email: behringer@ufl.edu

Personality interacts with habitat quality to govern individual mortality and migration patterns

Belgrad, B. A.*[1]; Griffen, B. D.[1,2]

[1]Marine Science Program, School of Earth, Ocean, and Environment, University of South Carolina [2]Department of Biological Sciences, University of South Carolina

Animal personalities are increasingly recognized as key drivers of ecological processes. However, studies examining the relative importance of personalities in comparison to other environmental factors remain lacking. We performed two field experiments to assess the concurrent roles of personality and habitat quality in mediating

individual mortality and migration. We quantified the predator avoidance response of mud crabs, *Panopeus herbstii*, collected from low and high quality oyster reefs and measured crab loss in a caging experiment. We simultaneously measured the distance crabs traveled across reef quality in a separate reciprocal transplant experiment. Habitat quality was the primary determinant of crab loss, although the distance crabs traveled was governed by personality which interacted with habitat quality to control the fate of crabs. While crabs on low quality reefs rapidly emigrated, starting with the boldest individuals, both bold and shy crabs would remain on high quality reefs for months and experienced higher predation risk, particularly among bold individuals. These findings suggest that personalities could produce vastly different population dynamics across habitat quality and govern community responses to habitat degradation.

Presenter's Email: babelgra@eckerd.edu

From Seeds to Shoreline: A youth program for salt marsh restoration

E.V. Bell

South Carolina Sea Grant Consortium

The salt marshes and tidal creeks along South Carolina's 2,786 miles of coastline often link terrestrial activities (natural and anthropogenic) with estuarine environmental quality. As South Carolina's coastal population increase, there is a persistent need to educate communities about the benefits of and threats to this habitat's ecosystem services. From Seeds to Shoreline (S2S) is South Carolina' only salt marsh restoration initiative for K-12 students and teachers. The program merges salt marsh ecology with environmental stewardship by engaging participants in cultivating and transplanting Spartina alterniflora, the dominant plant of southeastern salt marshes. The goal of S2S is two-fold: establish a science-based understanding of the salt marsh ecosystem and foster stewardship practices that provide for its future conservation. S2S is coordinated by the South Carolina Sea Grant Consortium in partnership with the South Carolina Department of Natural Resources and Clemson Extension. In 2014, funding from the Environmental Protection Agency enabled S2S to be piloted in Georgia and North Carolina. New educational products were developed including: Guide to the Salt Marshes and Tidal Creeks of the Southeastern United States and a Spartina poster. The S2S program has worked with an estimated 2,500 students and teachers who have transplanted more than 25,000 seedlings.

Presenter's Email: ev.bell@scseagrant.org

Context-Dependency of Phenotypic Differentiation along the Intertidal Gradient

Kylla Benes*; Matthew Bracken

University of California Irvine

Rocky shores are characterized by a gradient in emersion stress that can drive local adaptation if strong selection and/or barriers to dispersal occur across the gradient. But rocky shores are distributed along larger latitudinal environmental gradients, which could mediate local-scale processes and thereby result in geographic differences in local adaptation to tide height. We used the widely-distributed seaweed, *Fucus vesiculosus*, to test our hypothesis that phenotypic differentiation across tide heights would vary among geographic regions. Reciprocal transplants between the upper and lower edges of *Fucus'* intertidal distribution were conducted at sites spanning ~500-km of the Gulf of Maine (GOM) coastline. Changes in biomass revealed phenotypic differentiation across tide heights (i.e., local adaptation) in the northeast, but not elsewhere in the GOM. However, changes in tissue nitrogen did not respond to transplantation in the same way as growth, suggesting the importance of geographic variation in resource allocation. Greater tidal amplitude increases vertical distance between individuals across the intertidal gradient in the northeastern GOM. Thus, barriers to dispersal in some regions may drive geographic variation in phenotypic differentiation in this species. Our study highlights the importance of regional environmental variation in driving ecological and evolutionary processes on the local-scale.

Presenter's Email: kbenes@uci.edu

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Long-term changes in benthic community structure following the Deepwater Horizon event

S.K. Berke[1*]; Dorgan, K. M.[2,3]; Robertson, A. [2,3]; Bell, S.[4]; Caffray, T.[1]; Weldin, E.[1]; Budai, S.[1]; Parker, R. [2,3]; Gadeken, K. [2,3]; Clemo, W. [2,3]; Keller, E.L.[1]

[1] Siena College, [2] Dauphin Island Sea Lab, [3] University of South Alabama, [4] University of South Florida

Ecologists have long sought to characterize community responses to disturbance. Anthropogenic disturbances such as oil spills present especially thorny problems, because the toxic fingerprint of oil exposure can persist for years or even decades. In April 2010, an explosion on the Deepwater Horizon platform triggered the largest oil spill in history, sending nearly 500 million barrels of crude oil into the Northern Gulf of Mexico. We are assessing long-term impacts of this event on benthic invertebrate communities in unvegetated and seagrass (*Ruppia)* habitats of the Chandeleur Islands, LA. Oiled sites, identifiable by elevated hydrocarbons in the upper 15 cm of sediment, are paired with nearby unoiled sites. Seven years after the spill, taxonomic composition and functional group composition show differences for at least some oiled versus unoiled sites. These data suggest that return to pre-disturbance baselines may be inhibited by oil contamination within the uppermost layers of sediment. However, preliminary analyses hint that taxonomic and functional group responses may not always be consistent across all sites in all sampling periods. Furthermore, the extent to which oiled habitats retain their functional capacity in terms of biogeochemical cycling, productivity, bioturbation, etc., remains an important question.

Presenter's Email: sberke@siena.edu

The ecological importance of the Florida sea cucumber, *Holothuria floridana,* to seagrass and hard-bottom communities in the Florida Keys and the environmental variables that correlate with their distribution and abundance

Berkebile N[1*]; Behringer D.[1,2]; Baeza A.[3]

[1] School of Natural Resources and the Environment, University of Florida, Gainesville, FL 32653; [2] School of Forest Resources and Conservation, Fisheries and Aquatic Sciences, University of Florida, Gainesville, FL 32653; [3] Department of Biological Sciences, Clemson University, Clemson, SC 29634

Holothurians have been overexploited across the globe for the food and aquarium industries, but their ecological importance has often been overlooked. Our work focused on the Florida sea cucumber, *Holothuria floridana*, from the Florida Keys. To understand the ecology of *H. floridana*, we conducted field surveys and experiments to determine their role as a prey item, the effect of their foraging, and environmental characteristics that correlate with their distribution and abundance. Small *H. floridana* display cryptic behavior and coloration in hard-bottom habitats, while large *H. floridana* residing in seagrass beds do not. Therefore, to determine their relative susceptibility to predation, we conducted a tethering study using both. Predation occurred most often on smaller *H. floridana* in hard-bottom habitats. To assess foraging impacts on seagrass sediment characteristics, an enclosure study was conducted in which we manipulated *H. floridana* density. Addition of *H. floridana* reduced sediment chlorophyll a concentrations but surprisingly, not organic content. Sediment depth, percent cover-abundances of *Thalassia testudinum*, total macroalgae and sponges, and sediment chlorophyll a were significant drivers of their distribution. In sum, *H. floridana* may fulfill a specific niche as a prey item and, as their abundances soar within seagrass beds, they can significantly reduce benthic microalgae.

Presenter's Email: nberk001@ufl.edu

Using sediment profile imagery (SPI) to quantify relationships between water quality and benthic habitat condition

Blackwell, B.D.*; Nestlerode, J.A.; Hagy III, J.D.; Lisa, J.A.; Jarvis, B.M.; Murrell, M.C.

U.S. Environmental Protection Agency, Gulf Ecology Division

We present results from a monthly study in Pensacola Bay estuary (FL) designed to evaluate the impact of intermittent, seasonal hypoxia (DO < 2 mg L^{-1}) on benthic habitat condition. Samples were collected monthly from June 2015 to Dec 2016 at seven to nine sites along the estuarine salinity axis, ranging from near the mouth of the Escambia River to near the outlet with the Gulf of Mexico. Grain size analysis revealed that sediments were silt-dominated in the middle portion of the transect (76% silt) and graduated to sand dominance at the freshwater and marine extremes (~100% sand). Analysis of water column profiles showed that hypoxia was commonly observed in the middle portion of the transect during summer. Sediment profile imagery (SPI) showed features consistent with hypoxia, including a shallower apparent RPD and evidence of reduced benthic activity. The images provided visual evidence of the integrated effects of hypoxia on sediment physical, chemical, and biological composition. Whereas recent water quality management efforts in Florida (e.g., numeric nutrient criteria, marine dissolved oxygen standard) assumed linkages between dissolved oxygen and aquatic life use attainment based on laboratory tests, SPI methods can potentially provide an assessment of these relationships in realistic field settings.

Presenter's Email: Blackwell.bradley@epa.gov

Altered susceptibility to trematode parasite infection in native versus introduced populations of the European green crab, *Carcinus maenas*

Blakeslee, A.*[1]; Ruocchio, M.[1]; Moore, C.[1]; Keogh, C.[2]

[1] Department of Biology, East Carolina University, [2]Odum School of Ecology, University of Georgia

Non-indigenous species (NIS) often experience a reprieve from infection by their co-evolved indigenous parasite load when they invade novel regions. Yet absolute escape from parasites may be precluded (notably with time) by introduction(s) of parasites from the native range or novel parasite acquisition(s) in the non-indigenous range. As a result, NIS infection susceptibility may differ or change in indigenous versus novel regions due to divergent coevolutionary histories and parasite selective pressures—thus influencing host resistance and/or compatibility. To investigate this question, we reciprocally exposed native (Europe) and non-native (eastern North America) individuals of the globally-invasive green crab, *Carcinus maenas*, to trematode parasites from both regions. We found infection susceptibility to differ by parasite origin for European crabs only: European crabs exposed to European parasites had lower infection prevalence and intensity, and the lowest proportion of irregular trematode cysts or encapsulated cysts (via host immunity), compared with all other combinations. Moreover, all USA crabs became infected and cyst intensities did not differ by parasite origin. Our study provides preliminary evidence for how susceptibility may be relatively rapidly influenced by altered parasite selection pressures. Further experiments will test host susceptibility across additional parts of the crab's widespread range.

Presenter's Email: blakesleeap14@ecu.edu

Living shorelines: Synthesizing results of a decade of implementation in coastal Alabama

Blomberg, B.*[1]; Heck, K.[1]; Haner, J.[2]; Byron, D.[1]; Brown, M.K.[2]; Scyphers, S.[3]; Grabowski, J.[3]

[1]Dauphin Island Sea Lab; [2]The Nature Conservancy; [3]Northeastern University

Substantial funds have been invested in living shoreline projects to restore coastal habitats, protect shorelines and enhance resiliency of coastal communities. While a variety of techniques have been implemented, we don't yet have a firm understanding of the degree of success of different reef technologies and project designs. In this study, we synthesized data from 12 living shoreline projects implemented in Alabama over the past decade to evaluate project success. All projects involved the construction of oyster reef breakwaters but were done using a variety of technologies (e.g., bagged shell, reef balls, reef BLKS). Bagged shell reefs supported the highest oyster densities. Abundance of finfish and mobile invertebrates was highly variable by site, reef type, and taxon. Shoreline protection has been highly variable by site, reef type and year. Preliminary results suggest bagged shell

reefs may be the most effective in providing an array of ecosystem services. Next steps include valuation of market and non-market ecosystem services across project types and expected reef lifetimes. Social survey data collected in conjunction with select projects are also being synthesized and evaluated. Our results will help identify the most promising strategies to ensure that future investments in living shorelines maximize ecological and societal benefits.

Presenter's Email: bblomberg@disl.org

Exploring disease dynamics in the staghorn coral, *Acropora cervicornis*: genotypic response to pathogen transmission techniques

Bock, M.E.*; Fogarty, N.D.

Department of Marine and Environmental Sciences, Nova Southeastern University

Population losses of the threatened coral, *Acropora cervicornis*, have been attributed primarily to white-band disease (WBD). Although a positive linear relationship between disease prevalence and increased water temperature has been described, the pathogens of WBD, its vectors, and transmission are poorly understood. With an estimated sea-surface temperature rise of 1.8–4.0 °C by the end of the 21st century, higher incidences of disease outbreak are expected. To predict future local population success of *A. cervicornis*, we investigated pathogen transmission and resistance in 11 different genotypes using two common transmission methods. Coral fragments from each genotype were distributed evenly among twelve tanks at the Nova Southeastern University SEACOR aquaria facility, such that each treatment and respective control had three replicates. Overall, disease transmission was higher in the grafting treatment when compared to the homogenate, and transmission varied greatly by genotype. At least three out of eleven genotypes appeared highly susceptible to disease, with at least two of three of their fragments exhibiting signs of disease. Only one appeared resistant, showing no signs of disease throughout the study. While these results suggest a high potential for mortality in the future, more genotypes should be tested to accurately predict future success of this population.

Presenter's Email: mb3154@nova.edu

Top-Down Impacts (or Lack thereof) on Community Structure following Hurricane Sandy in Barnegat Bay, NJ, USA

Paul Bologna*; John Gaynor; Robert Meredith

Department of Biology, Montclair State University, United States

Barnegat Bay, NJ is a shallow, well-mixed estuary with substantial anthropogenic development which has seen a major increase in the scyphozoan *Chrysaora quinquecirrha* (Atlantic Sea Nettle). Communities were sampled monthly in the summers from 2012 to 2014. Prior to Hurricane Sandy, the gelatinous zooplankton community was dominated by *C. quinquecirrha* and the comb jelly, *Mnemiopsis leidyi*. Results showed significant top down control of *M. leidyi* by *C. quinquecirrha* in 2012, but following Hurricane Sandy, substantial community changes occurred. Specifically, with the destruction of polyp habitat for *C. quinquecirrha*, their population showed declines in 2013 and 2014. Concomitant with this change, *M. leidyi* populations significantly increased in 2013 as a response to lack of predator control, but dropped significantly in 2014. The drop in 2014 was unexpected as *C. quinquecirrha* populations remained low; however the increasing density and diversity of other gelatinous species changed the community dynamics and increased competition among these species. The community change was related to increases in coastal and open ocean species including *Turritopsis nutricula*, *Nemopsis bachei*, *Bougainvillea muscus*, and *Rathkea octopunctata*, suggesting that the storm not only destroyed polyp habitat, but also impacted regional ocean circulation and opened the system to increased competition.

Presenter's Email: bolognap@montclair.edu

BEM-SEERS 2017 Oral Presentation Abstracts

Does beach nourishment achieve ecological equivalence to natural beaches? Impacts of a beach nourishment project on Jamaica Bay (NY) horseshoe crabs

Botton, M.*[1], Colón, C. [2]; Rowden, J.[3]; Elbin, S.[4]; Kriensky, D.[4], McKown, K.[5]; Sclafani, M.[6]

[1]Department of Natural Sciences, Fordham University, [2]Department of Biological Sciences, Kingsborough Community College, [3]National Audubon Society, [4]New York City Audubon Society, [5]New York State Department of Environmental Conservation, [6]Cornell University Cooperative Extension

Beach nourishment is regarded as a more ecologically benign shore protection strategy than shoreline armoring. A project in Jamaica Bay, NY provided an opportunity to examine the responses of spawning horseshoe crabs (*Limulus polyphemus*) to beach nourishment using a BACI (before-after-control-impact) design. During Spring 2012, before beach nourishment, horseshoe crabs made minimal use of a highly eroded and hardened shoreline in comparison to a nearby reference site. In the first post-nourishment spawning season (Spring 2013), there was no detectable increase in horseshoe crab spawning activity on the newly restored beach. From 2014-2016, the density of spawning females has increased at the nourished beach, although their numbers and especially the density of horseshoe crab eggs remains significantly lower than at the reference site. Four years post-nourishment, significant differences in sediment texture and hardness persist between the nourishment and reference sites. Subtle differences in beach geomorphology over relatively short distances can be detected by horseshoe crabs and may underlie their selection of specific nesting sites. Our results suggest that the sediment composition of nourished beaches should be considered during the project design phase to bring about maximum benefits to horseshoe crabs.

Presenter's Email: botton@fordham.edu

Tracking benthic community succession in restored mangroves using community-wide metrics

Jill R. Bourque*; Amanda W.J. Demopoulos; Jennifer McClain-Counts; Nicole Cormier; Ken Krauss

U.S. Geological Survey, Wetland and Aquatic Research Center

Mangroves provide important ecosystem services, and their decline worldwide highlights the need for restoration. Restoration of the natural hydrological function of mangroves may provide a cost-effective approach by addressing the underlying physical parameters causing mangrove loss. We investigated the benthic community and trophic ecology along a gradient of mangrove deforestation within restored and unrestored areas, and natural, reference forests. Infaunal density, diversity, and community composition were assessed in relation to environmental factors. Fauna and primary producers were analyzed for stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes in order to characterize trophic structure. Infaunal communities differed between degraded and reference mangrove habitats and these differences persisted over time. Fauna collected from degraded areas were enriched in ^{13}C relative to reference areas, indicating a shift in the baseline carbon source. Fauna from the unrestored sites were isotopically different from those analyzed from restored areas. Our initial results suggest that the restored hydrological regime may enable the trophic pathways to be more similar to reference areas by facilitating the maturing of the mangrove ecosystem. These data serve as a baseline for assessing mangrove restoration success over time and provide insight on the ecosystem functioning in mangrove habitats.

Presenter's Email: jbourque@usgs.gov

Acidification and warming impair calcification and survivorship of Caribbean corals

Bove CB*[1]; Ries JB[2]; Davies SW[3,4]; Westfield IT[2]; Castillo KD[1, 3]

[1] Curriculum for the Environment and Ecology, University of North Carolina at Chapel Hill; [2] Department of Marine and Environmental Sciences, Northeastern University; [3] Department of Marine Sciences, University of

North Carolina at Chapel Hill; [4] Department of Biology, Boston University

Rising atmospheric carbon dioxide (pCO_2) has caused ocean temperature to increase and pH to decrease, raising concerns about the health of marine organisms. Corals are particularly vulnerable to these stressors, likely due to their narrow thermal tolerance and use of carbonate ions in calcification, although response patterns vary across taxa. We conducted 90-day laboratory experiments to investigate the independent and interactive effects of ocean warming (28, 31°C) and acidification on calcification and survivorship of four Caribbean reef-building corals collected from the Belize Mesoamerican Barrier Reef. Aragonite saturation states of 3.9, 3.2, 2.2, and 0.7 were achieved by sparging natural seawater with air-CO_2 mixtures formulated at 280, 400, 700, and 2800 ppm, respectively. Temperature and pCO_2 were fully crossed with three-fold treatment replication. Average growth for all species exhibited a decreasing trend with increasing pCO_2, although not always linear. Notably, three species exhibited net skeletal dissolution in treatments undersaturated with respect to aragonite, with only *Siderastrea siderea* exhibiting net calcification under these conditions. Survivorship was significantly influenced by experimental treatment for all but one species. These results emphasize the importance of quantifying the synergistic effects of warming and acidification on a diversity of species to better predict responses to climate change.

Presenter's Email: colleenbove@gmail.com

Short-term responses of arctic deep-sea benthic macrofauna to pulses of phytodetritus

Bravo, G*[1] ; Ciancio, J [2] ; Witte, U [3] ; Kazanidis, G [3] ; Bourgeois, S [3] ; Makela, A [3] ; Archambault, P [4]; Nozais, C[5]

[1]Université du Québec à Rimouski- Institut des sciences de la mer de Rimouski, Québec, Canada; [2]Instituto de Biología de Organismos Marinos, CENPAT-CONICET, Chubut, Argentina; [3]School of Biological Sciences, Oceanlab, University of Aberdeen, Aberdeen, Scotland, UK; [4]Département de biologie, Québec-Océan, Takuvik, Université Laval; Québec, Canada; [5]Département de biologie, Université du Québec à Rimouski, Québec, Canada

Deep-sea benthic ecosystems of the Arctic Ocean are fuelled by organic material originated in the euphotic zone and normally delivered in pulsed events. Where sea ice is present, this organic material can take the form of ice algae and phytoplankton. So far, little is known about the responses of macrofauna facing future changes regarding quantity and quality of food reaching the seafloor inflicted by sea ice reduction. We conducted on-board pulse-chase experiments on sediment cores collected from 376 m water depth in Baffin Bay (67°N, 63°W) to investigate the macrofauna response to a simulated phytodetritus pulse. Dual-labelled (13C and 15N) diatoms *Thalassiosira nordenskioeldii* (Phytoplankton treatment) and *Synedra hyperborea* (ice algae treatment) were added separately to intact sediment cores and incubated for 4 days to compare results from different food supplies. The macrofaunal community (28 taxa) was numerically dominated by agglutinated foraminiferans followed by bivalves and polychaetes. Sediment community oxygen consumption (SCOC) was doubled within 4 days in treatment cores compared to controls giving evidence of metabolic activity. First results from this study showed that the benthic community responded in a similar way to both phytoplankton and ice algae inputs.

Presenter's Email: gonzalobravoargentina@gmail.com

Evaluating Effects of Extreme Salinity Change on a Benthic Predator

Breaux, N.J.*[1], Lebreton, B.[2], Palmer, T.A.[1], Beseres Pollack, J.[1]

[1]Department of Life Sciences, Texas A&M University-Corpus Christi; [2]CNRS - University of La Rochelle

Baffin Bay, Texas is a predominantly hypersaline estuary where evaporation rates often exceed freshwater inflows. Despite salinities that may surpass 80 psu, this system supports historically large populations of Black Drum, a commercially important benthic predator. In 2012, Black Drum in Baffin Bay experienced a widespread emaciation event, but a lack of hydrological and benthic community data preceding this event made determination of potential drivers difficult. We are using infaunal community characterization and stable isotope analyses to evaluate Baffin Bay under a variety of conditions including hypersalinity and recovery from a 2015 low salinity

disturbance event. Under hypersaline conditions, Black Drum appear to become confined to Baffin Bay, even as food resources there become limited. Under low salinity conditions, potential food resources in the bay increased significantly. However, stable isotope analyses suggest that under these less extreme conditions, fish leave the bay to forage on a more diverse array of food items than those present in Baffin Bay. Results of this study will help us to better understand the direct effects of extreme salinity change on Black Drum, benthic macrofauna, and overall ecosystem resilience.

Presenter's Email: nbreaux@islander.tamucc.edu

Interaction modification on coral reefs via changes in the physio-chemical environment and microbiome by a mucus net-producing gastropod

Brown, A.L.[1*], Osenberg, C.W.[1]

[1]Odum School of Ecology, Athens, GA 30606

Interaction modifiers alter the intensity of pair-wise interactions between other species. On coral reefs, macroalgae interact with corals, and the strength of this interaction can influence shifts from coral-dominated to algal-dominated communities. Other organisms can potentially modify the effects of algae on corals. For example, the nets of the sessile vermetid snail, *Ceraesignum maximum*, decrease coral growth and survival. These nets also may exacerbate the environmental conditions that lead to deleterious effects of macroalgae on corals. Using a combination of field and lab studies, we tested if (and to what extent) *C. maximum* modifies the effects of algae on coral growth by changing environmental conditions and altering the coral microbiome. Growth of corals declined in response to the combined effects of algae and vermetids. Vermetid nets reduced flow even and led to changes in the oxygen microenvironment, even in the presence of high water flow. Potentially fueled by retention of microbial substrate (e.g., DOC) under nets, bacterial diversity and the relative abundance of potentially heterotrophic bacteria increased in the presence of vermetid nets and algae. These results indicate that vermetids exacerbate the effects of algae on coral growth potentially via changes in physio-chemical conditions and microbial communities. Thus the presence of *C. maximum* has the potential to degrade reefs.

Presenter's Email: anyabrown@uga.edu

Multiple anthropogenic stressors can disrupt a positive feedback loop in coral reefs

Buhler, S.[*1]; Allgeier, J. A.[2]; Layman, C. A.[1]

[1]Department of Applied Ecology, North Carolina State University
[2]Department of Ecology, Evolution, and Marine Ecology, University of California Santa Barbara

Residing in oligotrophic waters, coral reefs' high productivity is likely due to mechanisms that aid in tight nutrient cycling. Recent evidence suggests that fish, large forms of biomass on reefs, may provide an ideal ratio of nitrogen to phosphorous for coral fitness through their excretion. However, multiple anthropogenic stressors, e.g., habitat degradation and overfishing, may alter the ratio and amount of nutrients available, potentially decreasing coral growth. Here we experimentally test: (1) how the loss of both habitat structure complexity and predators affect a coral fish community and (2) how structure-induced changes in the fish community affect coral growth. In (1) we manipulated both reef complexity and predator (Nassau grouper) presence and found an additive effect of complexity and predator presence, increasing average total fish biomass by 200%. In (2) we manipulated fish biomass, mediated through structural complexity, and found that coral growth was highest in our high complexity treatments. Our findings suggest that high structural complexity may initiate a positive feedback mechanism in coral reefs. Restoration efforts should utilize this positive feedback loop by reintroducing coral fragments in a manner that maximizes their structural complexity to attract fish, thus increasing initial coral growth and ensuring survival in natural habitats.

Presenter's Email: sbuhler@ncsu.edu

Plankton community composition and diversity differ across environmental gradients on coral reefs in Bocas del Toro

Buie LB*[1]; Davies SW[1,2]; Aichelman HE[3]; Castillo KD[1,4]

[1]Department of Marine Sciences, University of North Carolina at Chapel Hill; [2]Department of Biology, Boston University; [3]Department of Biological Sciences, Old Dominion University; [4]Curriculum for Environment and Ecology, University of North Carolina at Chapel Hill

Coral reefs are one of the most diverse shallow water marine ecosystems, supporting a myriad of species. However, little is known about the diversity of the plankton communities residing in the water column above these reefs. Here we employ genomic techniques to examine the diversity of plankton communities on two distinct reef environments across the Bocas del Toro Archipelago in Panama. Eight reef sites, which were classified as either inner or outer reefs, were visited and temperature loggers were deployed for one year. Noon light measurements were recorded for each site and three replicate plankton tows were collected. Plankton community diversity was evaluated via Illumina Miseq metabarcoding of the 18S rRNA gene and these data were correlated with previously quantified abiotic factors (light and temperature parameters). We observed significant plankton community differences between reef types that correlated well with light levels, suggesting that the availability of light, along with other biotic and abiotic factors, drives plankton community assemblages. Interestingly, we found that temperature played only a minor role in distinguishing plankton diversity on reefs in Bocas del Toro, Panama.

Presenter's Email: logankbuie@gmail.com

Spatial and temporal ecology of parasites of the beach-dwelling bivalve *Donax variabilis* in South Carolina

Burge, Erin J.*

Department of Marine Science, Coastal Carolina University

The coquina clam *Donax variabilis* Say, 1822 is a familiar inhabitant of ocean-facing beaches throughout its range. It is an important link in coastal food webs from detritus and primary production to migratory and resident shorebirds and fishes. Its prevalence and visibility makes it an indicator of beach disturbances and anthropogenic impacts. A single study from the 1950s in Texas described a new species of trematode metacercariae from coquina, *Cercaria choanura* Hopkins, 1958, and documented relatively high prevalence and intensity of this larval parasite. Since the 1950s, however, no published work has described the ecology of this "forgotten" host:parasite system. Clams from three beaches in the Grand Strand area of northeastern South Carolina were collected over six months in 2013 and 16 months in 2014 – 2015 to describe the density and intertidal zonation of hosts and parasites. Demographics and densities of coquina were highly variable across the sampled beaches, all size classes of coquina were vulnerable to infection, parasite intensity increased with host shell length, and there was strong seasonality to infection. Detailed dissections suggest that at least three larval forms, trematode sporocysts, cercariae, and metacercariae, are found in *D. variabilis*.

Presenting author contact info: eburge@coastal.edu

Collective dispersal leads to variance in fitness and maintains offspring size variation

Burgess, S.C.*[1]; Snyder, R. E.[2]

[1] Department of Biological Science, Florida State University; [2] Department of Biology, Case Western Reserve University

We sought to understand how larval dispersal in turbulent coastal eddies influences selection on adult reproductive strategies of benthic marine organisms. We developed a general mathematical model that draws from theories on bet hedging, offspring size-number trade-offs, and stochastic dispersal in coastal currents. In our model, the dispersal of larvae is driven primarily by turbulent eddies that collect larvae into coherent "packets". The larvae in a packet succeed or fail as a group, which generates large variance in reproductive success of each individual parent. We ask when the stochasticity in packet success favors changes in offspring size, spreading offspring releases over time, or both, to decrease variance and increase long-term fitness. We find no evidence for bet hedging in offspring size. However, we find that multiple offspring sizes can coexist in a population for extended periods (hundreds of generations or more), especially when reproductive effort is spread over time. Turbulent dispersal and longer spawning durations could effectively maintain offspring size variation among mothers even in the absence of good and bad years or locations. Empirical comparisons of offspring size would, therefore, not always reflect environment-specific selection on optimal size.

Presenter's Email: sburgess@bio.fsu.edu

Believe me, climate change is a *#@% hoax: lessons from an immigrant lobster

Butler, M.J. IV

Department of Biological Sciences, Old Dominion University

Climate change, schlimate change. In case you came late to the party (the one that begins with a capital "R"), it is now accepted that the earth's temperature is rising. We know this because the lawns have gone brown on our nation's golf courses. Even though this change in climate has nothing to do with humans, some pansy scientists question whether it poses a problem for marine animals - especially ones like spiny lobster that feed rich people. In this talk, by a guy who knows more about marine science than all the AAAS fellows combined, I'll provide rock-solid proof that Chinese-driven changes in temperature and salinity in our coastal seas will have zip, nada effect on our lobster dinner menu. Laboratory experiments and modeling studies on postlarval and juvenile Caribbean spiny lobsters (*Panulirus argus*), some of which were conducted by females mind you, reveal moderate if any effects on lobster survival, susceptibility to disease, or distribution in the Florida Keys. So what's the fuss? Besides, connectivity modeling and genetic studies prove that all of Florida's lobsters are illegal immigrants from Central and South America and therefore should be deported, or consumed with garlic and butter.

Presenter's Email: mbutler@odu.edu

Ocean acidification and warming have negative effects on the calcification rate and mortality of Atlantic Sea Scallops

Cameron, L.*[1], Grabowski, J.[1] and Ries, J. B.[1]

[1]Northeastern University Marine Science Center

Increasing atmospheric pCO_2 causes declines in global ocean pH, and warming of surface waters. Calcifiers inhabiting the Northwest Atlantic are particularly vulnerable, as this region is experiencing enhanced rates of warming and seasonal calcium carbonate under-saturation. Here, we report on experiments investigating the impacts of acidification and thermal stress on the calcification rate of the Atlantic Sea Scallop *Placopecten magellanicus*. 144 *Placopecten magellanicus* specimens were cultured for 4 months in a fully crossed pCO_2 (385

(S.D.= 58.4), 855 (S.D.= 198.3), 2230 (S.D. =360.6) ppm/ $\Omega_{calcite}$ of 3.5 (S.D.= 0.4), 1.5 (S.D.= 0.3) and 0.7 (S.D.= 0.06)) and temperature (6.3 (S.D.= 0.5), 8.9 (S.D.= 0.4), 11.9 (S.D.= 0.4) °C) experiment. Net calcification rates were determined through monthly buoyant weight measurements. A statistically significant linear decrease in net calcification rate was shown under increasing pCO_2. Temperature did not significantly affect calcification rates by itself, but interacted significantly with elevated pCO_2 to negatively impact calcification rates. Mortality was highest in the high temperature treatments for all pCO_2 conditions, and interacted significantly with pCO_2, yielding the highest mortality rates in high temperature/high pCO_2 treatments. Our results show that acidification will negatively impact the calcification rate of *P. magellanicus',* with potentially deleterious effects for the fishing industry. For example, the increased energetic demands of calcifying in warmer, more acidic seawater may cause scallops to divert energy from tissue production in favor of shell production. Ocean acidification also appears to reduce the range of thermal tolerance for this species, limiting its resilience to future climate change.

Presenter's Email: cameron.lo@husky.neu.edu

An anthropogenic habitat provides a refuge for the range shifting mangrove tree crab within a suboptimal novel ecosystem

Cannizzo, Z. J.*[1]; Dixon, S. R.[1]; Griffen, B. D.[1,2]

[1]Marine Science Program, School of the Earth, Ocean, and Environment, University of South Carolina;
[2]Department of Biological Sciences, University of South Carolina

Many species are shifting their ranges in response to climate change. When such shifts lead to the colonization of novel ecosystems it is critical to establish how the shifting species itself is impacted by novel environmental and biological interactions. Anthropogenic ecological refuge habitats are an understudied phenomenon that may play a crucial role in the persistence and expansion of species into suboptimal novel ecosystems. We tested if the anthropogenic habitat of docks provide an ecological refuge for the range shifting mangrove tree crab *Aratus pisonii* within the suboptimal novel saltmarsh ecosystem. We compared the impact of the saltmarsh and dock habitats on ecological and life history traits that influence the ability of this species to persist and expand into the saltmarsh and compared these to baselines in the historic mangrove ecosystem. Specifically, we examined behavior, physiology, foraging, and the thermal conditions of *A. pisonii* in each habitat. Docks provide a more favorable thermal and foraging habitat than the surrounding saltmarsh and therefore facilitated similar behavior and biometrics to the historic mangrove ecosystem. Ultimately, docks act as ecological refuges within the suboptimal saltmarsh and may allow *A. pisonii* to expand more quickly into, and better survive in, this novel ecosystem.

Presenter's Email: cannizzz@email.sc.edu

Can soundscapes be used to monitor estuarine fish responses to oyster reef restoration?

Olivia N. Caretti*; David B. Eggleston; DelWayne R. Bohnenstiehl

Department of Marine, Earth & Atmospheric Science, North Carolina State University

Monitoring the success of marine habitat restoration can be costly and labor-intensive. In temperate estuaries, visual surveys are hampered by poor water visibility and an inability to conduct surveys at night. Moreover, traditional sampling with nets and traps occurs intermittently, and responses to restoration are only inferred through "snapshots" in time. Passive underwater acoustics may provide a low-impact alternative to monitor marine habitats with high spatial and temporal resolution. We investigated the use of marine soundscapes as a tool to monitor fish response to the restoration of oyster cultch reefs in Pamlico Sound, NC. Soundscape characteristics were expected to reflect the habitat complexity and diversity of fish communities among reefs that varied in complexity. Two months following reef construction, a weak positive relationship existed between habitat complexity, fish diversity, and soundscape characteristics. We expect this relationship to strengthen as the reefs develop. We therefore hypothesize that long-term acoustic sampling of marine habitats will provide essential

information on fish behavior and habitat development that cannot be determined solely through traditional sampling methods. The high spatial and temporal fidelity of passive acoustic monitoring may complement traditional sampling to provide a more complete understanding of the development and success of marine habitat restoration.

Presenter's Emailrmation: oncarett@ncsu.edu

Conflicting speeds of introgression among mitochondrial and nuclear genes suggest adaptive processes in a green crab hybrid zone

Voss, Erin R.[1]; and Carlon, D. B[1]*

[1]Coastal Studies Center and Department of Biology, Bowdoin College

Hybrid zones have been successfully used to explore the evolutionary dynamics of species and species boundaries ever since the advent of molecular markers, but they also have important ecological consequences as new combinations of genetic variation are tested in new physical and biological settings. The extreme of this process - called hybrid vigor by crop breeders – has the potential to explain why some biological invasions are particularly devastating. Here we present data on the green crab (*Carcinus maenus*) hybrid zone between northern and southern genetic lineages with potentially unique adaptive properties. We depart from the "neutral" view by including SNP markers sequenced from the green crab transcriptome that are associated from cold adapted and warm adapted lineage. As do others, we found that the mt CO1 shows a very long cline in southern and northern haplotypes, with northern haplotypes sampled from Long Island Sound. In strong contrast, our two exonic SNPs showed a very steep cline between "Down East" Maine (east of the Penobscot River) and the southern Gulf of Maine that is strongly correlated with a physical gradient of temperature, suggesting natural selection plays an important role in shaping nuclear variation post-hybridization.

Presenter's Email: carlon@bowdoin.edu

It's the economy, stupid! Putting a price on increased mussel mortality in changing oceans

Carrington, E. *[1]; M. George[1]; H. Hayford[1]; L Newcomb[1]; M. Roberts[1]; I. Jefferds

[1]Department of Biology and Friday Harbor Laboratories, University of Washington; [2]Penn Cove Shellfish, LLC, Coupeville, WA

Bivalve mussels often dominate temperate coasts, providing foundational structure for mid-intertidal zones and sustaining a worldwide aquaculture industry worth over $1.5 billion annually. Mussels achieve strong attachment to rocks and culture ropes with flexible tethers called byssal threads, but are prone to episodes of weak attachment that lead to dislodgment (fall-off) and ultimately mussel death. Our previous laboratory studies on *Mytilus trossulus* showed mussel byssal thread quality and quantity is lowered by ocean acidification (OA) and warming (OW), weakening overall attachment strength up to 40-80%, respectively. But how bad is weak attachment? Spurred by this simple question from the news media, we used our previous biomechanical model for *Mytilus edulis* in Narragansett Bay, RI to predict mussel dislodgment under different (climate-driven) weakening scenarios. Results indicate a nonlinear effect, where small (<20%) reductions in attachment strength have little impact on annual survival (>80%). Large reductions in strength, those expected with OA and/or OW by 2100, will reduce mussel survival to 10-60%, levels that may not be ecologically or economically viable. Congener mussel species respond to OA and OW differently; this ecomechanical approach is a useful tool for predicting relative performance of species under different growing conditions, in farmed or wild populations.

Presenter's Email: ecarring@uw.edu

BEM-SEERS 2017 Oral Presentation Abstracts

Not a fun threesome: the prevalence, impact and interaction of boring sponges and pea crabs on oysters

John Carroll[1*], Jessica Watts[2], Christopher Finelli [2], Daphne Munroe[3]

[1]Department of Biology, Georgia Southern University; [2] Department of Biology and Marine Biology, University of North Carolina Wilmington, [3] Haskins Shellfish Research Laboratory, Rutgers University

The eastern oyster, *Crassostrea virginica*, provides a number of ecosystem services and is an important commercial fishery species along US East and Gulf Coasts. Unfortunately, their populations have declined dramatically, due to overharvest, habitat loss, and disease. As both oyster restoration efforts and aquaculture of oysters continues to increase throughout their range, it is important to consider the impacts of a number of potential oyster pests, including the boring sponge *Cliona* spp. and the pea crab *Zaops (Pinnotheres) ostreum* on oyster populations. Both of these pests have been demonstrated to reduce oyster growth, condition, and in some instances, reproductive output. Boring sponges in particular are a major concern for both oyster growers and managers, and our monitoring efforts have suggested that pea crabs might be more prevalent in sponge-infested oysters. We conducted an observational study to determine if there was any relationship between pea crab prevalence and sponge presence, and to examine whether the presence of both pests had synergistic effects on oyster condition. Across two very different systems (NC and NJ), sponge infested oysters were more likely to have a pea crab than the background population, both reduced oyster condition in isolation, and the effects were additive.

Presenter's Email: jcarroll@georgiasouthern.edu

Exploring biodiversity patterns in soft-sediments of the highly saline, warm and oligotrophic Red Sea

Carvalho, S.; Alsaffar, Z.; Cúrdia, J.; Ellis J.I.

King Abdullah University of Science and Technology (KAUST), Saudi Arabia

Biodiversity patterns of shallow water soft-sediment benthic communities across multiple environmental gradients were analyzed in one of the most saline, warm and oligotrophic seas: the Red Sea. Preliminary results show unprecedented levels of diversity, with high species abundance ratios (>0.5 in more than half of the replicates). Over 450 taxa and approximately 6,500 individuals were identified with more than 40% of the taxa being either single- or doubletons. The ten most abundant taxa contributed to 46% of the total abundance, whereas 153 taxa were needed to reach 90% of the total abundance. Even though abundance is usually low, the dominance of some opportunistic polychaetes and bivalves increased in areas with intense coastal development. In general, the number of species in those areas also increased, suggesting intermediate states of ecosystem disturbance. No clear latitudinal gradient was observed across ~2000km of the Red Sea in agreement with patterns reported for fish and corals or macrobenthos at other latitudes. However, density did decrease, albeit minimally, with depth, whereas for species richness no differences were detected. The present study contributes to a better knowledge of benthic soft-sediment biotopes in sub-tropical marine ecosystems, which have been highly neglected as most studies focus on coral reefs.

Presenter's Email: Susana.carvalho@kaust.edu.sa

Shining a light on pan-regional cryptic reef benthic biodiversity using Autonomous Reef Monitoring Structures

Pearman, J. K.[1]; Aylagas, E.[2]; Borja, A.[2]; Cahill, A.[3,4]; Carugati, L.[5]; Chenuil, A.[4]; Chust, G.[2]; Danovaro, R.[5,6]; David, R.[4]; Feral, J-P.[4]; Irigoien, X.[1,2]; Lo Martire, M.[7,8]; Moncheva, S.[9]; Rodriquez-Ezpeleta, N.[2]; Siaulys, A.[10]; Timmers, M.[11]; Uyarra, M.C.[2]; Carvalho, S.[1]*

[1]King Abdullah University of Science and Technology (KAUST), Saudi Arabia; [2]AZTI-Tecnalia, Spain; [3]Albion College, USA; [4]Aix-Marseille Université, France; [5]Università Politecnica delle Marche, Italy; [6]Stazione

Zoologica "A. Dohrn", Italy; [7]CoNISMa, Italy; [8]EcoReach SRL, Italy; [9]Institute of Oceanology (IO-BAS), Bulgaria; [10]Klaipeda University, Lithuania; [11]National Oceanic and Atmospheric Administration (NOAA), USA

Understanding and expanding our knowledge of the biodiversity of cryptic reef benthic organisms (i.e. small organisms usually hidden in cryptic spaces) is important in preserving the ecological status of marine benthic habitats. Using standardized sampling units (Autonomous Reef Monitoring Structures), deployed across five regional seas (Northeast Atlantic Ocean, Baltic, Mediterranean, Black and Red Seas), we examined changes in diversity, composition and community structure of sessile and mobile organisms (separated into 106-500 μm and 500-2000 μm size fractions) through metabarcoding techniques targeting the mitochondrial cytochrome c oxidase I (COI) gene. The Red Sea was shown to have the highest richness with the Black Sea having the lowest. In general, Arthropoda dominated the mobile fractions but depending on the fraction and region examined, Porifera, Bryozoa, Cnidaria, and Mollusca were also relevant. Similarity amongst size fractions were greater within a location than between locations with the Atlantic Ocean (Bay of Biscay) and the Mediterranean assemblages showing a higher affinity compared to those from other areas. Despite the current limitations of molecular tools, we demonstrate that metabarcoding of ARMS has the potential to highlight biogeographic patterns of cryptic benthic communities across large spatial scales.

Presenter's Email: Susana.carvalho@kaust.edu.sa

Healthy versus diseased coral-associated microbiomes: a metatranscriptomic analysis

Certner, R. H. *[1]; Vollmer S. V.[1]

[1]Department of Marine and Environmental Sciences, Northeastern University

Among the greatest threats to global coral reef health are coral epizootics, which are increasing in frequency and severity. In particular, white band disease (WBD) has devastated Caribbean acroporid populations since its initial outbreak in 1979. However, despite its widespread and devastating effects, the etiology of WBD remains largely uncharacterized. A number of studies have published coral-associated bacterial metagenomes and 16S datasets as a means to identify potential pathogens responsible for coral disease. One problem with these approaches is that they only account for changes in community structure rather than bacterial metabolic activity. The relative presence or absence of certain bacterial species does not necessarily correlate to species influence. Thus, uncommon bacteria – easily overlooked in metagenomic and 16S analyses – may be a driving force behind the transmission and progression of coral disease. In this study, we focus on coral-associated bacterial gene expression in order to characterize the activity of microbial communities on healthy and diseased corals. We use next-generation metatranscriptomic sequencing to analyze the genetic differences between healthy versus WBD-infected *A. cervicornis* microbiomes. Multivariate analyses were then used to determine significant metabolic signatures that differ between these microbiomes.

Presenter's Email: certner.r@husky.neu.edu

Evolutionary transitions towards eusociality in snapping shrimps

Solomon Tin Chi Chak [1,2]*, J. Emmett Duffy[1,3], Kristin M. Hultgren[4] and Dustin R. Rubenstein[2]

[1] Virginia Institute of Marine Science, The College of William and Mary; [2] Department of Ecology, Evolution and Environmental Biology, Columbia University; [3] Tennenbaum Marine Observatories Network, Smithsonian Institution; [4] Biology Department, Seattle University

Animal social organization varies from complex societies where reproduction is dominated by a single individual (eusociality) to those where reproduction is more evenly distributed among group members (communal breeding). Yet, how simple groups transition evolutionarily to more complex societies remains unclear. Competing hypotheses suggest that eusociality and communal breeding are alternative evolutionary endpoints, or that communal breeding is an intermediate stage in the transition towards eusociality. We tested these alternative

hypotheses in sponge-dwelling shrimps, *Synalpheus spp.* Although species varied continuously in reproductive skew, they clustered into pair-forming, communal, and eusocial categories based upon several demographic traits. Evolutionary transition models suggested that eusocial and communal species are discrete evolutionary endpoints that evolved independently from pair-forming ancestors along alternative paths. This 'family-centered' origin of eusociality parallels observations in insects and vertebrates, reinforcing the role of kin selection in the evolution of eusociality and suggesting a general model of animal social evolution.

Presenter's Email: solomonchak@gmail.com

Den sharing and den fidelity in juvenile spiny lobsters

Michael Childress[1] and Rodney Bertelsen[2]

[1]Department of Biological Sciences, Clemson University, Clemson, SC, USA; [2]Florida Fish and Wildlife Research Institute, Marathon, FL, USA

Caribbean spiny lobsters are socially gregarious due to strong attraction to conspecific odor cues which may reduce risk of predation through increased efficiency in finding shelter (den finding) or cooperative group defense (den sharing). However, recent studies have found that conspecific attraction in juvenile Caribbean spiny lobsters has significantly decreased. What is unknown is whether this decrease is due to the loss of highly gregarious individuals from the population (selection) or a change in response to odor cues (plasticity). To examine this question, we conducted a mark-recapture study conducted using both visual and acoustically tagged individuals. Lobster den sharing was correlated with substrate composition more than shelter density or conspecific density. Furthermore, lobsters tagged while sharing shelters had higher frequency of future den sharing due to strong den fidelity. Finally, a comparison of den sharing frequency in Florida Bay over the past 20 years suggests that den sharing frequency has remained the same (50-60%) despite the decrease in conspecific attraction. Taken together these results suggest that loss of conspecific attraction in juvenile spiny lobsters is the result of behavioral plasticity rather than selection against social phenotypes and that lobsters may use cues other than conspecific presence to locate suitable shelters.

Presenter's Email: mchildr@clemson.edu

The influence of biogeochemistry and predation on chemosymbiotic clams (Lucinidae) in tropical seagrass beds

Chin, D.W.[*1]; Altieri, A.H.[2]; Peterson, B.J.[1]

[1]School of Marine and Atmospheric Sciences, Stony Brook University; [2]Smithsonian Tropical Research Institute

Lucinid clams host symbiotic sulfur-oxidizing bacteria and frequently dominate the infauna of tropical seagrass beds. Proposed explanations for this association include facultative mutualism, whereby lucinids reduce potentially toxic sulfide levels in seagrass sediments in exchange for oxygen and sulfide as fuel for their symbionts or physical protection from predators within seagrass structure. To explore these mechanisms, we surveyed lucinid communities at 11 turtlegrass (*Thalassia testudinum*) sites in Bahía Almirante, Bocas del Toro, Panama. We also conducted manipulative experiments to estimate predation pressure on lucinids and lucinid effects on sediment sulfide concentrations in the laboratory and field. As expected, lucinids consistently lowered sulfide levels in sediment porewater. This effect varied by species and scaled non-linearly with body size, suggesting it may be driven by introduction of oxygenated seawater to sediment rather than direct consumption of sulfides. Predation pressure on lucinids was low and is likely limited to episodic predation by drilling gastropods and rays. The structure of live lucinid communities was tied to water quality parameters, suggesting a connection with local nutrient status. Overall, we find a tentative basis for facultative mutualism between lucinids and subtidal *Thalassia* but evidence that this mutualism could be impacted by coastal development in Bahía Almirante.

Presenter's Email: diana.chin@stonybrook.edu

Could the viability of *Panulirus argus* Virus 1 in seawater explain its Caribbean distribution?

Clark, A.*[1]; Waltzek, T.B.[2], Behringer, D.C.[1,3]

[1]School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences, University of Florida; [2]Department of Infectious Diseases and Pathology, College of Veterinary Medicine, University of Florida, Gainesville, FL; [3]Emerging Pathogens Institute, University of Florida

The pathogenic virus, *Panulirus argus* Virus 1 (PaV1), infects most life history stages of the Caribbean spiny lobster (*Panulirus argus*) along coastal Florida, USA and throughout the Caribbean Sea. PaV1 exhibits strong genetic connectivity across much of this range. Theoretical modeling work has shown that postlarvae could be vectors of PaV1. Alternatively, passive transport of PaV1 virions could be a viable means for connectivity. The objective of this study was to measure the viability of PaV1 in seawater and confirm or refute model-based connectivity projections. Postlarval lobsters were collected from the Florida Keys and then screened for PaV1 using a TaqMan real-time quantitative PCR (qPCR) assay. PaV1-negative lobsters were added each day for seven days to water that had been previously inoculated with purified PaV1. Following a two-week incubation period, we detected active PaV1 infections in each exposed lobster. Therefore, the virus remained viable and capable of infection over the length of this trial. We recently repeated this study with an extended trial duration. Here, we present the results of this study. Identifying the viability of PaV1 will enhance our understanding of marine diseases and their connectivity.

Presenter's Email: clarkab@ufl.edu

Coral diversity enhances the growth, health, and resistance to macroalgal invasion of coral communities on degraded reefs

Clements, C.S.*[1]; Hay, M.E.[1]

[1]School of Biological Sciences and Aquatic Chemical Ecology Center, Georgia Institute of Technology

The relationship between biodiversity and ecosystem function has been an area of intense investigation in recent decades, and understanding its effects on productive and biodiverse ecosystems such as coral reefs is urgent as reefs degrade worldwide. 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 coral reef ecosystem function, and may have important implications for coral resistance and resilience to increasing disturbances.

Presenter's Email: cclements9@gatech.edu

Functional morphology of Eunicidan (Polychaeta) jaws

Clemo, W. C.*[1,2]; Dorgan, K. M.[1,2]

[1]Dauphin Island Sea Lab; [2]Department of Marine Sciences, University of South Alabama

Polychaetes exhibit diverse feeding strategies and diets, with some species possessing hardened teeth or jaws of varying complexity. Species in the order Eunicida have complex, rigidly articulated jaws consisting of multiple pairs of maxillae and a pair of mandibles. While all Eunicida possess this general jaw structure, several

characteristics of the jaws vary considerably among families. These differences, described for fossilized and extant species' jaws, have been used to infer evolutionary relationships, but current phylogeny shows that similar jaw structures are found among several families that are distantly related. Little has been done, however, to relate jaw functional morphology and feeding behavior to diet. To explore these relationships, we compared the jaw kinematics of two distantly-related Eunicidan taxa with similar jaw structures: *Diopatra* (Onuphidae), predominantly herbivorous and tube dwelling, and *Lumbrineris* (Lumbrineridae), a burrowing carnivore. Jaw kinematics were observed by filming individuals biting in a number of orientations. Differences in jaw structure and kinematics between *Diopatra* and *Lumbrineris* can be interpreted to be consistent with their differences in diet. Relating jaw morphology to diet would improve understanding of early annelid communities by linking fossil teeth (scolecodonts) to the ecological roles of extant species with similar morphologies.

Presenter's Email: wclemo@disl.org

Warming and acidification impact corallite morphology but backreef corals are less susceptible

Kathryn A. Cobleigh[1*]; Ashley D. Foguel[1]; Madelyn V. Roycroft[1]; Pualani Armstrong[1]; Sarah W. Davies[1]; Justin B. Ries[2]; Karl D. Castillo[1]

[1]Department of Marine Sciences, University of North Carolina at Chapel Hill, [2]Department of Marine and Environmental Sciences, Northeastern University

Ocean warming and acidification are projected to increasingly impact coral calcification over the foreseeable future. Whether reef-building corals will be able to maintain their skeletal morphology and continue to accrete complex reef structures as climate change persists is a paramount research priority. We conducted controlled laboratory experiments to investigate the independent effects of temperature (25, 28, 32°C) and acidification (pCO_2 = 324, 477, 604, 2553 μatm) on corallite height and septal infilling of the Caribbean reef-building coral *Siderastrea siderea* over 95 days using advanced stereomicroscopy. Warming (32°C) projected for the end-of-century increased corallite height and reduced corallite septal infilling relative to present-day control (28°C). In contrast, corallite height was not impacted by end-of-century pCO_2 (604 μatm) but corallite septal infilling was reduced relative to near-present-day pCO_2 (477 μatm) control. Our results suggest that this keystone Caribbean reef-building coral will develop deeper corallites, but with thinner septa under Intergovernmental Panel on Climate Change projected warming and acidification for 2100. These changes in skeletal morphology will exacerbate observed declines in the health of already vulnerable Caribbean reef ecosystems as corals allocate more resources toward linear growth (increased vertical extension) but at the cost of a weaker skeletal structure (decreased horizontal infilling) under climate change.

Presenter's Email: kathryncobleigh@gmail.com

Multivariate analysis between water quality variables and benthic macrophytes reveals susceptibility to seagrass die-off

Amanda M. Cole[1]*, Michael J. Durako[1], Margaret O. Hall[2]

[1]University of North Carolina Wilmington; [2]Florida Fish and Wildlife Conservation Commission

Seagrass communities, dominated by Thalassia testudinum, form the dominant ecosystem within Florida Bay. This area has had periodic large-scale seagrass die-offs, especially during drought conditions. This study investigated bay-wide temporal and spatial trends in macrophyte abundance and water quality in order to determine if there are specific factors that could be predictive of future die-offs. Water quality data were collected monthly-to-bimonthly from 2005 to 2013 at fixed water quality monitoring stations. Macrophyte data were collected during spring and fall from 2006 to 2013 at 15 permanent transects co-located with a subset of the water quality stations. Multivariate analyses examining relationships between water quality and benthic macrophyte communities both by year and by transect location (basin) were performed using PRIMER software. Salinity, pH, total organic carbon, total phosphorus, turbidity, DIN:PO4, phosphate, and temperature were determined to be the

water quality variables that were best correlated with variation in the macrophyte communities. Several basins with permanent transects had a major seagrass die-off during summer 2015. The LINKTREE analysis revealed that the affected basins were different from the other basins more than 2 years before the die-off event, based on seagrass cover and thresholds in pH and DIN:PO4. In drought conditions, the water quality variables, combined with deep sediments and high seagrass density seem to correlate with susceptibility to die-off.

Presenter's Email: amc5305@uncw.edu

Annual surveys of Scleractinian and/or Gorgonian Populations in the Florida Keys from 2012 to 2016.

Colella, M. A.*; Ruzicka, R.R.; Brinkhuis, V.; Boisvert, T.; Cummings, K.; Ellis, A; Halperin, A; Huebner, L.

Florida Fish and Wildlife Research Institute

In 2011 the Coral Reef Evaluation and Monitoring Project (CREMP) expanded monitoring techniques beyond spatial cover to include more detailed assessments focused on population structure and health of stony corals and octocorals. From 2012 to 2016 colony density, size-frequency, and condition were assessed annually at 37 permanent sites for scleractinian corals and 18 permanent sites for octocorals throughout the Florida Keys. Preliminary analysis indicates that total stony coral colony density, averaged for all reefs, ranged from 7.30 ± 0.72 (±SE) in 2012 to 6.82 ± 0.66 in 2015. Octocoral colony density, averaged for all reefs, ranged from 13.89 ± 1.35 in 2013 to 15.29 ± 1.52. Colony densities for 2016 were not finalized at the time of submission. The higher octocoral abundances reflect previous CREMP findings that octocorals are succeeding corals as the most abundant organism following multiple mortality events in the Florida Keys. Increases in octocoral abundance is particularly pronounced at sites that experienced high levels of coral mortality during a recent cold event in 2010.

Presenter's Email: Mike.Colella@MyFWC.com

Modeling the effects of varying disturbance frequency and magnitude on population persistence in predator-prey systems

*Christian J. C. Commander; J. Wilson White

University of North Carolina, Wilmington

Human activities are rapidly and significantly transforming environments, altering historic ecosystem disturbance regimes. Disturbances can alter the physical environment and disrupt ecosystem function, impacting population abundance, demographic rates, or both. While the effects of disturbance frequency and magnitude on species diversity and competitive interactions have been well studied, less is known about their distinct effects on predator-prey interactions, particularly those including harvested species. We developed simple dynamic models to examine the effects of varying disturbance frequency and magnitude on prey population persistence in predator-prey systems. We then extended this analysis to a more realistic model of eastern oysters (*Crassostrea virginica*) and their predator, the southern oyster drill (*Stramonita haemastoma*), to assess how disturbances, characterized by changes in estuarine salinity and temperature, affect the predator-prey interaction. Initial results reveal that increasing the magnitude of disturbance increases the probability of prey population extinction more than increasing frequency. Additionally, effects differ depending on predator-prey dynamics and whether the disturbance affects population abundance or demographic rates. Oysters provide habitat and invaluable ecosystem services, so it is critical to conservation and restoration efforts to further understand the effects of varying disturbances on interacting populations in order to aid managers in improving long-term population outcomes.

Presenter's Email: cjc1285@uncw.edu

Spatial variation in fishing mortality of mature female blue crabs (*Callinectes sapidus*) in individual subestuaries of the Chesapeake Bay

Corrick, C.T.*[1,2]; Johnson, E.G.[1,2]; Ogburn, M.B.[2]; Aguilar, R.[2]; Hines, A.H.[2]

[1]Department of Biology, University of North Florida; [2]Smithsonian Environmental Research Center

Blue crabs (*Callinectes sapidus*) play many important ecological roles and are a valuable fishery species in the United States. Chesapeake Bay and its tributaries provide greater than 30% of national commercial landings annually. *C. sapidus* exhibits a complex life cycle in which, following mating, females migrate to the saline waters of the Bay mouth where eggs hatch and advect offshore. Recent management has focused efforts on the female blue crab fishery to protect the spawning stock and enhance recruitment back into the Bay. To track female migration and quantify exploitation rates on the blue crab spawning stock, we conducted a broad scale mark-recapture study (n=7,072) in 12 Chesapeake Bay subestuaries and one coastal embayment. Tagging was conducted in fall of 2014 (September and October), when the majority of female blue crabs mature and migrate to the spawning grounds, and in summer of 2015 (July), when additional females mature and migrate to these spawning grounds. Approximately 8.1% of tagged females were recaptured within one year of release. Overall reporting and exploitation rates of the 2015 spawning stock were approximately 75.3% and 11.6% respectively. Fishery exploitation of mature females is valuable to management because it directly affects recruitment in subsequent years.

Presenter's Email: c.corrick@unf.edu

Microplastic ingestion by *Venerupis philippinarum* and *Crassostra gigas* on intertidal shellfish farms and 'wild' beaches in British Columbia, Canada

Garth A. Covernton*[1,2]; Sarah E. Dudas[2]; Christopher M. Pearce[3]; Helen Gurney-Smith[4]; John F. Dower[1]

[1] Department of Biology, University of Victoria; [2] Centre for Shellfish Research, Vancouver Island University; [3] Marine Ecosystems and Aquaculture Division, Pacific Biological Station, Fisheries and Oceans Canada; [4]Ecosystems and Ocean Science, St. Andres Biological Station, Fisheries and Oceans Canada

Microplastic contamination is an emerging threat to marine ecosystems. Many aquatic animals, including fish, mammals, molluscs, and other invertebrates have been shown to ingest microplastics. These particles can disrupt digestive and reproductive processes, act as vectors for other harmful pollutants, and reduce overall animal health. In British Columbia, bivalves are economically important for both aquaculture and wild harvest. As nonspecific filter feeders they are susceptible to ingesting and concentrating microplastics from the water column. Shellfish aquaculture often uses plastic infrastructure (e.g. anti-predator netting and fencing, PVC pipes, etc.) that may become degraded and release microplastics. We quantified the extent of microplastic ingestion by two commercially important species, Manila Clams (*Venerupis philippinarum*) and Pacific Oysters (*Crassostra gigas*), by transplanting adult individuals to 11 shellfish farms and 11 nearby unmodified beaches throughout southern BC. The bivalves were left for 2-3 months, and then digested with 10% KOH, filtered, and their microplastic content visually quantified with light microscopy. Preliminary results suggest that ingested particle concentrations are highly variable between individuals, even within site, and primarily consist of fibers between 100 and 1000 μm in length. Our results show microplastic ingestion by BC shellfish to be low relative to global numbers.

Presenter's Email: gcov@uvic.ca

Some like it cold? – links between genotype and freezing tolerance in a green crab hybrid zone

Coyle, Aidan*[1]; Carlon, D. B.[1]

[1]Coastal Studies Center and Department of Biology, Bowdoin College

The European green crab *Carcinus maeanus* is a super invader, spreading to temperate and subtropical habitats around the world, re-engineering intertidal and shallow benthic ecosystems. On the East coast of the United States, a northern and southern genetic lineage of green crabs meet in the Gulf of Maine (GoM) and hybridize with complex genetic consequences. To understand the ecological consequences of hybridization in the GoM, we tested for differences in cold adaption among crabs carrying different mitochondrial and nuclear genes (exonic SNPs) collected from the across the GoM hybrid zone. A cold stress experiment at 2.5 d C (N = 243) evaluated the effects of collection site, genotype, size, sex, # of walking legs, and molting phase on cold stress tolerance (righting response). A first pass at the data with a multiple logistic regression model with all terms but genotype revealed that collection site followed by sex explained the most variation in cold tolerance (LRTs = 8.02 and 2.17). Cold tolerance decreased from the northern edge of the hybrid zone dominated by northern genotypes to the southern edge of the hybrid zone in Casco Bay A new model including nuclear and mitochondrial genotype terms will also be presented.

Presenter's Email: acolye@bowdoin.edu

Confirmation of blue crab (*C. sapidus*) predation on juvenile winter flounder (*P. americanus*) in southern New England waters using a PCR-method

Kelly J. Cribari*; Abigail K. Scro; Kathryn R. Markey; David L. Taylor

Roger Williams University, Department of Marine Biology

Increasing water temperatures in the Northwestern Atlantic have resulted in a northward expansion of blue crabs (*Callinectes sapidus*) to Southern New England waters, including the Narragansett Bay estuary and associated tidal rivers and coastal lagoons. The increased abundance of blue crabs in these areas may have important consequences to resident biota. For example, blue crabs may adversely affect juvenile winter flounder (*Pseudopleuronectes americanus*) populations via predation. Polymerase chain reaction (PCR)-based methods were used to detect crab predation on juvenile winter flounder. PCR methods were verified through laboratory-feeding trials prior to testing on crabs collected from the Narragansett Bay, Seekonk and Taunton Rivers, and Rhode Island coastal lagoons. A unique 208-bp region of the DNA was amplified using a winter flounder-specific primer set. Results analyzing 216 crab stomachs from 2014-2015 indicated a 38.9% incidence of predation. Occurrences of crab predation on winter flounder were examined in relation to biotic and abiotic factors, and revealed significant relationships between winter flounder size, salinity, and collection year. Genetic analysis of the stomach contents revealed predation rates exceeding those estimated from traditional visual analysis of stomach contents. PCR results could suggest that crabs are an important source of predator-induced mortality for juvenile winter flounder.

Presenter's Email: kcribari681@g.rwu.edu

Reproductive physiology, temperature, and biogeography: the role of fertilisation in determining the distribution of the barnacle *Semibalanus balanoides*

Sam Crickenberger*; David S.Wethey

University of South Carolina, Columbia, SC, USA

Marine benthic populations are dependent on early life-history stages surviving multiple population bottlenecks. Failure at one or several of these bottlenecks can alter species' patterns of distribution and abundance. The barnacle *Semibalanus balanoides* is found along temperate and sub-arctic shorelines of the Atlantic and Pacific Oceans. Over the past century the southern range limits of *S. balanoides* have shifted hundreds of kilometres poleward on both coasts of the Atlantic. Here we tested if temperature limits fertilisation and used these data, along with those from previous studies, to create mechanistic biogeographic models to understand which potential population bottlenecks in the early life-history of *S. balanoides* influence its distribution and abundance. In the

western Atlantic survival of new recruits is likely more important in setting the southern range limit than the effects of temperature on early life-history stages because fertilisation, brooding, and the probability of larval release matching phytoplankton availability were all predicted to be high near the historical range edge. Phytoplankton mismatch may partially explain the ephemeral nature of *S. balanoides* in some parts of the English Channel. Further south along the coast of France predicted brooding success was reduced in a pattern consistent with historical range shifts in this region. Within Galicia, Spain fertilisation was predicted to be low near the southern limit, and likely plays an important role in setting this range edge. Mismatches between phytoplankton abundance and larval release in Galicia may further limit reproductive success within this region.

Email: scricke@gmail.com

Tidal creek geomorphology and biotic interactions drive spatial patterning in facilitation cascades across southeast US salt marshes

Sinead Crotty*[1]; Christine Angelini[1]

[1]Department of Environmental Engineering Sciences, University of Florida

Facilitation cascades occur where a foundation species (FS) facilitates a secondary, dependent, foundation species (SFS) and together they support larger communities and higher ecosystem functions than those supported by FS alone. Although SFS patch size and cover are known to play a critical role in mediating facilitation cascade strength, the factors that drive observed variation in their spatial distribution remain unclear. Here we test the relative importance of tidal creek geomorphology, flow regimes, and predation in mediating ribbed mussel-SFS cover, recruitment, survival, and growth in cordgrass FS-dominated southeastern US salt marshes. Regional surveys reveal that mussel mound size and cover universally increase with tidal creek length, tidal prism, and submergence time. Results from a predator exclusion experiment further reveal that associational defenses and predation reinforce aggregated mussel distributions across marsh elevations by stifling mussel survival and recruitment off of existing mounds. Within mounds, mussel growth is dynamically controlled by tidal submergence and the interplay between intraspecific facilitation and competition as mound size increases. These findings reveal that geologic processes control SFS cover at landscape scales by dictating tidal creek geomorphology, and that inter- and intraspecific interactions collectively drive variation in SFS habitat patch size at local scales.

Presenter's Email: scrotty@ufl.edu

The future of Ecology, the view from June 1978

Cunningham, C. W.[1]

[1] Biology Department, Duke University

The summer of 1978 witnessed the dramatic collapse of competition theory to "explain everything" about community ecology. The backlash by Simberloff and others offered zero intellectual content. In marine ecology Geerat Vermeij was championing the role of predation and biogeography in structuring communities; presenting ideas many times more complex and interesting than other advocates of predation-based theory. Some future paradigms, such as ecological faciliation, were not even imagined. As so often happens, the last days of a dying paradigm can produce its very best work. For marine ecology, the summer of 1978 witnessed some of very best experiments testing for the existence of competition, tied to a magnificent tour de force of behavioral ecology.

Presenter's Email: cliff@duke.edu

A novel interaction: The thin stripe hermit crab, *C. vittatus*, kills the Florida Crown Conch, *M. corona* for its shell

Cutter, J.*[1]; Devlin, D.[2]

[1] Department of Biology, Florida Atlantic University; [2] Department of Biology, Texas A&M University – Corpus Christi

Hermit crabs require a shell for protection against predators and desiccation. Previous research indicates that hermit crabs do not have the ability to obtain a shell directly from a healthy gastropod or even from gastropods that were killed by immersion in boiling water. Instead hermit crabs can only acquire shells left empty after snail mortality. In contrast, two manipulative experiments demonstrate that the hermit crab *Clibanarius vittatus* have the ability to kill *Melongena corona* gastropods and remove them from their shells. The outcome of this interaction did not vary with the sex of *C. vittatus*; there was no significant difference between the number of females and males that killed *M. corona*. This type of interspecies interaction is undocumented. In most cases *C. vittatus* did not consume *M. corona* tissue, therefore this interaction does not fit the definition of predation. Competition occurs when two organisms compete over a common, necessary, and limited resource. However, there is no known instance where competition occurs over part of an individual's body or for which one of the organisms involved has nothing to gain. This research will add to our understanding of ecological interactions and the ecology of benthic ecosystems.

Presenter's Email: jcutter2015@fau.edu

Biological characterization of coastal benthic communities in Churchill, Manitoba

Cypihot, V.*[1]; Archambault, P.[2]; Howland, K.[3]

[1] Institut des Sciences de la Mer, Université du Québec à Rimouski; [2] Département de Biologie, Université Laval; [3]Department of Fisheries and Oceans Canada, Freshwater Institut

Coastal habitats provide unique conditions as it is the location of strong land and ocean interactions which allow a specific diversity of species to establish. However, in the Canadian Arctic, this unique habitat may experience a growing number of impacts such as oil spills and aquatic invasive species. In this context, effective, low-cost sampling methods are required to obtain baseline data on Arctic species and coastal environments in remote areas. The Emergency Spatial Pre-SCAT (shoreline cleanup assessment technique) for Arctic Coastal Ecosystems (eSPACE) project developed a classification of habitats by videography using parameters such as substrate and geomorphology. In order to verify the relationships between this habitat classification and the biological composition, the objective of this study was to characterize coastal benthic communities and associated habitats in Churchill, Manitoba. To ground truth the videographic classification of habitat with biological data, species abundance, diversity and biomass of algal and benthic communities were collected in six different habitats (Boulder, sand, bedrock platform/ramp, marsh, mixed sediment, mixed tidal flat). Results show differences and similarities between biological composition of each habitat which will allow for direct information on the relative biological importance of the sampled habitats and help validate the classification of these habitats.

Presenter's Email: valerie.cypihot@gmail.com

Human development and coastal zone impacts on the behavior of the ghost crab, *Ocypode quadrata.*

Davis, S.*; Rosch, E.

Department of Marine Science, Coastal Carolina University

Anthropogenic disturbances, such as the destruction of sand dunes and coastal development, have been shown to impact beach-dwelling organisms like the ghost crab, *Ocypode quadrata*. Such impacts may be assessed by

examining evidence of their exploratory movements. Ghost crabs are primarily nocturnal, and they leave behind distinct tracks from their nightly activities. The current study examined how the level of human activities affected the abundance and lengths of these tracks. Relationships connecting a burrow's beach zone location (dune, mid-beach, high tide) to the characteristics of the tracks were also analyzed. Ghost crab tracks were compared between two beaches with different levels of development to demonstrate possible patterns. The results of this study suggest that coastal development does indeed affect the exploratory behavior of this species, which carries important implications for the protection of coastal habitats and the well-being of this and other beach-dwelling organisms.

Presenter's Email: sndavis1@coastal.edu

An evaluation of relative extinction risk within the flatheads, flying gurnards, and scorpionfishes of Oceania

Deal, J.*[1]; Motomura, H.[2]; Ralph, G.[3,4]; Carpenter, K.[3,4]; and Harwell, H.[1]

[1]Dept. of Organismal and Environmental Biology, Christopher Newport University; [2]Kagoshima University Museum; [3]Old Dominion University; [4]Marine Biodiversity Unit, Global Species Programme, International Union for Conservation of Nature.

The remote region of Oceania is home to high species diversity and endemism, yet the conservation status of many of its species remains unknown. To redress this, a collaborative effort to complete the first comprehensive assessment of the relative extinction risk of all marine bony fishes of the region is underway. Here, we present the conservation status of each member of the fish families Dactylopteridae, Platycephalidae, and Scorpaenidae occurring in Oceania. Species-specific information regarding taxonomy, distribution, population status, habitat, ecology, potential threats, and conservation measures was compiled from available literature, reviewed, and supplemented by experts at a Red List Assessment Workshop in Suva, Fiji (March 2015). Applying IUCN Red List Criteria, each species was assigned a Red List Category, and digital species distribution maps were compiled to identify geographic areas of high species richness and potential areas of concern. Of the 91 species assessed, 89% were listed as Least Concern and 9% were Data Deficient. Two Hawaiian endemics (*Caracanthus typicus* and *Sebastapistes coniorta*) were Near Threatened due to restricted range size and potential effects of coral reef degradation, bycatch, and subsistence fisheries. Our results provide important baseline data to help guide future marine conservation and management efforts within the region.

Presenter's Email: jessica.deal.11@cnu.edu

Development of a sandwich hybridization assay for the harmful cyanobacterium *Microcystis*

Nicole Dearth*[1]; William J. Jones[2,3]; Rebecca Mortensen[1]; Cameron Doll[4]; James L. Pinckney[3,5]; Dianne I. Greenfield[1,3,4]

[1]Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina; [2]Department of Environmental Health Sciences, Arnold School of Public Health, University of South Carolina; [3]School of the Earth, Ocean, and Environment, University of South Carolina; [4]Marine Resources Research Institute, South Carolina Department of Natural Resources; [5]Department of Biological Sciences, University of South Carolina

Cyanobacteria are responsible for the largest number of harmful algal blooms (HABs) worldwide. The genus *Microcystis* is a major contributor to these HABs, and some species produce the hepatotoxin microcystin that affects humans, pets, and wildlife through direct bloom contact or consumption of contaminated water. Stormwater detention ponds, such as those found along the South Carolina (SC) coast, often harbor *Microcystis* blooms. Their associations with residential and recreational areas pose threats to public health. Molecular techniques enable rapid and accurate species identification and quantification of HABs and other plankton, thereby facilitating 'early warnings' of blooms and management responses that safeguard public health. Sandwich hybridization assay (SHA), the technique considered here, directly (e.g. no genetic material purification or

amplification) identifies and quantifies planktonic species using ribosomal RNA (rRNA). SHA utilizes two DNA probes; a capture and signal probe that bind to the targeted rRNA sequence creating a "sandwich" wherein the results are measured by absorbance. SHA for *Microcystis* was developed using 16S rRNA from GenBank®, and validated using cultures and local (SC) isolates. Bloom samples spanned April 29-July 26, 2016, and multiple cyanobacteria species, including *Microcystis* spp., were observed.

Presenter's Email: njudy@email.sc.edu

Agelas Wasting Syndrome alters microbial symbiont communities of the Caribbean brown tube sponge, *A. tubulata*

Deignan, Lindsey K*; Pawlik, Joseph; Erwin, Patrick M

Dept. of Biology and Marine Biology and Center for Marine Science, UNC Wilmington, NC 28409

The brown tube sponge *Agelas tubulata* (cf *A. conifera*) is an abundant and long-lived sponge on Caribbean reefs. Recently, a disease-like syndrome known as *Agelas* Wasting Syndrome (AWS) was described from *A. tubulata* in the Florida Keys, where it increased from 7 to 35% of the population between 2010 and 2015. In this study, we characterized the microbial symbiont community of *A. tubulata* for the first time from individuals collected within the same monitoring plots where AWS was described. We also sampled tissue from *A. tubulata* exhibiting symptoms of AWS to determine the effect of disease on the diversity and structure of microbial symbiont communities. Bacteria from phyla *Proteobacteria*, particularly the class *Gammaproteobacteria*, and *Chloroflexi* dominated the sponge microbiomes. Microbial community structure differed significantly between the diseased and healthy sponge samples, with greater variability among communities in diseased samples compared to healthy samples. These differences in microbial community structure were attributed in large part to a shift in the dominant, ammonia-oxidizing (*Thaumarchaeota*) symbionts present in diseased and healthy sponge samples. Further research is required to determine the functional consequences of this shift in microbial community structure and the causal relationship of dysbiosis and sponge disease in *A. tubulata*.

Presenter's Email: lkd6379@uncw.edu

Determining an environmental flow regime using benthic macrofauna as biological indicators of ecosystem health

Elizabeth A. Del Rosario*; Evan L. Turner; Paul A. Montagna

Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi

The demand for water in Texas continues to grow with limited supply, putting the health of our coastal bays and estuaries at risk. Texas has implemented environmental flows regulations requiring the release of impounded waters. Pumped inflow is the primary source of freshwater into the Nueces Estuary, Texas, USA and without it the estuary becomes a hypersaline nonproductive system. Continuous long-term sampling of benthic macroinfauna in the main tributary, Rincon Bayou, was used to determine the extent supplemental freshwater inflow altered ecosystem health. *Streblospio benedicti* and Chironomid larvae were the most numerically dominant species and considered biological indicators. Each indicator species optimal salinity and depth values were predicted and combined to determine an optimal range for the production of the presence of benthos. The purpose of this study was to link environmental parameters with the biological response of the indicator species to determine an optimal pumping regime. Salinity and depth can be altered in direct response to the management of pumping operations, thus controlling biological response in the estuary. Species diversity was significantly correlated to freshwater inflow increases. Continues low flow regimes where determined to be the most ecologically beneficial with haphazard regimes creating a highly disturbed environment.

Presenter's Email: edelrosario@islander.tamucc.edu

Ocean acidification may lead to altered micromechanical properties of the mineralized cuticle in juvenile red and blue king crabs

Dickinson, G. H.*[1]; Coffey, W. D. [1]; Nardone, J. A. [1]; Yarram, Y. [1]; Long, W. C.[2], Swiney, K. M.[2]; Foy, R. J.[2]

[1] Department of Biology, The College of New Jersey; [2] NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center, Resource Assessment and Conservation Engineering Division, Kodiak Laboratory

Crustaceans exhibit mixed responses to the decrease in pH or carbonate availability associated with ocean acidification (OA). In decapods, the cuticle resists mechanical loads, provides protection from environment and predators, and enables mobility; however, little is known about how OA or interactions between OA and temperature affect its structure or function. Here, the effects of OA on mechanics, structure, and composition of the cuticle in two Alaska king crab species was assessed. Juvenile blue king crabs (*Paralithodes platypus*) were exposed for a year to three pH levels: 8.1 (ambient), 7.8, and 7.5. Juvenile red king crabs (*Paralithodes camtschaticus*) were exposed for 6 months to two pH levels, 8.0 (ambient) and 7.8, at three temperatures: ambient, +2°C, and +4°C. Cuticle microhardness (resistance deformation), structural organization, ultrastructure, and elemental composition was assessed for the carapace and the crushing claw. In both species, OA reduced endocuticle microhardness in the claw, but not in the carapace. In red king crabs, increased temperature did not alter the response. This trend occurred without a corresponding reduction in calcium content, suggesting that calcium content is not a sufficient proxy for mechanical properties. Reduced claw microhardness, indicative of more compliant material, could compromise the utility of crushing claw.

Presenter's Email: dickinga@tcnj.edu

Effects of Black Mangrove Expansion on Salt Marsh Fauna Before and After a Flood

Diskin, M.S.*; Smee, D.L.

Texas A&M University – Corpus Christi

Climate change is facilitating black mangrove (*Avicennia germinans*) encroachment into Gulf of Mexico (GOM) estuaries, where mangroves are displacing *Spartina alterniflora* and other marsh plants. Western GOM estuaries have low tidal exchange, and salinity ranges from 0 to >50 ppt depending upon rainfall. Besides promoting encroachment of tropical species into the GOM, climate change will likely affect estuarine salinity by making droughts longer and more intense and making storms and flooding more severe. We investigated the combined effects of mangrove encroachment and salinity changes on associated wetland fauna. In the spring and fall of 2014, communities were significantly different and organisms significantly less abundant in wetlands dominated by mangroves, even when *S. alterniflora* remained abundant. In spring 2015, flooding and reduced salinity obscured this trend, although in fall 2015 salinity increased, and organisms were again more abundant in areas without mangroves. Thus, climate change can have significant effects on the distribution of wetland foundation species and associated faunal community structure, but, ultimately, precipitation and changes in salinity regimes can override the influence of foundation species on fauna. Climate change is altering the faunal composition of coastal wetlands by facilitating shifts in foundation species and by altering precipitation and salinity regimes.

Presenter's Email: mdiskin@islander.tamucc.edu

Impacts of hand harvesting on intertidal oyster (*Crassostrea virginica*) population structure and cultch density in Northeast Florida

Olivia Escandell; Silas Tanner; Nicole Dix*; Pamela Marcum; Julia Lanoue; Mathew Monroe; Jason Lynn

Guana Tolomato Matanzas National Estuarine Research Reserve

Centuries of anthropogenic pressures, including harvesting, have reduced eastern oyster (Crassostrea virginica) populations throughout North America. St. Johns County in Northeast Florida reports the second highest commercial landings of wild caught oysters in Florida; however, the effects of harvesting on local oyster populations have not been studied. Harvesting oyster reefs can impact sustainability of oyster populations by removing reproductive individuals and dead shell important for larval settlement. While previous studies have investigated the effects of tonging and dredging on oyster reefs, effects of hand harvesting, the technique used in St. Johns County, are not well-documented. Reefs in three regions of the Tolomato and Matanzas Rivers were sampled for population structure metrics, associated sessile fauna, and cultch density during 2014 â€“ 2016. In all regions, total oyster density and spat (< 25mm) density were significantly lower in harvest zones than outside. Non-harvested size class distributions were consistently skewed to the right compared to harvested populations. Other harvest effects were regionally dependent and may have been attributed to differences in harvest pressure. Overall, results indicate that hand harvesting can impact oyster populations. Determining how these impacts are related to long-term sustainability of the resource is an important next step.

Presenter's Email: nikki.dix@dep.state.fl.us

Investigating population genetics and gene expression of scleractinian coral in a highly variable environment along the northern Florida Reef Tract

Dodge, D. L.*[1]; Beal, J.[2]; Voss, J. D.[1]

[1]Harbor Branch Oceanographic Institute, Florida Atlantic University; [2]Florida Fish and Wildlife Conservation Commission

Coral reef populations on Florida's central east coast are susceptible to many anthropogenic influences including controlled freshwater discharges and agricultural runoff. Natural environmental variability is relatively high as a result of seasonal rainfall and upwelling patterns. Neither coral spawning nor gamete development have been observed at the northern end of the Florida Coral Reef Tract. This region is strongly influenced by the Florida Current and represent the upper latitudinal limits for many scleractinian coral species along the Florida Coral Reef Tract. We hypothesize that this region may represent a population sink for multiple coral species. To better understand coral population structure and responses to sublethal stressors, populations of the scleractinian coral *Montastraea cavernosa* were examined using a combination of genomic and transcriptomic techniques. Microsatellite markers were used to assess population structure and connectivity along Florida's east coast. RNA-Seq analysis were completed on an Illumina HiSeq platform to characterize transcriptomic responses of corals in this highly variable environment over time. The goals of this project are to quantify coral responses to estuarine discharge, provide insight into the fundamental metabolic processes that may enhance stress tolerance and coral resilience, and to promote data-driven management decisions that enhance conservation of these coral ecosystems.

Presenter's Email: ddodge2015@fau.edu

Acoustics as a tool for studying infaunal impacts on sediments

Kelly M. Dorgan*[1,2]; Grant Lockridge[1,2]; Will M. Ballentine[1]; Preston S. Wilson[3,4]; Megan S. Ballard[4]; Kevin M. Lee[4]

[1]Dauphin Island Sea Lab, [2]Department of Marine Sciences, University of South Alabama, [3]Mechanical Engineering Department, University of Texas, Austin, [4]Applied Research Laboratories, University of Texas, Austin

Infaunal organisms alter their sediment environments by burrowing through and feeding on sediments and constructing and irrigating tubes and burrows. Irrigation and burrowing alter pore water chemistry and geochemical cycling. Tubes that extend above the sediment-water interface, feeding pits and fecal mounds have been shown to alter bottom boundary layer flow and consequently influence suspension feeding and erosion and

deposition of sediments. Impacts of infauna on subsurface physical properties of sediments have been less well studied, however. We apply high-frequency acoustics to characterize the physical impacts of infaunal activities. Sound speed and attenuation were measured in laboratory mesocosms with single species and combinations of tube-building and burrowing taxa. Burrowing species such as the brittle star, *Hemipholis elongata*, increase porosity, whereas tube-building species such as the polychaete, *Owenia fusiformis*, increase the structure of sediment grains. Increased porosity is predicted to decrease sound speed, whereas structuring by tubes is predicted to increase sound speed. Depth of impact and spatial variability were determined by measuring sound speed at varying orientations and depths in mesocosms. Acoustic propagation in sediments is a promising method for characterizing and quantifying physical ecosystem engineering in visually opaque sediments.

Author contact info: kdorgan@disl.org

Land use and environmental variables influence abundance of antibiotic-resistant bacteria and potential for their delivery to the coast

Jason A. Duff*; Risa A. Cohen

Georgia Southern University, Department of Biology, Statesboro GA

The global presence of antibiotic-resistant bacteria (ARB) in aquatic systems influences public health by reducing antibiotic efficacy and the environment by altering the structure and activity of microbial communities. Wastewater treatment plant (WWTP) discharges, agricultural runoff and environmental variables such as precipitation and warm temperatures are thought to increase ARB abundance. Therefore, we examined relationships between ARB populations and land use, precipitation and temperature within the Ogeechee River Basin, GA, USA. Presence and quantity of ARB in water samples collected from streams influenced by WWTP effluent and agricultural runoff was compared to reference sites. Sampling events included wet and dry periods over three months to establish whether ARB concentrations correlated with precipitation and temperature. Inputs from WWTPs increased the percent ARB relative to reference sites by 2-50 times regardless of local environmental factors. Regardless of land use, ARB levels positively correlated with temperature and precipitation indicating a major role of runoff in delivery to and maintenance of ARB populations in aquatic systems. Presence of ARB in the Ogeechee River is primarily influenced by local land use during dry periods, while potential for increased ARB delivery to the coast occurs during periods of high precipitation and runoff from the landscape.

Presenter's Email: jd06731@georgiasouthern.edu

Does variability in water temperature and dissolved oxygen influence the movement patterns of two Caribbean fish?

Duffing Romero, M.D[1*], Nemeth, R.S.[1], Ault, J.S.[2], Luo[2], J., Pittman, S.J[3].

[1]Center for Marine and Environmental Science, University of Virgin Islands, St. Thomas, USVI; [2]Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Fl.; [3]Marine Institute, University of Plymouth, UK

Movement plays an important role in an animal's behavior and life history demographics, and is a key component of ecological processes. Measuring and mapping movement patterns for highly mobile fish species may shed light on habitat space-use requirements, behavioral responses to environmental factors and population dynamics. Changes in ambient water conditions (e.g.. temperature, dissolved oxygen, etc.) can influence an individual's physiology and thus movement patterns. While some laboratory studies have examined the effects of environmental factors on fish physiology, few have examined how ambient water conditions affect fish movements in marine habitats. This study investigates the potential influence of water temperature and dissolved oxygen on the movement patterns of Atlantic tarpon (*Megalops atlanticus*) and lane snapper (*Lutjanus synagris*) in Brewer's Bay, St. Thomas, U.S. Virgin Islands. Fifteen fish of each species bearing acoustic transmitters were

tracked in an acoustic array and proximal data loggers measured dissolved oxygen and temperature. I expect the movement patterns of lane snapper and tarpon to shift in response to large changes in water condition. This study provides a better insight on which fish species are indicators for environmental variability and thus aiding fisheries managers in making accurate predictions on fish populations.

Presenter's Email: marapp15@gmail.com

How Mark Bertness is partly to blame for my becoming a seagrass ecologist and what's come of it so far

Duffy, J. E

Tennenbaum Marine Observatories Network, Smithsonian Institution, Washington DC 20013-7012.

When I was a lad starting out in marine ecology Mark Bertness took an interest in me (as he did in many others) for reasons I still don't understand. The session organizers forbade us from getting too smarmy about this, so here I'll just say that Mark's example in salt marshes was key to my committing to make the leap to a different ecosystem that many thought was already well understood but actually wasn't. The leading reference book on seagrass ecology, published in 2000, made almost no mention of animals at all. But thanks to work of several other pioneers (come to my talk and I'll mention your names!) we now understand that food-web interactions often fundamentally influence the structure and functioning of seagrass ecosystems, and that this community perspective is essential to effective management of seagrass and other coastal habitats. Mark also motivated many, including me, to think critically and broadly about how local community interactions change across environmental and geographic gradients. This was a major step in moving classical experimental ecology into the era of global change research. My pontification will be interspersed with actual scientific data from seagrass systems.

Presenter's Email: duffye@si.edu

Mapping the habitats of potential Common eiders (*Somateria molissima)* preys in East Bay bird sanctuary, Nunavut

Dufour, M.*[1]; Archambault, P.[2]; Bêty, J.[3]; Gilchrist, H. G.[4]

[1] Department of Oceanography, Université du Québec à Rimouski, [2] Department of Biology, Université Laval, [3] Department of Biology, Chemistry and Geography, Université du Québec à Rimouski, [4] National Wildlife Research Center, Environment Canada

In the Arctic, climate change is causing an increase of global temperatures and a decrease of ice cover duration and extent. Ice cover in Arctic ecosystems is essential for benthic organisms because of tight benthic-pelagic coupling with the ice algae. Benthic organisms are an important food source for the higher trophic levels, including common eiders. Up to 8000 eider pairs bredd in the East Bay Bird Sanctuary, Nunavut, Canada. They must acquire the energy and nutrients required for reproduction in the surronding of the breeding colony when the sea ice cover is still very high. Isotopic analysis have shown that eiders forage on four main preys: Hiatella arctica, Serripes spp, Acmaea testudinalis and amphipods. Few datas are available about the marine environment in the surronding of the eider breeding colony. In September 2016, 30 stations were sampled. On each station, images of the sea bed were taken and environmental parameters were recorded. Data analysis will allow us to do the mapping of the habitats, to make a link between the environmental conditions and the abundance of benthic organisms and finally to verify for a correlation between the abundance of potential preys and the use of habitat by eiders.

Presenter's Email: myduf8@gmail.com

Complexity-induced demographic trade-offs for a Caribbean herbivore

Robert P. Dunn*[1,2]; Andrew Altieri[3]; Kevin A. Hovel[1]

[1]San Diego State University, Coastal & Marine Institute; [2]UC Davis, Environmental Science & Policy; [3]Smithsonian Tropical Research Institute

The foundation species that support many coral reef communities are changing, shifting either to macroalgal dominance or to an alternative coral community characterized by reduced structural complexity. We explored how the structural complexity and identity of three corals commonly observed on contemporary Caribbean reefs mediate the abundance, behavior, and demographic characteristics of an increasingly important herbivore, the urchin *Echinometra viridis*. Tethered urchins survived better on the more structurally complex coral *Agaricia tenuifolia* and hydrocoral *Millepora alcicornis* than on less complex *Porites* species. However, natural densities of urchins did not follow the same pattern, suggesting that other factors also drive habitat associations. In habitat choice experiments, urchins demonstrated a preference for the structurally complex *A. tenuifolia*, but only when waterborne cues of predators were introduced. In addition, despite minimal differences in the standing stock of algae associated with the different corals, urchins inhabiting *Porites* colonies had a higher reproductive condition than those collected from the other corals, suggesting a fitness trade-off to inhabiting the riskier coral. An understanding of the potential drivers of herbivore habitat associations are vital for predicting the persistence of coral-dominated reefs due to potential feedbacks between declines in coral reef structural complexity and shifts to algal dominance.

Presenter's Email: rpdunn@ucdavis.edu

Short-term variability in water quality and weather as an effect of tropical cyclone events in the southeastern United States

Shannon K. Dunnigan*; Kathryn M. Petrinec; Nicole Dix

Guana Tolomato Matanzas National Estuarine Research Reserve

Long-term monitoring networks, such as the System-Wide Monitoring Program (SWMP) with the National Estuarine Research Reserve System (NERRS), provide opportunities to examine the effects of storm events within a relevant time frame. Each NERR has at least four water quality stations and one weather station which continuously measures a variety of parameters every 15 minutes. The effects of recent storms on water quality were analyzed using SWMP data from the Guana Tolomato Matanzas NERR in Ponte Vedra Beach, Florida. Results were compared to findings from the active tropical storm season of 2004. Additionally, SWMP data from other NERRs were analyzed to track and visualize water quality and weather changes due to the passage of storms in late 2016. Overall storms tended to reduce pre-storm salinity ranges, increase strong northeasterly winds, as well as result in large drops in salinities due to high rainfall levels during each storm. In general, studying storm effects on water quality helps us to understand how natural events impact short-term variability so that ultimately we may be able to detect anthropogenic or long-term drivers of change in our estuaries

Presenter's Email: Shannon.Dunnigan@dep.state.fl.us

Influence of reef characteristics on the abundance and social structure of two reef parrotfishes

Ehlers, A.*; Whittaker, S.; Fraser, L.; Smith, K.

Department of Biological Sciences, Clemson University

Coral reef communities are changing rapidly with a shift from hard corals to soft corals and sponges. What is unknown is how these changes in reef substrate will influence the abundance and structure of reef fish

communities. In this study, we compared the abundance, territory size, and social structure of two common herbivores, redband and stoplight parrotfishes, on inshore (high hard coral) versus offshore (low hard coral) reefs in the middle Florida Keys. Inshore, redband and stoplight parrotfishes are equal in abundance, territory size, harem size, and social structure. But in offshore reefs, redband parrotfish are three times as abundant as stoplight, and have increased territory size, harem size, and initial phase to terminal phase ratios. What is unclear is why future reefs with lower structural complexity would favor the small generalist herbivore over the larger specialist herbivore? This could be the result of shifts in foraging efficiency due to changes in algal food availability, shifts in predation risk due to changes in physical structure, or shifts in competitive ability due to changes in behavior. Future studies should test which of these changes best explains this predicted shift in reef fish community structure.

Presenter's Email: abigaie@clemson.edu

What factors influence den sharing in juvenile spiny lobsters?

Ashley Ehlert*; Michael Childress

Department of Biological Sciences, Clemson University

Caribbean spiny lobsters are one of the most important commercial fisheries but recent observations suggest there has been a decrease in their attraction to conspecifics. In this study, we examined the relative influence of conspecific density, substrate composition, and individual phenotype on the frequency and pattern of juvenile lobster den sharing in Florida Bay, FL. We installed nineteen Vemco acoustic receivers in a one hectare hexagonal grid and mapped the relative abundance of benthic habitat, potential dens, and juvenile lobsters. We then tagged juvenile lobsters using both visual and acoustic tags, and tracked their den sharing over three weeks. Den sharing for visually resighted lobsters was not correlated with conspecifics density, but was positively related to hardbottom habitat. Lobsters initially found sharing dens were more likely to be found sharing dens in future observations. The tracks from acoustic tagged lobsters indicated that individuals move around the habitat extensively during the night but have a high probability of returning to the same den each day. These results suggest that initial den selection is mediated by substrate conditions more than conspecific presence, and that consistency in den sharing is driven more by high den fidelity rather than individual social preferences.

Presenter's Email: Ashley.ehl@gmail.com

Genomic analysis of *Serratia marcescens* associated with white pox disease in elkhorn corals (*Acropora palmata*)

Nicole Elledge*[1]; Lee Pinnell[1]; Ron Eytan[2]; Jeffrey Turner[1]

[1]Texas A&M University- Corpus Christi, [2]Texas A&M University- Galveston

Serratia marcescens has been identified as an etiological agent in white pox disease in the elkhorn coral, *Acropora palmata*. This enteric bacterium has been associated with a variety of hosts including plants and animals. It can also be found outside of these hosts, in environmental ecosystems and wastewater. Consequently, *S. marcescens* can accidentally be introduced to aquatic environments and coral populations if wastewater is treated improperly. Previously, *S. marcescens* isolates were collected from the surface mucous layer of diseased and healthy *A. palmata* during and after a white pox outbreak in the Florida Keys. Forty-one isolates were selected for whole-genome sequencing based on pulsed-field gel electrophoresis patterns and differential production of the red pigment prodigiosin. We sought to analyze the genomes of these isolates to correlate genetic variation with virulent and avirulent phenotypes. Whole-genome phylogenetic analysis and average nucleotide identity calculations indicate the majority of these isolates (N = 37) are clonal, but intra-clonal genetic variation still persists. We will continue analyzing these results by assessing the clonal variome to look for gene change, loss, and gain. The results of this study will provide us with a better understanding of the genetic variations that occur in white-pox associated *S. marcescens.*

Presenter's Email: nelledge@islander.tamucc.edu

Whatdunnit? Fate-tracking a threatened Caribbean coral across the Florida Reef Tract

Ellis, A. B.*[1]; Lunz K. S. [1]; Shea, C[1]; Ames[1], K.W.; Halperin A. A. [1]; Neely K. L.[2]; Williams, D.E.[3]; Gilliam, D.[4]; Goergen, E.[4]

[1]Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission; [2]Florida Keys Community College; [3]Cooperative Institute for Marine and Atmospheric Studies, University of Miami
[4]Halmos College of Natural Sciences and Oceanography, Nova Southeastern University

Populations of elkhorn coral, *Acropora palmata*, have declined over 90% in their Caribbean range since the 1980s. Due to their importance as ecosystem engineers and their ability to structurally stabilize reef environments, establishing a regional mapping and monitoring program was crucial to determine the relative importance of various spatial, temporal, and physical factors affecting the survival of *A. palmata*. Starting in 2010, wild *A. palmata* colonies were monitored along the Florida Reef Tract (FRT) from Southeast Florida to the Dry Tortugas. Results suggest colony fate was affected by initial live skeletal area, geographic region, season, year, and multiple stressors (e.g., bleaching, disease, and presence of corallivorous snails). The synergistic effect of these factors led to extirpation at several sites. These results offer insight into regional survival variability and will aid in predicting where future populations of this threatened coral will persist along the FRT.

Presenter's Email: ananda.ellis@myfwc.com

Modeling coral species distributions along environmental gradients in the Red Sea

Ellis, J.I.*[1]; Jamil., T.[2]; Anlauf, H.[1]; Jones, B.H.[1]; Dasari, H.[2]; Krokos, G.[2]; Hoteit, I.[2]; Carvalho, S.[1]

[1] Red Sea Research Center, King Abdullah University of Science and Technology (KAUST); [2] Earth Sciences and Engineering, King Abdullah University of Science and Technology (KAUST)

Global climate change has profound implications on species distributions and ecosystem functioning. In the coastal zone, ecological responses to climate change may be driven by temperature, salinity, heat flux, wave energy, upwelling events and freshwater inputs, which can also interact with additional stressors (e.g. nutrient enrichment). The Red Sea is a narrow, semi-confined body of water experiencing high salinities and temperatures. Thus, it is a natural laboratory to study community structure under these conditions. Distinct gradients in temperature, salinity and nutrients are observed along the latitudinal axis of the Red Sea. We investigated how coral reef species respond across these environmental gradients using multiple linear regression models integrating *in situ*, satelitte and modelled data. Species responded to climate variables (sea surface temperature, salinity, heat flux, and evaporation), nutrients (chlorophyll, nitrate, nitrite, silicates) and photosynthetically active radiance. The regression model for each species showed significant interactions between climate and nutrient variables. On average, the R^2_adjusted increased by 77% in when interactions were considered. The nature of the resulting effects (antagonistic or synergistic) was species-dependent. The observed responses and effects have important implications for a better understanding the ecological impact of climate change on coastal ecosystems.

Presenter's Email: joanne.ellis@kaust.edu.sa

Experimental evidence that native grouper can indirectly ameliorate the negative effects of invasive lionfish

Robert D. Ellis*[1]; Meaghan E. Faletti[2]

[1]Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, [2]University of South Florida, College of Marine Science

Non-trophic interactions between Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) and native Atlantic and Caribbean reef fishes are not yet well understood. To determine the effects of competitive and behavioral interactions between native predators and invasive lionfish, we experimentally altered the presence of lionfish and

red grouper (*Epinephelus morio*) in karst solution-hole habitats in Florida Bay, USA, and then tracked subsequent changes in the juvenile reef fish and motile macroinvertebrate communities for 6 weeks. Relative to solution holes where we excluded both predators, mean juvenile reef fish abundance declined 83.7% in solution holes with a lionfish but increased by 154% in solution holes with a red grouper. The composition of lionfish stomach contents shifted from mostly teleost fishes when present in solution holes alone, to mostly crustaceans when in the presence of a red grouper. Concurrently, the abundance of 2 species of cleaner shrimp (*Ancylomenes pedersoni* and *Periclimenes yucatanicus*) decreased by 14.7% when lionfish were present but increased by 56.2% when lionfish were excluded. We suggest that these results are a result of altered lionfish predatory behaviors in the presence of red grouper and highlight the importance of intact native predator communities for ameliorating the negative effects of biological invasions.

Presenter's Email: robert.ellis@myfwc.com

Effects of Salinity on the Toxicity of Oil Dispersants in Eastern Mud Snails

Evans, B.*[1]; DeLorenzo, M.[2]; Key, P.[2]; Chung, K.[2]; Fulton, M.[2]

[1]Eckerd College; [2]Center for Coastal Environmental Health and Biomolecular Research, National Centers for Coastal Ocean Science, National Ocean Service, National Oceanic and Atmospheric Administration (NOAA)

Chemical dispersants can be effective at mitigating oil spills. However, their use should be carefully considered due to their potential toxic effects in the marine environment. It is uncertain what role abiotic factors may have on dispersant toxicity. This study looked at the effect of salinity on oil dispersant toxicity in the Eastern mud snail, *Ilyanassa obsoleta*. Using two dispersants authorized for oil spill response, Corexit 9500 and Finasol OSR 52, mean acute lethal toxicity (LC50) values and sublethal effects were examined at 10, 20, and 30 ppt salinity in adult and larval snails. Two biomarkers (lipid peroxidation and acetylcholinesterase) were used to measure sublethal effects. 96-hour static renewal LC50 values indicated significant differences in toxicity between dispersants and salinities. Larval snails were significantly more sensitive than adult snails to both dispersants, and both life stages were significantly more sensitive to Finasol than to Corexit. Larval snails were more sensitive to dispersants at lower salinity, while adult snails were more sensitive at higher salinities. Dispersants increased lipid peroxidation activity and decreased acetylcholinesterase activity in adults. These results demonstrate dispersant toxicity varies among compounds and organism life stages, and that physicochemical properties can affect the potential dispersant toxicity to estuarine species.

Presenter's Email: brittany.evans@noaa.gov

A comparison of microbial symbiont community structure and host specificity in introduced and native ascidians from artificial versus natural habitats

Evans, J.[1*]; Erwin, P.M.[1]; Shenkar, N.[2]; López-Legentil, S.[1]

[1]University of North Carolina Wilmington, [2]Tel-Aviv University

Harbor systems are passive gateways for the introduction of non-native ascidian species. Once established, ascidians compete fiercely with the surrounding benthos and may spread through localized dispersal, even populating adjacent natural reef systems. To investigate the potential role of microbial symbionts in the success of ascidian introductions and spread, we evaluated the host-specificity of microbial communities within two ascidian species commonly found in harbors and natural habitats off the North Carolina coast. Replicate samples of the native ascidian *Eudistoma capsulatum*, the introduced ascidian *Distaplia bermudensis*, and ambient seawater were collected from artificial (harbor) and natural reef substrates in March 2016. Microbial communities in seawater samples and ascidian tunics were characterized with next-generation (Illumina) sequencing of 16S rRNA gene sequences. Ascidian microbial communities clustered strongly in response to host species, with significant differences in community structure between the two species and seawater. Further, symbiont community structure differed significantly between native ascidians collected from artificial and natural habitats, though this was not

the case for the introduced species. These findings suggest that introduced ascidians form stronger associations with their microbial symbionts than native species, potentially contributing to the fitness, survival and spread of introduced ascidians across a wide range of environmental conditions.

Presenter's Email: jse5258@uncw.edu

Biogeography of plant zonation in coastal wetlands on the Pacific coast of South America

J M. Fariña[1,3 *];Q. He[2]; B. R. Silliman[2] and M. D. Bertness[3]

[1] Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Católica de Chile, Santiago, Chile, [2] Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University. Beaufort, USA, [3] Department of Ecology and Evolutionary Biology, Brown University, Providence, RI, USA, USA

We investigate biogeographic patterns of plant zonation in coastal wetlands on the Pacific coast of South America. Plant zonation patterns were quantified in ten Chilean marshes in a 2000-km latitudinal gradient, where climate shifts from hyper-arid at low to hyper-humid at high latitudes. Climate, tidal regimes, edaphic factors and were determined and multivariate analyses were conducted to explore their relative importance in predicting large-scale variation in salt marsh plant communities. Different plant species were constrained in different climate regions, especially at the extreme dry and wet latitudes. Local-scale plant zonation was present in hyper-arid and semi-arid climates, but not in arid, humid, and hyper-humid climates. Latitudinal variation in low marsh plant communities was largely a function of precipitation, while that in high marsh plant communities was jointly mediated by precipitation, temperature, tidal frequency, soil salinity, and disturbances from tsunami and land-sourced floods. On a general biogeographic perspective, salt marshes on the Pacific coast of South America belong to the Dry Coast and Temperate types. Presence of local-scale plant zonation within a salt marsh vary across latitude, and can be jointly mediated by climatic, oceanographic, edaphic and disturbance factors and mechanistically understood by extrapolating experimentally generated and validated community assembly models.

Presenter's Email: jfarina@bio.puc.cl

Synergistic effects of temperature, food quality and food quantity on larval sea urchin development

Colette J. Feehan*; Diane K. Adams

Rutgers University

Changes to the marine milieu under climate change can have additive, antagonistic, or synergistic effects on marine organisms. Determining which of these outcomes a set of stressors will elicit can be established with laboratory microcosm experiments with simultaneous manipulation of multiple factors. Here, we examine the effects of multiple stressors on development of a larval echinoid, the green sea urchin *Strongylocentrotus droebachiensis*, prompted by recent observations of anomalously warm sea temperatures off the Pacific coast of North America. The region of warm temperature, termed the "warm blob", has low associated chlorophyll concentrations, indicating a region of low phytoplankton productivity. In a laboratory experiment, we reared larvae under conditions of historical and warm temperatures in combination with high and low phytoplankton concentrations to simulate conditions before and after the onset of the warm blob. Additionally, we included a third factor of food type, providing larvae with a phytoplankton or kelp detritus diet to examine whether, in the absence of abundant phytoplankton, suspended kelp detritus and associated microbes can provide a suitable diet for larvae. We document synergistic negative effects of warm temperature and decreased food quality or quantity on the development of larvae of a keystone marine species.

Presenter's Email: cfeehan@marine.rutgers.edu

Foraging ecology of blue crabs (*Callinectes sapidus*) and their potential impact on winter flounder (*Pseudopleuronectes americanus*)

Molly Fehon*; David Taylor

Roger Williams University

The blue crab, *Callinectes sapidus*, is a temperate species that is expanding its geographic range northward, possibly altering benthic community structure in Southern New England waters. This study examined the potential impact of blue crabs on local fauna by analyzing their abundance, size-structure, and diet. Crab predation on winter flounder, *Pseudopleuronectes americanus*, was of particular interest due to locally declining populations of this species. Crabs were collected from the Seekonk River (RI) and Taunton River (MA) from May to August 2012-2016, and preserved for measurements and visual stomach content analysis. Crab abundance exhibited both spatial and temporal variations in the rivers, but overall estimates were consistent with southern Mid-Atlantic populations. Decomposition of length-frequency distributions revealed three distinct cohorts, suggesting that multiple life history stages utilize the riverine habitat. Direct visual analysis of stomach contents indicated that crabs undergo ontogenetic dietary shifts. The main prey of small crabs were crustaceans, whereas larger conspecifics preferentially consumed bivalves. There was also evidence of crabs consuming fish, including winter flounder, with rates of predation positively related to predator-prey size ratios. The incidence of crab predation on flounder was minimal, however, and thus crabs may not be an important source of mortality for juvenile flounder.

Presenter's Email: mfehon618@g.rwu.edu

Bioaccumulation of mercury in two salt marsh forage fish collected from Dunn Sound, South Carolina

Daniel P Ferons[1]*; Jane L Guentzel[1]; Andrew Heyes[2]

[1]Department of Marine Science, Coastal Carolina University, Conway, SC; [2]Center for Environmental Science, University of Maryland, Solomons, MD

Mummichogs (Fundulus heteroclites) and Atlantic silversides (Menidia menidia) are year-round forage fish within South Carolina salt marshes. Atlantic silversides target zooplankton within the water column while mummichogs target prey from the water column, on and around Spartina alterniflora, and from the sediment. This study quantified and compared whole body total and methyl mercury concentrations. Samples were collected in February, April, July, and October 2014, with an additional collection in April 2015 as an annual comparison. Gut contents were quantified and compared to determine if total and methyl mercury concentrations were impacted by the fishes diet. Atlantic silversides had significantly higher whole body total and methyl mercury concentrations than mummichogs when comparing all sampling events. However, there was no significant difference between the percent total and methyl mercury concentrations within the fish. This suggests that both species of fish assimilate mercury at the same rate. Gut contents by weight and number were significantly different between Atlantic silversides and mummichogs. Atlantic silversides preyed primarily on crustaceans within the zooplankton whereas mummichogs preyed on organisms across the food web. Differences in the mercury concentrations of these two fish may impact the bioaccumulation and biomagnification of mercury within the salt marsh food web.

Presenter's Email: dpferons@coastal.edu

Synergistic effects of temperature and sedimentation on coral recruits: Does reducing a local stressor increases coral resilience to global warming?

Figueiredo, J.*, Fourney, F.

Department of Marine Environmental Sciences, Halmos College of Natural Sciences and Oceanography, Nova Southeastern University

Corals face worldwide population declines due to global climate change and local anthropogenic impacts. The effects of global climate change are hard to tackle, but recent studies show that some coral species can better handle climate change stress when provided with additional energy resources. The local stress that most undermines energy acquisition is sedimentation because it impedes coral feeding and their ability to photosynthesize. To investigate if reducing local sedimentation will enable corals to better endure ocean warming, we quantitatively assessed the synergistic effects of increased temperature and sedimentation (rate, grain size composition, and turbidity) on the survival of coral recruits of the species *Porites astreoides*. Anthropogenic sedimentation (fine grain size, common in dredging) negatively impacted coral recruit survival, but natural sedimentation (coarse grain sizes) did not. When anthropogenic sedimentation rates and turbidity were kept at minimal levels (7 NTU), the survival of coral recruits reared at warmer temperatures was not significantly different from the survival of coral recruits reared at current day temperature and sedimentation (>15 NTU). These results suggest that a reduction of US-EPA allowable turbidity from 29 to 7 NTUs near coral reefs would facilitate coral recruit survival under global warming.

Presenter's Email: jfigureiredo@nova.edu

Is there a Vision for Change in the Quest for Ocean Literacy?

Christopher Finelli*[1]; Sara Lindsay[2]

[1]Department of Biology and Marine Biology, University of North Carolina Wilmington; [2]School of Marine Sciences, University of Maine

In the past 15 years two major national initiatives have sought to improve education in the life sciences and the marine sciences. The 2011 publication of Vision and Change in Undergraduate Biology Education was the culmination of years of regional and national conversations regarding undergraduate biology curricula. This initiative and report laid out a comprehensive plan, including core content and competencies that should form the basis of undergraduate life science curricula across the country. Similarly, the Ocean Literacy Framework (2005) identifies essential principles of ocean sciences (but not skills) that are deemed essential to include in K-12 curricula. No similar guidelines exist for undergraduate marine science education. We are interested in the extent to which the marine biological community is familiar with Vision and Change, the Ocean Literacy Framework, and other efforts to improve undergraduate life science and marine science education, and to learn which elements (if any) the community feels are relevant to the teaching of modern marine biology.

Presenter's Email: cfinelli@uncwil.edu

Artificial coastal defences: enhancing biodiversity using sensitive design

Firth, L. B.*[,1]; Thompson, R. C.[1]; Evans, A. J.[2]; Moore, P. J.[2]; Knights, A. M.[1]; Chee, S.-Y.[3]; O'Shaughnessy, K. A.[1]; Hanley, M. E.[1]; Nash, [4]; Browne, K.[5]; Strain, E. M.[6]; Bishop, M.[7]; Johnston, E. L.[8]; Hawkins, S. J.[9,10]

[1] School of Biological and Marine Sciences, Plymouth University, Plymouth, UK, [2] Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, UK, [3] Centre for Marine and Coastal Studies, Universiti Sains Malaysia, Malaysia, [4] School of Science, Galway-Mayo Institute of Technology, Galway, Ireland, [5] Department of Zoology, National University of Ireland Galway, Ireland, [6] Sydney Institute of Marine Science, Australia, [7] Department of Biological Sciences, Macquarie University, Sydney, Australia, [8] School of

Biological, Earth and Environmental Sciences, University of New South Wales, Australia, [9] Marine Biological Association of the United Kingdom, UK, [10] National Oceanography Centre Southampton, University of Southampton, UK

Coastal defence structures are proliferating as a result of rising sea levels and stormier seas. With the realisation that most coastal infrastructure cannot be lost or removed, research is required into ways that coastal defence structures can be built to meet engineering requirements, whilst also providing relevant ecosystem services - ecological engineering. This approach requires an understanding of the types of assemblages and their functional roles that are desirable and feasible in these novel ecosystems. We discuss case studies describing experiments informing building coastal defences in a more ecologically sustainable manner in the UK, Ireland and Malaysia. Finally, we outline guidelines and recommendations to provide multiple ecosystem services while maintaining engineering efficacy. This work demonstrated that simple enhancement methods can be cost-effective measures to manage local biodiversity. Care is required, however, in the wholesale implementation of these recommendations without full consideration of the desired effects and overall management goals.

Presenter's Email: louise.firth@plymouth.ac.uk

Rapid evolution of heat-shock protein (*hsp*) expression facilitates invasion of an ecosystem engineer

Ben A. Flanagan *[1]; Stacy A. Krueger-Hadfield [2]; Courtney J. Murren[1]; Allan E. Strand[1] and Erik. E. Sotka[1]

[1]Department of Biology and Grice Marine Laboratory, College of Charleston; [2]Department of Biology, University of Alabama at Birmingham

Rapid evolution of introduced species can facilitate successful invasions, yet relatively few studies have documented both phenotypic shifts and the candidate loci that underlie these shifts. Introduced populations of the ecosystem engineering seaweed *Gracilaria vermiculophylla* rapidly evolved greater tolerance for extreme heat conditions relative to native source populations of northeastern Japan. Here, we used RT-qPCR and chemical inhibitors to assess the role of heat-shock proteins *hsp70* and *hsp90* in explaining these population-level differences in heat stress tolerance. We collected thalli from nine native Japanese and nine eastern North American sites, exposed thalli to 40°C for 1, 2, or 4 hours, immediately isolated total RNA and performed RT-qPCR and measured thallus survival for eight days at more benign conditions (20ºC). Relative to native Japanese populations, introduced populations induced both *hsp*s to a higher level and had greater survivorship at extreme temperatures. Moreover, reducing *hsp* function through chemical inhibition during extreme heat events lowered thallus survivorship relative to thalli unexposed to *hsp* inhibitors, indicating a central role for *hsp* in mediating heat stress tolerance. Our results suggest *hsp* family represents a molecular basis of invasiveness, because its role in tolerating heat stress facilitated successful colonization and spread of the seaweed in areas outside of the thermal niche in native source regions.

Presenter's Email: flanaganba@g.cofc.edu

Extensive phenotypic variation among the three Caribbean acroporid corals

Fogarty, N.D*[1]; M.V. Hightshoe[1]; M.E. Bock[1]; A.F. Budd[2]; S.A. Kitchen[3]; M. Devlin-Durante[3]; I.B. Baums[3]

[1] Department of Marine and Environmental Sciences, Nova Southeastern University; [2] Department of Earth and Environmental Sciences, University of Iowa; [3] Department of Biology; Pennsylvania State University

The merging of two genomes through hybridization produces a unique combination of traits and phenotypic variation in the hybrids. This phenotypic variation may promote hybrid adaptation to habitats not accessible to the parent species. In the past, hybridization between Caribbean *Acropora palmata* and *A. cervicornis* corals was rare and restricted to the F1 generation. New genetic data indicates that hybrids are now mating with each other (F2) and are capable of mating with *A. palmata* and *A. cervicornis* (backcross). In parallel, a variety of intermediate morphologies to the arborescent staghorn and elkhorn shaped parental species are now observed. Here, we

conducted morphometric analyses using high-resolution 3D scans and scanning electron microscopy on Caribbean acroporid colonies representing the continuum of phenotypes between *A. cervicornis* and *A. palmata* and correlated the data with the genetic origin of the hybrid (i.e., F1, F2 or backcross). Our results suggest that intermediate morphologies are not restricted to F1 hybrids, but a mixture of backcross and possibly F2 individuals. These data together with recent field observations of disease resistance and thermal tolerance, increased hybrid abundance, and hybrid habitat expansion suggests that the hybrids' ecological role and evolutionary potential is changing.

Presenter's Email: nicole.fogarty@nova.edu

A bait box for all seasons: live marine baitworm trade as a vector for non-indigenous species

Fowler, A. E.* [1,2]; Blakeslee, A. M. H. [2,3]; Canning-Clode, J. [2,4,5]; Repetto, M. F. [2,6]; Ruiz, G. M. [2]; Miller, A. W. [2]

[1]Department of Environmental Science and Policy, George Mason University, Fairfax, VA, 22030; [2]Marine Invasions Laboratory, Smithsonian Environmental Research Center, Edgewater, MD 21037; [3]Biology Department, East Carolina University, Greenville, NC 27858; [4]MARE – Marine and Environmental Sciences Centre, Estação de Biologia Marinha do Funchal, Cais do Carvão, 9000-107 Funchal, Madeira, Portugal; [5]Centre of IMAR of the University of the Azores, Department of Oceanography and Fisheries. Rua Prof. Dr Frederico Machado, 4, PT-9901-862 Horta, Azores, Portugal; [6]Biology Department, Temple University, Philadelphia PA 19122

A central goal in ecology is understanding the factors that allow particular species to successfully invade novel communities. We used the highly tractable, year-round Maine live marine bait trade to explore how seasonal changes in the abundance and diversity of source taxa can drive propagule pressure patterns and successful invasions. We sampled algae in both source (Maine) and recipient regions (Mid-Atlantic) in spring, summer, and fall, identifying 42,735 live macro-organisms from 56 taxa. The community changed seasonally in abundance, richness, and diversity (taxonomic and functional) in both the field and recipient region, with the highest propagule pressure during spring and summer. Vector stage and season significantly influenced taxonomic and functional group richness, while abundance and the percent of live organisms was driven by vector stage alone. Strikingly, seasonal changes were driven more by functional groups and not by traditional taxonomic levels. Therefore, in similar temperate vectors, season, combined with high propagule pressure, can predict the timing of cumulative richness, diversity, and functional traits that influence the chances of successful invasions. Therefore, seasonal fluctuations increase the probability that taxa survive in the vector. This research highlights the importance of considering both vector seasonality and species traits in invasion risk scenarios.

Presenter's Email: afowler6@gmu.edu

Tidal Creek Effects on Oyster Reef Associated Nekton and Benthos Condition and Density

Funk, T. S. *; O'Shaughnessy, K; Walters, K.

Department of Marine Science, Coastal Carolina University, Conway SC 29528

Oyster reefs are essential fish habitat and worldwide loss has potential to affect negatively reef-associated nekton populations. Along the 100 km Myrtle Beach, SC shoreline oyster reefs ostensibly have disappeared within swash tidal creeks, estuarine systems that empty into coastal oceans over shoreline beaches. To address losses shell bag reefs were constructed within multiple swash and local inlet tidal creeks. The ability of reefs to attract nekton was compared between the two creek systems. Here we report results from various traps (baited minnow traps, gill nets, pull traps) sampled directly on or near constructed reefs. Limited natural reefs and compromised water quality within swash creeks suggested reef associated nekton within swashes would be reduced. *Lagodon rhomboides* and *Fundulus heteroclitus* constituted 97.7% of fishes captured by minnow traps and numbers depended on species and creek type, tidal elevation, and diel stage. Minnow and pull traps returned greater fish density and condition (Fulton's K) from swash creeks while gill net catch was greater within inlet creeks. Invertebrate catch consisted mostly of *Palaemonetes*

sp. and trended inversely with creek usage by pinfish and mummichogs. Loss of oyster reefs within swashes does not appear to have affected negatively the abundance of certain reef-dependent species.

Presenter's Email: tsfunk@g.coastal.edu

Multiple stressor effects on benthic meiofauna – does the timing and order of stressor application matter?

Furtado, R.*[1]; Bishop, M. J.[1]

[1] Department of Biological Sciences, Faculty of Science & Engineering, Macquarie University, NSW, Australia.

Burgeoning human populations in the coastal zone have introduced a diversity of stressors to estuaries worldwide, altering the structure and function of these ecosystems. Although many ecological studies have considered the independent effects of these stressors on ecological systems, our understanding of how multiple stressors interact to influence ecosystem structure and function remains poor. Multiple stressors may have additive, antagonistic or synergistic effects on ecological systems, which may be determined by whether the ecosystem is exposed to the stressors simultaneously or in succession. Despite many stressors occurring asynchronously, most studies examining multiple stressor effects have assumed that these act on ecosystems synchronously. This study addressed whether the interactive effect on sediment meiofaunal communities of two common stressors to estuarine ecosystems, nutrient enrichment and physical disturbance of sediment, are dependent on whether these are applied synchronously or asynchronously and where asynchronously, whether the order of their application matters. Results show that physical disturbance had a greater effect on meiofaunal community structure when applied together with than when applied before or after nutrient enrichment. Hence, the timing of stressor application is important in determining the nature of multiple-stressor impacts, and may have important implications for matters of coastal zone management.

Presenter's Email: ramila.furtado@students.mq.edu.au

Characterization of early life history and sexual system of the yasha goby *Stonogobiops yasha*

Laüra Gaitan Daza*[1], Joseph T. Szczebak[1], Bradford D. Bourque[1], Andrew L. Rhyne[1,2], and Kerri S. Warren[1].

[1] Department of Biology, Roger Williams University; [2] New England Aquarium

Stonogobiops yasha is a species that has remained largely unstudied since its first description in 1997. In 2016, the RWU CEED Wet Lab successfully bred this fish in captivity. Facilitated by this success, our research aimed to, for the first time, (a) characterize the embryonic and larval development of *S. yasha* from fertilization to juvenile metamorphosis, and (b) determine the sexual system employed by *S. yasha* (i.e., gonochorism or hermaphroditism). Embryonic development lasted 5 days, with larval hatching occurring the morning of day 5. Flexion occurred between day 6-12, settlement morphology was evident at day 15-20, and metamorphosis between day 27- 50. To test the hypothesis that *S. yasha* are protogynous sequential hermaphrodites, recently settled juveniles (n=63) were separated into 20 pairs and 23 individual. Half of the pairs and individuals were given PVC-pipe burrows, with controls kept in bare-bottom tanks. Total length (mm) was measured monthly and secondary sexual traits daily through visual observations. At 70 and 200 days post hatch, juveniles were processed histologically to assess gonad development, comparing results to previously processed adults. This research aims to provide essential data for understanding an undescribed benthic species, and ultimately provide possible phylogenetic relationships within the Gobioid family.

Presenter's Email: lgaitandaza299@g.rwu.edu

Corals vs. Macroalgae: Relative susceptibility to sedimentation and ocean warming

Galarno, A.*; Figueiredo, J.

Department of Marine and Environmental Sciences, Nova Southeastern University

Sedimentation and ocean warming are two major anthropogenic stressors affecting coral recruitment. It is unclear how these conditions may also impact the recruitment of macroalgae, which compete for space with corals and often undermine their recruitment. To determine the relative susceptibility of corals and algae to sedimentation and ocean warming, we quantitatively assessed the synergistic effects of sedimentation and elevated temperature on the survival and growth of newly settled recruits of the coral *Montastraea cavernosa,* and the macroalgae, *Dictyota sp.* We tested the combined effect of two temperatures and three sedimentation rates, respectively, 29°C (current) and 31°C (projected for 2070), and 30, 60, and 120 mg cm^{-2} day^{-1} sedimentation, representing pristine to dredging conditions. After 12 weeks, sedimentation rate significantly affected the survival of *M. cavernosa* juveniles. The lowest mortality was at 30 mg cm^{-2} day^{-1} of sediment at 29°C. *Dictyota sp*. had higher mortality at 31°C. The growth rate of *M. cavernosa* was affected by temperature and sedimentation rate, while only temperature affected the growth rate of *Dictyota sp*. We conclude that macroalgae are less susceptible to sedimentation than corals. These results suggest that under ocean warming conditions, phase-shifts to algae-dominated reefs can be accelerated by higher sedimentation rates.

Presenter's Email: ag2135@nova.edu

Hard Rock! Stable Sponge Microbiome in a Heavy Metal Polluted Environment

Shelby E. Gantt*; Susanna López-Legentil; and Patrick M. Erwin

Department of Biology and Marine Biology, Center for Marine Science, University of North Carolina Wilmington

Marine sponges have been shown to harbor diverse microbial symbiont communities that play key roles in host functioning, yet little is known about how anthropogenic disturbances, such as heavy metal pollution, impact sponge-microbe interactions. The Mediterranean sponge *Crambe crambe* is known to accumulate heavy metals in polluted environments including harbors. In this study, we investigated whether the microbiome of *C. crambe* differed between sponges inhabiting a polluted harbor in Blanes (Spain) and a nearby (< 1 km) natural environment. Triplicate sponge and ambient seawater samples were collected from each site and the microbial composition of each sample was determined by 16S rRNA gene sequence analysis (Illumina Hi-Seq platform). No significant differences in the diversity or structure of microbial communities in *C. crambe* were detected between habitats, while a significant difference in community structure was observed in ambient seawater inside and outside of the polluted harbor. The microbiome of *C. crambe* was clearly differentiated from free-living seawater microbes and dominated by *Proteobacteria*, specifically a single betaproteobacterium that accounted for 86-91% of all sequence reads. These results indicate that sponge microbiomes exhibit greater stability and pollution tolerance than their free-living microbial counterparts, potentially mitigating the effects of pollutants on coastal marine communities.

Presenter's Email: sgantt10@gmail.com

Scale dependent drivers of MPA performance: A case study of the spiny lobster (*Panulirus interruptus*) on Santa Catalina Island

Garza, C.D.*[1]; Windell, S.W.[1]; McCormick, M.[1]; Litvin, S.[2]

[1]School of Natural Sciences, California State University Monterey Bay, Seaside, California, 93955, U.S.A.; [2]Hopkins Marine Station of Stanford University, Pacific Grove, California, 93950 U.S.A.

Marine Protected Areas (MPA) are a key tool for resource managers in the management of coastal resources. Mismatches in the scale of MPA design and the scale at which target species utilize habitat may affect estimates of MPA performance and success. In this study, we describe the utilization of intertidal habitat by the California spiny lobster, *Panulirus interruptus*, inside and outside of a long standing MPA on Santa Catalina Island, California, U.S.A. Our results demonstrate lobsters outside the MPA were greater in number and had a higher ratio of reproductively active females. This difference is suggested to be due to the presence of mussel beds comprised of the mussel, *Mytillus californianus*, outside of the MPA which comprised 75% of the diet, as estimated through stable isotope analysis, of lobsters outside the MPA. Through the application of landscape based survey methods, we highlight how the performance of an individual MPA may originate at sub-meter scales via interactions between the underlying geological and biogenic habitat that lobsters preferentially forage across. We close with a discussion on the need to integrate landscape based survey approaches, and stable isotope analysis to move towards incorporating bio-energetic performance of MPAs into current assessments of MPA success.

Presenter's Email: cogarza@csumb.edu

Carbon limitation and photorespiration regulate primary production to a greater degree in Halophila johnsonii than Thalassia testudinum

Gavin, Nathan*; Durako, Michael

University of North Carolina Wilmington

Photosynthesis of many seagrasses is limited by availability of dissolved inorganic carbon (DIC), especially in shallow, high-light environments. Carbon-limitation can lead to loss of primary production through photorespiration. If over-reduced photosystems persist, oxidative stress may occur from a surplus of reactive oxygen species (ROS). We compared carbon uptake mechanisms, photorespiration and ROS production between two seagrass species over a range of pH, DIC and O2 concentrations. Due to differences in leaf morphology and H. johnsonii's ability to grow under high irradiance associated with an intertidal distribution, we hypothesized H. johnsonii would have lower rates of photorespiration and ROS production compared to T. testudinum during light-saturated photosynthesis. Results indicated both species utilize external, membrane-bound carbonic anhydrase (CA) to catalyze dehydration of HCO3-(aq) into CO2 but T. testudinum also exploits an active proton pump to create localized H+ gradients within the leaf boundary layer. HCO3-(aq) conversion was inefficient for both species, as photosynthetic rates declined significantly as [CO2] decreased. Furthermore, in contrast to our hypothesis, photorespiration and ROS formation were significantly higher in H. johnsonii than T. testudinum ($P<0.05$). Our results suggest efficiency of carbon acquisition and fixation is unlikely to contribute to H. johnsonii's ability to grow at more shallow depths than T. testudinum.

Presenter's Email: nmg4567@uncw.edu

Building on the Bertness legacy of community ecology for conservation and management of tidal marshes responding to climate change

Keryn Gedan[*1]

[1]Biological Sciences, George Washington University, Washington, DC 20052

Mark Bertness' work on tidal marsh plant communities forms a foundation for understanding how these ecosystems are assembled and respond to environmental change. He has shown that marsh plant communities exhibit telltale signs to recent human impacts. Experiments by Mark and his students have demonstrated the vulnerability of high marsh to encroachment by *Spartina alterniflora* and *Phragmites australis* in response to nutrient pollution and the simplification and loss of forb pannes in response to temperature increase and hydrologic alteration. Compounding these, sea level rise is pushing *S. alterniflora* into higher elevation areas formerly occupied by high marsh species. Work in the Bertness lab has driven me to focus on marsh migration, or

the movement of the upland tidal marsh ecotone, as an outlet for high marsh responding to sea level rise and other stressors. I will present data on the rates of marsh migration in an area undergoing rapid sea level rise, the Chesapeake Bay, and describe the unusual plant communities assembling in the newly forming high marsh. The high marsh zone is under tremendous pressure from global change, and, as Mark's work has taught us, conservation efforts will only be successful with complete understanding of the ecosystem's ecological underpinnings.

Presenter's Email: kgedan@gwu.edu

Genetic diversity of a skilled hitchhiker; comparisons of green mussels from native and introduced populations and vessel intercepts

Matthew R. Gilg*[1]; P. Joana Dias[2]; Sherralee Lukehurst[2]; Mareike Huhn[2]; Hawis Madduppa[2]; Simon McKirdy[2]; Paul de Lestang[2]; W. Jason Kennington[2]; Justin I. McDonald[2]

[1]University of North Florida; [2]Department of Fisheries, Western Australia

Insight into a species native and introduced range and population connectivity, through human mediated introductions or natural dispersal, is essential in understanding the invasion process. Genetic diversity, propagule pressure and environmental conditions all have been recognised as playing a determinant role in invasion success. Here, we aim to improve our understanding of the population genetics of the Asian green mussel *Perna viridis* within its native range in Asia and at well documented introduced locations in the USA and Caribbean. We also analyse genetic data from vessels intercepts and incursions to test whether introductions via vessels are likely to result in a reduction in genetic variation. Samples were analysed by sequencing of the mitochondrial locus COI and genotyping at 22 microsatellite loci. Sites within the native range showed little genetic structure with sites falling into one of two groups. Vessel intercepts and recent incursions tended to have relatively high estimates of genetic variation, especially when compared to established introduced populations, suggesting that the initial introduction may often contain relatively high diversity and a founder effect is not a necessary consequence.

Presenter's Email: mgilg@unf.edu

Growth, reproduction, senescence, and survivorship in Pederson's cleaner shrimp *Ancylomenes pedersoni*

Gilpin, J. A.*; Chadwick, N. E.

Department of Biological Sciences, Auburn University

Symbiotic cleaner organisms may perform key functional roles in reducing rates of parasitism in communities, but little is known about their life history traits on coral reefs. Studies on cleaner fishes indicate that cleaning behaviour, which removes parasites from coral reef fishes leads to enhanced biodiversity and fish abundance on reefs in the tropical Indo-Pacific region. Cleaner shrimps, including the Pederson's shrimp *Ancylomenes pedersoni*, perform this main role in the tropical western Atlantic Ocean and Caribbean Sea. They are popular ornamental organisms, heavily collected on some reefs, but the community-wide impacts of their removal remain unknown. We quantified growth, reproduction, senescence and survival of these shrimps under laboratory culture conditions, and field patterns of abundance and population size structure of shrimps and their host sea anemones on coral reefs at St. Thomas, U.S. Virgin Islands. Our data revealed short lifespans, with life histories differing prominently between males and females, and that members of both genders exhibit clear signs of senescence prior to death. Field populations appear to be highly dynamic and dominated by small individuals. This work aims to provide a more scientific basis for marine resource managers to determine regulatory limits on the ornamental fishery for this key organism.

Presenter's Email: jag0038@tigermail.auburn.edu

The Importance of Keeping the Big Ones: Clutch quality and Reproductive Senescence in Caribbean Spiny Lobster

Gaya Gnanalingam*; Mark J Butler IV

Department of Biological Sciences, Old Dominion University

The Caribbean spiny lobster, *Panulirus argus* is one of the most iconic species in the Caribbean, supporting some of the region's largest and most economically valued fisheries. The average size of spiny lobsters, however, has decreased worldwide over the last 30 years with the largest individuals primarily targeted by fishers. Given their high fecundity, large lobsters potentially contribute disproportionately to a population's reproductive capacity, so the loss of these largest individuals is of particular concern to the sustainability of fisheries. Novel management schemes are needed to conserve large breeding lobsters and a combination of harvest slot limits and marine protected areas are one potential solution. Consideration of new management strategies that focus on maximizing reproductive potential requires detailed information on reproductive output and quality relative to lobster size. Here we present the results of a series of laboratory experiments testing the relationship between lobster size, gamete production, and larval quality over multiple mating events. In particular, we examined the possibility of reproductive senescence associated with lobster size or with multiple clutches in a season. The results highlight the importance of maintaining large individuals in populations of *P. argus* and provide support for management tools aiming to conserve these individuals.

Presenter's Email: ggnan001@odu.edu

Variability in Caribbean Sponge Communities Associated with Levels of Land-Based Sources of Anthropogenic Impacts

Gochfeld, D. J.*[1]; Olson, J. B.[2]; Brandt, M. E.[3]; Diaz, M. C.[4]; Easson C.G.[4]

[1]National Center for Natural Products Research, University of Mississippi, [2]Department of Biological Sciences, University of Alabama, [3]Center for Marine and Environmental Studies, University of the Virgin Islands, [4]Halmos College of Natural Sciences and Oceanography, Nova Southeastern University

Sponge community structure has been proposed as an indicator of environmental health. On islands with large populations, there is typically a greater impact of land-based sources of stress from runoff on nearshore reefs than on offshore reefs. St. Thomas has a large population that is locally concentrated. Although studies of specific stressors affecting St. Thomas' reefs have not been performed, proximity to population and sedimentation rates were used as proxies for anthropogenic impacts. We surveyed reefs at three inshore impacted sites considered relatively impacted (near population centers or marinas), and three offshore sites considered relatively un-impacted (offshore islands and a nearshore reef exposed to minimal population density). The shallow reefs of St. Thomas host very high densities and diversity of sponges, and impacted reefs had significantly higher sponge densities and diversity than un-impacted reefs. Sponge community structure varied between impacted and un-impacted sites, although un-impacted sites were generally more variable in their community constituents than impacted sites. Impacted reefs were dominated by one species, which represented the largest difference between impacted and un-impacted reefs. These data illustrate the variability in stress tolerance among Caribbean sponge species, and support the potential for sponge assemblages to serve as indicators of environmental health.

Presenter's Email: gochfeld@olemiss.edu

A comparison of fish assemblages on outplanted *Acropora cervicornis* reefs and natural reefs in Southeast, Florida, USA

Ellen D. Goldenberg*; Elizabeth A. Goergen; David S. Gilliam

Department of Marine and Environmental Sciences, Nova Southeastern University

The Staghorn Coral (*Acropora cervicornis*) has historically been a major contributor to reef structural complexity providing habitat for many fish and invertebrate species. Unfortunately, due to impacts from disease, bleaching, and anthropogenic stressors, *A. cervicornis* populations have suffered drastic declines over the past several decades. In an attempt to preserve biodiversity, many organizations have turned to growing *A. cervicornis* in nurseries and outplanting them back onto the reef. This practice has been shown to be an effective method for increasing *A. cervicornis* abundance, however the effects on the fish assemblage have not been thoroughly assessed. This gap is addressed by comparing fish populations on natural reefs to that of outplanted *A. cervicornis* reefs in Southeast, Florida. Using the Reef Visual Census (RVC) method, surveys were conducted to record fish species and size at four locations containing both control (natural) reefs and outplanted *A. cervicornis* reefs from 2012 to 2016. Fish abundance and diversity were greater on reefs containing outplanted *A. cervicornis* colonies. This indicates a positive impact on reef fish communities from restoration efforts through the outplanting of nursery reared corals.

Presenter's Email: eg871@nova.edu

How long do oysters stay scared? Non-consumptive effects of predators on oysters depend on exposure regime and predator identity

J. Stephen Gosnell*[1]; Erica A. Levine[2]; Emily M. Goetz[3]

[1] Department of Natural Sciences, Baruch College and Graduate Center, City University of New York; [2] Marine Biology, Northeastern University; [3] Department of Environmental Studies, Middlebury College

Although non-consumptive effects of predators on prey is an area of growing interest in ecology, few studies consider how temporal variation in predator presence impacts these interactions. Building on previous work in oyster reefs, we considered how varying the amount of time (0, 1, 3 consecutive, 3 separate, or 7 days/week) oysters (*Crassostrea virginica*) were exposed to predators in a 2-month field study impacted oyster traits. We also used equipment commonly employed in off-bottom oyster aquaculture to estimate how non-consumptive effects might impact real-life management efforts. Results indicated that effects depended on predator identity. Crabs had minimal impact on oysters, but increasing exposure to conchs led to decreases in traits related to oyster growth. The relationship between exposure and non-consumptive effects was best described by an exponential decay model, suggesting minimal exposure has the largest relative impact. However, we observed no consistent difference in traits between oysters exposed to conchs 3 separate days a week and those exposed to conchs 3 consecutive days a week, indicating oysters quickly transitioned from predator-stressed to non-stressed states. These results suggest non-consumptive effects may be an important regulator of oyster reef dynamics and may impact aquaculture efforts.

Presenter's Email: stephen.gosnell@baruch.cuny.edu

Criteria for sustainability in coastal management: lessons from marine aquaculture

Jon Grant

Dept. of Oceanography, Dalhousie University, Halifax NS

Ecosystem-based management (EBM) of the ocean is an appealing idea that is often more ambitious in concept than in practice. In the coastal zone, the diversity of activities and resource use present multiple EBM challenges. Marine spatial planning provides a mechanism for executing EBM wherein footprints of activities such as fishing, energy development, and recreation can ideally be mapped and used in conflict resolution. These spatial footprints are not easily determined due to measurement difficulties and variability in time and space. Compromised ecosystem services exceed the resilience of coastal environments and push them into alternate stable states, a case exemplified by eutrophication. Quantification of ecosystem goods and services provides a basis for comparing

sustainability of resource use, but questions regarding which services, their thresholds, and at what spatial scale complicate convergence to practical management. Among these activities, aquaculture of fish and bivalves attempts to be compatible with the nutrient budgets of coastal environments without altering provision of services. However, marine aquaculture has many potential problems associated with cultured animal health, waste management, and interaction with wild species. Coupled physical-biogeochemical models provide a way to predict and map spatial variables with the option of what-if scenarios used to plan both culture biomass and location. Benthic variables related to hypoxic stress such as faunal diversity and sediment sulfide figure prominently in assessments of aquaculture impacts. As with other variables, extrapolation of benthic health to larger spatial scales remains a challenge. I report on examples of simulation models and field observations applied to both bivalve culture (unfed) and salmon farming (fed) with regard to the types of models we have developed for application to siting, impacts, health management, and marine spatial planning. These results are applied to the suitability of aquaculture for coastal environments, sustainability criteria applied at ecosystem scale (i.e. EBM), and comparability with other activities (fisheries) whose sustainability has been similarly evaluated.

Presenter's Email: jon.grant@dal.ca

The effects of allelochemicals from bloom-forming seaweeds (*Ulva compressa* and *Ulva rigida*) on shellfish larvae

Green, L.A.[1]*; Gomez-Chiarri, M[2]; Ranson, H[3]; Rowley, D[3];Thornber, C.S.[1]

[1]Department of Natural Resources Science, University of Rhode Island; [2]Department of Fisheries, Animal, and Veterinary Sciences, University of Rhode Island; [3]Department of Biomedical and Pharmaceutical Sciences, University of Rhode Island

Seaweed blooms have been increasing in frequency and severity worldwide due to anthropogenic activities. Narragansett Bay has experienced seaweed blooms dominated by blade-forming *Ulva* for over a century. Previous research has shown that *Ulva* can produce allelochemicals that negatively affect other seaweeds. The objective of this study was to determine whether allelochemicals from the dominant bloom-forming species of *Ulva* in Narragansett Bay affect survival or behavior of oyster larvae through a series of laboratory challenge experiments. Oyster larvae (2-11 days old) were exposed to crude extract from cultured *Ulva compressa* or *U. rigida* (5 g/L) that was either nutrient replete or deplete and their survival was determined over one week. We found a significant negative effect of *Ulva* extract on oyster survival, which depended on both the *Ulva* species and the nutrient condition. Survival of larvae exposed to nutrient replete *Ulva compressa* extract dramatically decreased over time, with less than 25% survival after one week. Larval survival was not significantly affected by nutrient deplete *Ulva* extract, although larvae exposed to this extract had a slower swimming speed. Our results suggest that *Ulva* blooms may cause oyster larval mortality under eutrophic conditions, which are common in coastal ecosystems.

Presenting author's contact info: lindsaygreen@uri.edu

Microbial communities in marine sediments control native/invasive macrophyte interactions

Gribben, P.*[1]; Thomas, T.[1]; Nielson, S.[1]; Seymour, J.[2]; Ravaglioli, C.[3]; Bulleri, F.[3]

[1] Centre for Marine Bio-Innovation, School of Biological, Earth and Environmental Sciences, University of New South Wales, [2]Plant Functional Biology and Climate Change Cluster, University of Technology, Sydney, [3]Department of Biology, University of Pisa

Our inability to manage invasive macrophytes stems in part from a lack of understanding of the processes that control their successful establishment and spread. To date, studies have largely considered how above-ground processes control native/invasive plant interactions. Emerging research from terrestrial ecosystems demonstrates that below-ground processes under microbial control can determine the outcome of interactions between native and invasive plants. Whether sediment microbes control native/invasive macrophyte interactions in marine

ecosystems is untested. We first show that sediment bacterial communities differ between the native seagrass *Zostera capricorni* and the invasive alga *Caulerpa taxifolia* and that those differences relate to functional changes in sulfur cycling between the macrophytes. Second, by experimentally manipulating the microbial communities we show that intact microbial communities in *Z. capricorni* sediments provide biotic resistance to *C. taxifolia* fragments compared to when they are inactive, and intact microbial communities in *C. taxifolia* sediments have positive feedbacks for fragment growth. Third, in a field experiment, using a similar but different complex of macrophytes, we show that fragments of *C. cylindracea* are similarly reduced when exposed to intact sediments from native *Posidonia oceanica.* Thus, similar to terrestrial ecosystems, microorganisms may indirectly control the success of invasive macrophytes in marine ecosystems.

Presenter's Email: p.gribben@unsw.edu.au

Using iNaturalist.org as a tool for collaborative research and publishing open access field guides

A.E. Grogan*

Coastal Carolina University Department of Marine Science

The website iNaturalist.org provides an open access platform for professionals, students, and citizen scientists to post and discuss photo observations. Users can search observations by taxa, location, or via specific project pages and guides. This site can be used for casual naturalists but has great potential for researchers. This platform allows researchers from multiple agencies or academic affiliations to collaborate on assessing biodiversity, distribution, and abundance of taxa within a region. Creating a project page allows multiple users to post observed taxa. Project administrators have the ability to make allowable posts as detailed or simple as desired. These projects are searchable and can provide valuable information to researchers not involved directly. Various users without affiliation to a project can provide feedback to verify the identity of posted observations. Likewise guides can be created for various situations either taxa or location based. As part of ongoing phytoplankton research, Coastal Carolina University has been working on developing an iNaturalist guide to Marine Phytoplankton of the Grand Strand Region of South Carolina. Site verified guides are image based providing an excellent learning tool for students and novice identifiers as well as providing freely accessible information to any user.

Presenter's email: aegrogan@coastal.edu

Effects of lesion distribution on coral growth and morphology

Hamman, E.A.*[1]

[1] Odum School of Ecology, University of Georgia

Many predators and herbivores do not kill their prey, but rather remove or damage tissue. As a result, prey are often able to heal or regenerate this lost tissue. When the prey are modular or colonial organisms (e.g. corals, sponges, and seagrasses), the regeneration of tissue and recovery of the colony is dependent on connected units. For example, many coral predators remove coral tissue from larger colonies consisting of many polyps. Polyps share nutrients with their neighbors, and thus, the distribution of feeding on a coral colony is likely to affect tissue regeneration and coral growth in the presence of corallivores. Here, I use a combination of field experiments and surveys to study how the distance between scars affects skeletal growth and morphology, and how predator presence relates to coral growth and morphology. Scars near one another reduced linear extension a year later, while corals with lesions far apart showed no difference in growth from control corals. Additionally, corallivorous snails increased heterogeneity on the colony and locally decreased linear extension rates. These results suggest clustered coral damage has a greater effect on coral growth and recovery from damage than damage spread throughout the colony and could contribute to topographically diverse reefs.

Presenter's Email: hamman@uga.edu

Stone crab respiration and ingestion with respect to temperature variation and sequential autotomization

Hancock, E. H.*[1]

[1]School of Earth, Ocean, and Environment, University of South Carolina

The stone crab, *Menippe* spp., is harvested in a claw only fishery along the Gulf and southeastern Atlantic coasts of the United States. As climate change continues to warm the waters in these areas, crabs are forced to cope with higher water temperatures and lower dissolved oxygen. In an effort to inform fishery sustainability as well as prepare for a potential range expansion of the crab, this study investigates the energetic intake and expenditure of individual stone crabs. Crabs were found to respire more as claws are sequentially autotomized and as water temperature increases. Mortality as a result of claw loss was lower when using stimulated sequential autotomization rather than the traditional fishery style declawing methods. The consumption of oysters in field cages increased with water temperature and crab size. Ingestion efficiency did not significantly vary with crab size, water temperature, or claw loss. We hypothesize that the ingestion efficiency did not change with the loss of the claws due to a unique feeding behavior. The front four walking legs were used more in food manipulation than both major and minor claws. Results highlight the importance of temperature consideration in physiological processes of poikilotherms, especially those harvested in commercial fisheries.

Presenter's Email: Hancocke@email.sc.edu

What Caused the Drift Macroalgae Die-off Prior to the 2011 Superbloom in the Indian River Lagoon, Florida?

Hanisak M.D.*[1]; Wills P.S.[1]; Robinson C.[1]; Chamberlain R.[2]; Morris L.[2]

[1]Harbor Branch Oceanographic Institute at Florida Atlantic University; [2]St. Johns River Water Management District

Unprecedented phytoplankton "super blooms" caused catastrophic loss of seagrass in the Indian River Lagoon (IRL), Florida, in 2011-2012. Curiously, the drift macroalgae (DMA) community declined precipitously in summer-fall 2010, prior to the seagrass decline, following a period of several extreme variations in the environment. We conducted a series of single-factor and multi-factor experiments on the effects of extreme salinity, temperature, and low light levels on DMA in laboratory-controlled tanks. Growth and changes in tissue nutrient content (N, and P) were measured. Our results indicate that the most likely cause for the DMA die-off was low light availability. That DMA declined before seagrass is probably a reflection of their much lower capacity for storing food reserves compared to seagrasses. Our nitrogen (N) and phosphorus (P) flux measurements demonstrated the ability of DMA to act as important nutrient sinks and sources in the IRL system. When DMA declined, they contribute significant amounts of N and P in the environment which are then available to bloom-forming phytoplankton. This project has provided a better understanding of macrophyte nutrient cycling in the IRL and how the disruption of this role may have contributed to the development and persistence of the severe phytoplankton blooms in 2011.

Presenter's Email: dhanisak@fau.edu

Highly abundant and well-mixed microphytobenthos in shallow subtidal calcareous reef sands

Hannides, A.K. [1]; Fogaren, K.E. [2]; Glazer, B.T. [2]; Sansone, F.J.[2]

[1]Department of Marine Science, Coastal Carolina University; [2]Department of Oceanography, University of Hawaii at Manoa

The limited investigations of the function of microphytobenthos (MPB) in carbonate reef sediments indicate that MPB abundance is fairly high and that, due to their relatively high coverage, calcareous reef sands could account

for a significant portion of primary productivity in reef systems. Elevated abundances may be explained by high sand permeability and intense physical mixing of the solid and fluid phase, exposing the constantly mixed surficial MPB to nutrients from below and light from above. Building on past methodological work on chlorophyll content determination in calcareous sands, we explored patterns in the spatial distribution of chlorophyll stocks across gradients in sand characteristics and surface topography at two sites on O`ahu, Hawai`i. Ripple crests were characterized by higher permeabilities and/or porosities than the adjacent troughs, as expected by their relatively higher mixing frequency and intensity. Chlorophyll concentrations were also higher in ripple crests as compared to adjacent troughs, and also exhibited a positive correlation with sand permeability across stations and ripple segments. Our results lend support to this mechanistic explanation behind high MPB abundances in intensely reworked reef sands and provide further impetus to studies of their role in reef system biogeochemistry and energetics.

Presenter's Email: ahannides@coastal.edu

Getting to the dinner table: the impact of an invasive ecosystem engineer on predator foraging in Southeastern mudflats

Linsey E. Haram*[1]; Kaitlin Kinney[2]; Erik Sotka[3]; James E. Byers[1]

[1]Odum School of Ecology, University of Georgia; [2]Department of Biology, Ohio State University; [3]Department of Biology, Grice Marine Laboratory, College of Charleston

Invasive species can have particularly far-reaching effects when they are ecosystem engineers – organisms that regulate the availability of biotic and abiotic resources through physical state changes within an ecosystem. As a result, invasive ecosystem engineers can destroy, alter or create habitats. The invasion of estuaries by the ecosystem-engineer, *Gracilaria vermiculophylla*, a red seaweed from Asia, is of particular interest in the coastal communities of Georgia. Unlike other invaded regions, Georgia's estuaries have low native seaweed diversity, making *G. vermiculophylla* a new life form. Such an introduction may have transformative consequences, providing novel habitat for invertebrates, which may ultimately lead to predators shifting their foraging behaviors and habitat use in response. Through a series of studies, we assessed how the novel invasive ecosystem engineer alters shorebird foraging in Georgia mudflats. Given that *G. vermiculophylla* acts as islands of attraction for epifaunal invertebrates, we hypothesized that shorebirds would be more abundant on invaded mudflats and would forage more in areas with *G. vermiculophylla*. However, we found that not all shorebird species react favorably to the seaweed, demonstrating the complex nature of the effects of invasive ecosystem engineers, causing an array of behavioral reactions by native predators.

Presenter's Email: lharam@uga.edu

Soundscape manipulation through the experimental addition of snapping shrimp does not affect rates of *Crassostrea virginica* larval recruitment

Sean Hardison* and Ami Wilbur

University of North Carolina - Wilmington

Exposure to oyster reef soundscapes has been shown to positively affect larval settlement of the eastern oyster *Crassostrea virginica*. The dominant component of these soundscapes is formed by *Alpheus* spp. snapping shrimp activity, which use oyster reefs as habitat. To better understand the applicability of soundscape manipulation for reef restoration, we sought to manipulate larval recruitment by seeding newly built experimental reef plots with snapping shrimp over the course of the *C. virginica* spawning season. Acoustic samples were taken biweekly at reefs with and without added snapping shrimp, and we followed larval recruitment with settlement tiles at each reef site, where half of all tiles were covered with a 4 mm mesh to reduce predation effects. A snap detection algorithm was applied to identify patterns of snapping shrimp activity throughout the experimental area, and recordings showed significantly higher ($p < 0.01$) rates of high amplitude snapping shrimp activity (>143.55

dB re 1 µPa) on reef sites where shrimp were added. Larval recruitment was significantly higher ($p < 0.05$) on covered tiles on reefs without shrimp. Our data suggests that any signal in larval recruitment derived from snapping shrimp acoustic cues is likely drowned out by post-settlement mortality.

Presenter's Email: sbh4808@uncw.edu

Every invasion tells a different story: cryptic lineages and hybridization in a cosmopolitan marine invertebrate

Harper, K.*[1]; Scheinberg, L.[2]; Boyer, K.[2] ; Sotka, E.[1]

[1]Graduate Program in Marine Biology, The Graduate School at the College of Charleston, SC; [2]Department of Biology; San Francisco State University, CA

Marine biological invasions are accelerating in number and impacts. To understand and manage such invasions, it is important to both accurately identify invasive species and identify their introduction sources and pathways. This effort is complicated by the rampant speciation and potential hybridization of invertebrates. As one case study, we collected 349 individuals of the estuarine amphipod *Ampithoe valida* from across native and introduced populations, Sanger sequenced mitochondrial COI and genotyped ~10K nuclear single-nucleotide-polymorphisms (or SNPs) using RADseq. Across the native range of *A.valida*, we found both mitochondrial and nuclear divergence between Pacific and northwestern Atlantic populations, indicating two subspecies or species. In contrast, three introduction events generated distinct genetic outcomes. An introduced population in Argentina has both Atlantic mitochondrial and nuclear genotypes. However, two California populations show varying levels of mito-nuclear discordance: San Francisco Bay populations have Pacific mitochondria and a mix of Atlantic-and-Pacific SNPs, while Humboldt Bay has Atlantic mitochondria and a mix of Atlantic-and-Pacific SNPs. The mito-nuclear discordance among introduced populations suggests recent hybridization of Atlantic and Pacific sources in these estuaries and possibly adaptive introgression of mitochondrial loci, nuclear loci, or both. More generally, we find that mitochondrial loci alone generate a mistaken demographic and evolutionary history that can be resolved with nuclear SNPs.

Presenter's Email: harperke@g.cofc.edu

Variability in coral and octocoral recruitment along the Florida Reef Tract

Leah Harper[1]*; Elijah O' Cain[2]; Lindsay K. Huebner[3]; Rob Ruzicka[3]; Daniel F. Gleason[4]; and Nicole D. Fogarty[1]

1Department of Marine and Environmental Sciences, Nova Southeastern University;[2]Department of Biology, Georgia Southern University;[3]Coral Program, Florida Fish & Wildlife Research Institute;[4]Institute for Coastal Plain Science, Georgia Southern University

There is consensus that recruitment failure is impeding coral recovery along the Florida Reef Tract (FRT), but how this parameter varies at the reef scale and through time is unknown. To fill this knowledge gap we are quantifying scleractinian and octocoral recruitment at 30 long-term monitoring sites across the FRT that are part of the Coral Reef Evaluation and Monitoring Project. At each site, 32 pairs of grooved terracotta settlement tiles (15x15cm) were attached to the substrate and retrieved after one year (n = 1,920 total tiles). There was high variability in recruitment among regions (i.e., SE Florida, upper, middle, and lower Keys) and even among sites within a region. There is a latitudinal shift in recruit position from upper to lower surfaces progressing from north to south along the FRT. Brooding scleractinians (with the exception of *Siderastrea siderea*) were most common and octocoral recruitment more localized. This study is informing reef management efforts of the regional differences in coral recruitment within the FRT suggesting that multiple management plans may need to be employed.

Presenter's Email: lh1185@nova.edu

Application of Landscape Ecology to Facilitative Interactions between Estuarine Ecosystem Engineers

Harris, R. D.*[1]; Byers, J. E.[1]

[1] Odum School of Ecology, University of Georgia

Both the Eastern Oyster, *Crassostrea virginica* and Smooth Cordgrass, *Spartina alterniflora* have been studied extensively, however little work has looked at spatial relationships between them. This is surprising as both species physically engineer the environment, provide extensive ecosystem services and ecosystem function while living in close proximity to one-another. How these species adjust to climate change will likely have large community wide implications. Climate change is driving current sea level rise and increased storm frequency and intensity. This trend is predicted to intensify and will have a dramatic effect on coastal habitat patterns of these two engineers. Here we take a landscape ecology approach, to study abiotic stress, patch distribution, edge and matrix relationships between these species. Ecosystem engineer spatial patterns within an ecotone were documented using aerial photography, and observed to change across intertidal and estuarine scale gradients. We show that abiotic forces drive estuarine scale distribution, however facilitative interactions mitigate abiotic stress, driving reef scale distribution.

Presenter's Email: Robert.d.harris@gmail.com

Southeast Florida stony coral mortality associated with the 2014-2016 disease event

Hayes, Nicole K.*[1]; Walton, Charles J.[1]; Brinkhuis, Vanessa[2]; Ruzicka, Rob[2]; Gilliam, David S.[1]

[1]Department of Marine and Environmental Sciences, Nova Southeastern University; [2]Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute

Southeast Florida (USA) reefs represent the northern extent of the Florida Reef Tract (FRT) and exist as a series of linear reefs adjacent to a highly developed coastline. The Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP) has monitored this region via annual image analysis since 2003 and stony coral, gorgonian and barrel sponge demographic data since 2012. In late 2014, increased instances of disease and diseased related mortality were reported throughout the Southeast Florida Reef Tract. By summer 2016, significant region-wide declines in *Dichocoenia stokesii*, *Meandrina meandrites*, and *Montastraea cavernosa* colony density were recorded, as well as a decline in overall stony coral density. Significant *M. cavernosa* losses, one of the major reef building corals of the region, is of particular concern as it has historically been considered one of the hardier species and commonly contributes to the larger size classes on the reef. Prior to this event, species wide stony coral mortality of this magnitude had not been observed. With disease observations continually reported for more than two years, it appears that the northern portion of the FRT is experiencing the largest multi-species stony coral mortality event in recent times.

Presenter's Email: nh567@nova.edu

Global Change Biogeography:
Integrating biogeography into understanding ecological generalities in the Anthropocene

Qiang He*; Brian R. Silliman

Division of Marine Science and Conservation, Duke University

Human-driven environmental changes are accelerating and are impacting marine, freshwater, and terrestrial ecosystems across the globe. The worldwide nature of human-driven environmental changes necessities a better understanding of the relevance of microecological-scale discoveries across macroecological scales. Such an understanding has been rapidly advancing with the use of meta-analysis and standardized protocols, both of which have their advantages and disadvantages. Here we introduce Global Change Biogeography, which emphasizes the

use of biogeographical theories in understanding generalities and variabilities in the impact of environmental change on ecosystems across large spatial scales. Case studies on the impact of climate change on positive species interactions and on the impacts of eutrophication and warming on top-down control in coastal wetlands illustrate the value of Global Change Biogeography. Biogeographical theories can also be powerful for understanding generalities in other global change issues, such as large-scale species invasions, habitat loss-driven species extinctions, and species range shifts under climate warming. We suggest that a new fruitful line of Global Change Biogeography studies will be tremendous in advancing understanding of human impacts on Earth's ecosystems across local, regional, and global scales in an increasingly human-dominated biosphere.

Presenter's Email: Qiang He, Email: q.he@duke.edu

Exploring the indirect effects of the presence of black sea bass (*Centropristis striata*) on the survival of bay scallops (*Argopecten irradians*)

Heck, S.M.*; S.V. Milea; B.J. Peterson

Stony Brook Southampton Marine Station, Stony Brook University, Southampton, NY

Predation is among the dominant forces that drive the structure and function of marine ecosystems. Predators can influence the structure of marine communities by directly altering the abundance and behavior of their prey and inducing indirect cascading effects through the food web that result from these direct interactions. Driven by the effects of a changing climate, the geographic range and relative abundance of many species has begun to change. For black sea bass (*Centropristis striata*), the extent of their range has been increasing northward along the northeastern United States. Given that black sea bass are predators of many crustaceans that prey on bay scallops (*Argopecten irradians*), we wanted to explore if the presence of black sea bass indirectly influences the survival of juvenile bay scallops by decreasing the foraging rates of crustacean predators. We set out to investigate this concept through a field experiment in seagrass patches within Shinnecock Bay, NY. Our results suggest that the presence of black sea bass indirectly increases the survival of juvenile bay scallops. In areas where crustaceans dominate the predator assemblage, black sea bass may become progressively more important in enhancing scallop survival through a critical life history stage.

Presenter's Email: heck.stephen@gmail.com

Cross-ecosystem predators drive New England salt marsh community structure and ecosystem multifunctionality

Hensel, M.J.S.*, Byrnes, J.E.K

Department of Biology, University of Massachusetts-Boston

Cross-ecosystem predators are common interactors in coastal food webs, connecting adjacent terrestrial and aquatic habitats through consumption. In turn, coastal food webs support valuable ecosystem functions and services. However, human impacts like habitat fragmentation and overharvest tend to affect these mobile, large cross-ecosystem species disproportionately. Thus, understanding how changes in cross-ecosystem interactions alter food webs structure and function is key for conservation of habitats like salt marshes. Here, we use a combination of surveys and experiments to determine how cross-ecosystem predators shape New England salt marsh communities and ecosystem multifunctionality. Surveys indicated that the most common cross-ecosystem predators were marine (fish, crabs) and avian (shorebirds), but the abundance of each species and group of species varied throughout marshes in New England. A 5-month exclusion experiment showed that marine species, (e.g. green and blue crabs), are the strongest predators of resident marsh species (e.g. burrowing crabs, ribbed mussels), which regulate primary production, sedimentation, and infiltration rates. Bird predation is less consistent but

exhibits some synergism with marine predators to affect the marsh community. As habitat fragmentation and overfishing continue to affect coastal marshes, it is increasingly important to determine how changes in marsh food webs affect their service provisioning over time.

Presenter's Email: mjshensel@gmail.com

3D printing for benthic ecologists: Applications, implications, and limitations in the marine realm

Stephen G. Hesterberg*; Elizabeth A. Salewski; C. Cole Duckett; Susan S. Bell

Department of Integrative Biology, University of South Florida

Recent advances in three-dimensional (3D) imaging and software over the last decade have made modeling of complex objects increasingly more accessible to ecologists. One avenue of opportunity provided by these technologies is the low-cost reproduction of high-resolution images via 3D printing. Here, we discuss 3D printing in the context of benthic ecology, with special emphasis on the technology's experimental application and limitation within the marine environment. We assembled examples from our ongoing research in an oyster reef system and demonstrate how paired laser or CT scanning, software analysis, and 3D printing can be used to overcome certain methodological challenges encountered in our research. By doing so, we aim to facilitate the expansion of 3D printing technology and discuss its array of potential applications for benthic ecology.

Presenter's Email: hesterberg@mail.usf.edu

Disease resistance in the threatened staghorn coral, *Acropora cervicornis*

Hightshoe, M. V.*; Miller, S.; Fogarty, N. D.

Department of Marine and Environmental Sciences, Nova Southeastern University

The staghorn coral, *Acropora cervicornis*, is a major reef-building scleractinian coral found throughout Florida and the Caribbean that experienced dramatic population declines starting in the 1970s. The declines are attributed primarily to coral bleaching and white-band disease (WBD), and other tissue loss syndromes. Previous research indicates that disease-resistant genotypes exist based on work conducted in Panama. It is unknown if disease resistant genotypes exist in Florida Keys populations. We tested the potential for rapid tissue loss (RTL) resistance among 48 *A. cervicornis* genotypes maintained in a Florida Keys nursery by grafting active disease fragments to apparently healthy fragments. Tissue degradation was documented visually by the presence or absence of RTL (denoted by a characteristic margin where the zooxanthellate tissue is denuded from the skeleton), followed by histological analysis to further characterize potential tissue degradation. In this preliminary disease screening, 41 out of 48 genotypes did not show signs of rapid tissue loss transmission after five days. Only two control fragments showed signs of disease transmission. Continued histological analysis and a highly replicated disease transmission study in 2017 will help confirm disease resistance. These results will help inform and potentially increase the efficacy of future management strategies of *Acropora* populations.

Presenter's Email: mh2120@nova.edu

Shared enemies, habitats, and alien invaders: Interactions between exotic Asian tiger shrimp (*P. monodon*), native shrimp, and red drum predators

Jennifer M. Hill[1,2]*; Brian Klimek[2]; Olivia Caretti [3]; Kenneth L. Heck Jr.[2]

[1]Louisiana Tech University, Ruston, LA; [2]Dauphin Island Sea Lab, Dauphin Island, AL; [3]North Carolina State University, Raleigh, NC

Since 2011, Asian tiger shrimp (*Penaeus monodon*) have steadily appeared in commercial shrimp catches from North Carolina to Texas. Their consistent presence is concerning because the tiger shrimp's large body size, crustacean diet, and estuarine distribution suggests that tiger shrimp may consume and/or compete with native shrimp. Furthermore, tiger shrimp size may hinder predation and limit biotic resistance to tiger shrimp invasion. To assess these concerns, we used mesocosm experiments to examine predatory and habitat displacement interactions between tiger shrimp and native shrimp. We also used large mesocosms to differentially compare red drum (*Sciaenops ocellatus*) predation rates on tiger shrimp and native shrimp and their anti-predator responses. In contrast to initial fears, tiger shrimp predation rates on native shrimp were low. However, interactions between native shrimp and tiger shrimp often displaced native shrimp from preferred habitats. Surprisingly, interactions between tiger shrimp and native shrimp did not increase predator-driven mortality in the presence of red drum. Red drum consumed fewer tiger shrimp than native shrimp potentially due to their larger size. Together these results suggest that tiger shrimp may have few negative impacts on native shrimp, even though there appears to be limited biotic (predator) resistance to tiger shrimp invasion.

Presenter's Email: jmhill@latech.edu

Spatial variation and the invasibility of mesofaunal communities associated with the sponge *Tedania ignis*

Hill, K.*

Department of Biological Science, Florida State University

The Caribbean fire sponge, *Tedania ignis*, is a dominant species in mangrove and seagrass habitats in the Florida Keys and is associated with a wide array of mesofauna including polychaetes, crustaceans, and brittle stars. Previous studies have described the relationship between mesofaunal communities and sponge morphology, depth, and seasonality. Recently, habitat was shown to influence mesofaunal community composition and diversity, but this was documented in a sponge species whose morphology differs between habitats. I investigated the influence of habitat on mesofaunal communities associated with *Tedania*, a massive sponge with consistent morphology between habitats, and confirmed that community composition is strongly correlated with habitat. After establishing baseline community composition, I examined the invasibility of mesofaunal communities, which can allow us to identify mesofauna that are more likely to invade or be evicted from their host. I performed reciprocal transplants of *Tedania* between mangroves and seagrass to identify patterns in community turnover and found that symbiont community diversity and abundance are influenced by both the native source and the transplant site. While the most abundant mesofauna, the polychaete *Branchiosyllis oculata*, was found in nearly all sponge samples, some of the rarer mesofauna such as *Leucothoe* amphipods were displaced following the transplant.

Presenter's Email: kmhill@bio.fsu.edu

The best offense is a good defense: *Hemigrapsus sanguineus* aggregations defend against both predators and competitors

Niels-Viggo S. Hobbs

Biological Sciences Department, University of Rhode Island

The Asian shore crab, *Hemigrapsus sanguineus*, is a well-documented invader of northern Atlantic rocky and cobble coastlines. While cohabitation and conspecific tolerance is integral to the success of *H. sanguineus*, the mechanism by which competitors are excluded has not been fully studied. Here, I analyze the degree to which olfaction, vision, and direct interaction act to repel competitors. Simple laboratory habitat selection experiments show the immediate presence of *H. sanguineus* is necessary to prevent use of preferred cobble shelter by the competitor, *Carcinus maenas*, with olfactory cues providing a secondary mechanism. While Rhode Island rocky intertidal habitats are dominated by *H. sanguineus*, their distribution can be highly patchy. I conducted a second series of laboratory experiments to determine the effect of predation risk on aggregation by observing the

distribution of small numbers of *H. sanguineus* exposed to olfactory, visual, and direct contact cues from *C. maenas*. Under immediate risk and when exposed to olfactory cues, *H. sanguineus* demonstrated a greater tendency to aggregate.

Presenter's Email: nvshobbs@uri.edu

Tracking Biological Invasions: An Assessment of Mussel Species in the St. Johns River, Jacksonville, FL, USA

Holt, Walter A.*; Garner, Yvette L.

University of West Georgia, Department of Biology, Carrollton, GA, USA 30118

With much transoceanic transportation in the modern age, the introduction of non-native marine species has increased in recent years, particularly in bivalve molluscs. The green mussel (*Perna viridis*), an Indo-Pacific native, is believed to have originally been introduced to Tampa, Florida via international shipping in 1999 where it was discovered clogging the water intake pipes of a local power plant, and has been subsequently found in the St. Johns River, Jacksonville, Florida. Similarly, the charru mussel (*Mytella charruana*), a South and Central American native, caused comparable fouling problems to the Jacksonville Electric Authority's water intake pipes in Jacksonville, Florida starting in 1986 with reported die offs during colder months. Since then, green and charru mussels throughout the St. Johns River are sparsely documented in the literature, therefore, this study provides baseline data regarding the range, abundance and sizes of non-native and native mussel species for this estuary. Higher mean abundances of *M. charruana* were found in lower salinity conditions upriver, the native mussel (*Ischadium recurvum*) was found in greater abundances in higher salinity conditions near the mouth of the river, and *P. viridis* was mainly absent from the river.

Presenter's Email: wholt2@my.westga.edu

Do patch edges elevate predation risk for eelgrass epifauna? A global test

Hovel, K.*[1]; Duffy, J.E.[2]; Stachowicz, J.J[3]; Reynolds, P.L.[3]; ZEN Partners

[1] Coastal and Marine Institute, San Diego State University; [2] Tennenbaum Marine Observatories Network, Smithsonian Institution; [3] University of California Davis

Ecological processes often vary with proximity to patch edges. Edges are prominent features of many seagrass habitats and may strongly influence predator-prey interactions, but the magnitude of "edge effects" may be dictated by seagrass structural complexity. As part of the *Zostera* Experimental Network, we conducted a global test of whether proximity to eelgrass patch edges affects predator-induced mortality risk for epifauna, and whether edge effects depend on structural complexity. Working at 17 sites on three continents, we exposed eelgrass epifauna to predators by tethering them at patch edges and in patch interiors with varying levels of structural complexity. We also compared risk for mesograzers tethered in seagrass to those tethered in unvegetated sediment. Proximity to edges and the presence of eelgrass affected mortality risk at most sites; however, the odds of mortality were elevated along edges (and outside of seagrass) at some sites, whereas the converse was true at others. Structural complexity had comparatively smaller effects on predation risk than did proximity to edges. In some instances, covariates of eelgrass habitat, such as epifaunal density, more strongly affected predation risk than did structural attributes of eelgrass habitat. We show that patch edges have prominent but variable effects on predation risk.

Presenter's Email: khovel@mail.sdsu.edu

Resilience of transplanted fused staghorn coral, *Acropora prolifera,* to non-natal habitats shaped by environmental and ecological conditions

Howe, C.*[1]; Fogarty, N.[2]; Holstein, D.[3]; Smith, T. B.[1]

1Center for Marine and Environmental Sciences University of the Virgin Islands; [2]Department of Marine and Environmental Sciences, Nova Southeastern University; 3Duke University Marine laboratory, Nicholas School of the Environment, Duke University

Caribbean corals *Acropora cervicornis* and *A. palmata* hybridize to form the fused staghorn coral, *A. prolifera.* Recent studies suggest the combination of adapted traits from both parent species provides *A. prolifera* with novel genetic architecture that may allow it to persist in a wide range of environments. However, it is unclear if *A. prolifera* can persist in non-natal habitats to which they are not adapted. Our objective is to compare the resilience of non-natal *A. prolifera* genotypes to natal genotypes in a unique location. In November 2016, 5 fragments from 8 colonies were collected from Inner Brass (IB), an island north of St. Thomas USVI, and Flat Cay (FC), an island south of St. Thomas (n=40; N=80). Both control and transplanted fragments were planted randomly in two plots (1m-2.5m) at Flat Cay. Growth, mortality, disease, predation and bleaching were monitored monthly. Preliminary results show no disease, mortality, predation, or bleaching except for one fragment from IB that paled, suggesting natal location did not influence hybrid health. Because these data suggest *A. prolifera* can live outside their natal habitat, have unique traits, and robust survival they may be useful in coral restoration efforts.

Presenter's Email: Colin.Howe15@gmail.com

Patterns in the natural transmission of the parasitic dinoflagellate *Hematodinium perezi* in the blue crab *Callinectes sapidus*

Juan P. Huchin-Mian*; Hamish J. Small; Brittney Barris; Jeffrey D. Shields

Virginia Institute of Marine Science, The College of William & Mary

Hematodinium perezi is a highly pathogenic dinoflagellate endoparasite that infects blue crabs *Callinectes sapidus* from high salinity waters along the eastern seaboard of the United States. Little is known about the dynamics and factors associated with the parasite's natural transmission. Juvenile blue crabs were deployed as naïve sentinels to investigate transmission in an endemic location on the Eastern Shore of Virginia. Over 560 uninfected crabs were collected from a non-endemic site, placed into individual housing units and deployed in both a control non-endemic site and in a highly endemic site for 3, 7, 10, and 14 days. After deployment, crabs were examined for the presence of *H. perezi*. Prevalence levels from the endemic location ranged from 42.1% (7 d) to 88% (10 d). None of the crabs (n=193) deployed at the non-endemic control site were infected by *H. perezi.* In addition, 467 crabs were tagged to determine the association between host molting and transmission. Our findings indicate that transmission of *H. perezi* can occur rapidly and at very high levels in endemic sites, and infection is not associated with host molting.

Presenter's Email: jpablo@vims.edu

Variability in juvenile coral and octocoral abundance along the Florida Reef Tract

Huebner, L. K.*[1]; Harper, L.[2]; Ruzicka, R.[1]; Fogarty, N. D.[2]; Gleason, D. F.[3]

[1]Coral Program, Florida Fish & Wildlife Research Institute; [2]Department of Marine and Environmental Sciences, Nova Southeastern University; [3]Institute for Coastal Plain Science, Georgia Southern University

A number of reefs in the Florida Reef Tract (FRT) are experiencing a shift from scleractinian coral to octocoral dominance. To determine if this community shift can be explained by differences in juvenile abundance, we present results from two years of an ongoing study conducted at 30 Coral Reef Evaluation and Monitoring Project

sites throughout the FRT. Sites were stratified by region (Southeast Florida, Upper, Middle, and Lower Keys) and habitat type (reef terrace, patch, forereef, deep reef). At each site in both years, we surveyed the same 32 0.25m^2 quadrats (n = 960 quadrats total) for scleractinian and octocoral juveniles < 40mm. Octocoral juveniles tended to be more abundant in northern regions of the FRT and scleractinian juveniles more common at southwest sites. The dominant genera were *Porites* and *Siderastrea* for scleractinians and *Antillogorgia, Eunicea*, and *Gorgonia* for octocorals. Overall, fewer colonies of both groups were found in 2016 than in 2015. While preliminary, this study suggests that when it comes to reef recovery, future communities could be different than current communities on the regional or habitat level, and it may not be appropriate to apply a single management plan to the entire FRT.

Presenting author email: Lindsay.Huebner@MyFWC.com

Factors Influencing the Distribution and Abundance of *Sphaeroma terebrans* in Florida Red Mangroves

Sarah Huff[1]*; Donna Devlin[1,2]

[1]Florida Atlantic University at Harbor Branch Oceanographic Institute; [1,2]Dept. of Life Sciences, Texas A&M University-Corpus Christi

Sphaeroma terebrans, a wood boring isopod, is known to burrow into free-hanging aerial roots of *Rhizophora mangle*. Roots provide the isopod with protection from desiccation and access to plankton. However, in some south Florida restoration sites, *S.terebrans* has been discovered burrowing into the grounded roots and trunk of young red mangroves, causing them to topple. Factors controlling isopod distribution and abundance remain unclear; both nutrients and cover by oyster and barnacles have been suggested to affect abundance. Surveys and two manipulative experiments were conducted in restored mangrove habitat to investigate the interaction between mangroves and *S.terebrans*. Mangroves showed differences ($p < .0001$) in burrowing activity among sites. When roots from nutrient treated (N &P >20 yrs) trees were placed at affected sites, we found no clear colonization patterns associated with nutrient treatment. Soil samples from each location are currently being analyzed to determine if soil nutrients may explain variation. A second manipulative experiment using oysters as a natural barrier against burrowing was performed to assess effectiveness and feasibility as a restoration tool. Results highlight the need for additional information to determine the influence of environmental factors on this species interaction and its role in mangrove conservation.

Presenter's Email: shuff2015@fau.edu

Inherit resilience in seagrass: Quantifying genetic and kin structure variation between life history strategies

Jarvis, J.C.*; Willeboordse, P.L.; Kamel, S.J., Eulie. D.O.

Department of Biology and Marine Biology, University of North Carolina Wilmington

In an ecological context, genetic structure refers to the patterning of species genetic diversity across multiple local populations within a single metapopulation. This structure can have significant effects on interactions between conspecific individuals as well as population level resilience to disturbance. Throughout their distribution in the northern hemisphere, *Z. marina* populations express life history strategies which range from perennial to annual forms. Increased sexual reproduction in mixed-annual and annual populations compared to perennial meadows may result in greater variation in genetic and kin structures, potentially providing a greater resilience to disturbance. However, the genetic and kin structures of populations which express the less commonly observed annual life history strategies are unknown. Spatially explicit measurements of genetic and kin structures in perennial and mixed-annual meadows were collected near the southern limit of the species distribution along the western Atlantic Ocean. To link genetic results to resilience capacity, recovery mechanisms were also quantified via seed bank viability. Understanding the effects of life history on both the genetic and kin structures within *Z. marina*

populations and their impacts on meadow resilience to disturbances is crucial to increase the effectiveness of seagrass conservation.

Presenter's Email: jarvisj@uncw.edu

Fiddle me this: Why do fiddler crabs follow Bergmann's rule?

Johnson, D.S.[1], Longmire, K.[1], Sebillian, S.[1], Crowley, C.[2]; and Williams, B.[1]

[1]Department of Biological Sciences, Virginia Institute of Marine Science, The College of William and Mary; [2]Department of Mathematics and Statistics, University of Vermont

Bergmann's rule describes one of the best known biogeographic pattern in which organisms at higher latitudes are larger than ones at lower latitudes. In a survey of 15 marshes along the Atlantic coast of the U.S., we found that the saltmarsh fiddler crab, *Uca pugnax*, follows Bergmann's rule with Massachusetts crabs (19 mm carapace width) almost twice as large as Georgia crabs (10 mm carapace width). A long-standing question is what drives the pattern described by Bergmann's rule. Here we use environmental and biological data to explore a number of mechanistic hypotheses including the temperature-size hypothesis, environmental-stability hypothesis and Thorson's rule.

Presenter's Email: dsjohnson@vims.edu

Trophic Cascades in Kelp-Urchin Dynamics: Not Everywhere and Not Always

Johnson, L.E. [1*]; MacGregor, K.A.[1]; Narvàez, C.[1]; Suskiewicz, T.[1]

[1] Department of Biology and Québec-Océan, Université Laval

The concept of trophic cascades is intimately connected to the pioneering work of Robert Paine and is one of the best documented phenomena in ecology. The classic example of a trophic cascade is the sea otter/sea urchin/kelp system of Alaska where sea otters act as keystone predators. Efforts in northwestern Altantic ecosystems to fit urchin-kelp dynamics into a similar trophic cascade driven by lobster abundance ultimately failed to find any such relationship. Subsequently, strong evidence has suggested that in the Gulf of Maine, groundfish, particularly Atlantic cod, historically drove a trophic cascade, but overfishing of both finfish and urchins created a kelp-dominated state, which is now maintained by crab predation. In contrast, along the Altantic shores of Nova Scotia the control of urchins is driven by a cyclic disease process that does not involve higher trophic levels. Finally, in the Gulf of St. Lawrence and the Atlantic shores of Newfoundland and Labrador, the current state of urchin domination may be the natural state with little evidence for either trophic cascades or any other top-down control. The contrast among these three ecosystems is a clear reminder of both the complexity of natural systems and the need to use care when generalizing.

Presenter's Email: ladd.johnson@bio.ulaval.ca

Habitat disturbances lead to beta diversity increase driven by species replacement and total abundance rise: the *Sabellaria alveolata* reef case

Auriane G. Jones *[1]; Stanislas F. Dubois[1]; Nicolas Desroy[2]; Jérôme Fournier [3,4]

[1]IFREMER, Laboratoire Centre de Bretagne, DYNECO, Laboratoire d'Ecologie Benthique Côtière (LEBCO); [2]IFREMER, Laboratoire Environnement et Ressources Bretagne nord; [3]CNRS, UMR 7208 BOREA; [4]MNHN, Station de Biologie Marine de Concarneau

Sabellaria alveolata is a gregarious polychaete which, by use of sand particles, is able to build three dimensional structures known as reefs, fixed atop of rocks or built on soft sediments. These structures are known to host a highly diversified associated fauna, modified when the reef undergoes disturbances such as human trampling and winter storms. The goal of this study was to investigate the effects of a continuous and increasing disturbance on the reef's beta diversity. The disturbance continuum was materialized by an increasing mud content in the reef samples. Indeed, mud establishment is the consequence of multiple and often concomitant disturbances affecting the reef. The macrofaunal changes along the disturbance continuum were evaluated at two contrasting seasons (February and September), using pair-wise beta diversity indices (Sorensen and Bray-Curtis dissimilarities and their decomposition into turnover and nestedness). Linear models and multivariate analysis indicated that presence/absence and abundance based beta diversity increased along the disturbance gradient driven by a species replacement and a rise in the associated fauna abundance. The results obtained using the beta diversity indices build a case for the recognition of the ecological value of "degraded" *S. alveolata* reefs as biodiversity and recruitment promoters.

Presenter's Email: auriane.jones@ifremer.fr

"I will out-live all of you": Longevity and persistence of individual knobby periwinkles (*Cenchritis muricatus*)

Judge, M. L.

Department of Biology, Manhattan College

The littorinid snail, *Cenchritis muricatus*, is the sole macrofaunal inhabitant of Caribbean supralittoral rocky walls, at times surpassing 14 meters above mean sea level. These marine snails are typically found inactive above the splash zone. In order to assess survivorship and growth, 327 individually-tagged periwinkles (mean shell height = 15mm; range 7-22mm) were released in early 2003 (St John, USVI) and followed >13 years. Repeated (>850) recaptures of snails showed an absence of mortality and a decline in recovery rates consistent with tag loss (down to 4% after 13 yr). More than 15% of marked individuals were recaptured 5x, while four other periwinkles were overlooked > 10 yrs and recovered only once after initial release. Among the 7 individuals re-measured on 7 or more occasions during the full 13 years, no individual grew more than 1.5mm and all remained < 16.5mm. Finally, von Bertalanffy growth function (VBGF) models have remain unchanged for the past 9 years and confirm cessation of growth at 16.5mm. The combination of tagged individuals recaptured after 13 years and VBGF suggest that the average lifespan might exceed several decades.

Presenter's Email: michael.judge@manhattan.edu

Modeling Particle Removal and Nutrient Dynamics on a Restored Oyster Reef

Kahover*, K., Harris, L., Testa, J., Forsythe, M.

Chesapeake Biological Lab, University of Maryland

Oyster reefs create complex habitats that facilitate a variety of biogeochemical processes. For example, elevated rates of denitrification have recently been observed on restored oyster reefs, and have been attributed to the reef community itself, as opposed to the underlying sediment. Few models have been developed that describe these complex transformations at the spatial and temporal scale at which they occur. To better understand how oyster restoration affects local nitrogen dynamics, we have developed a high resolution model that incorporates the numerous hydrodynamic, physiological, and microbial processes specific to restored reefs. The model describes the advection and diffusion of chlorophyll across a reef, as well as its removal through oyster filtration. The environmental conditions that influence these processes are derived from the Regional Ocean Modeling System. Biodeposit production, resuspension, and nutritive quality are also incorporated into the model. Accumulations of biodeposits and other seston then serve as substrate for the sediment nutrient flux model, which simulates the diagenesis and transformation of nitrogen species on the reef. This modeling tool is aimed at enabling managers to quantify the ecosystem services associated with oyster reefs of varying size, shape, and density.

Presenter's Email: kahover@umces.edu

Effects and Interactions between Dissolved Nutrients, Environmental Variables, and Acidification in the Indian River Lagoon

Bret Kaiser*[1]; Brian Lapointe[1]

[1]Harbor Branch Oceanographic Institute, Florida Atlantic University

In the eutrophic waters of the Indian River Lagoon (IRL), there have been reported decreases in overall shellfish size, which may be related to coastal acidification. In order to understand the relationship between acidification and eutrophication, water samples from 20 sites spanning the IRL were collected and analyzed for dissolved nutrients and acidity (omega values) in spring (dry season) and fall (wet season), 2016. Additionally, three sites were sampled weekly to observe temporal variability of nutrients and acidity. For the IRL-wide dry season, sites with a higher nitrogen concentration were more acidic (some with omega values <2) with a slight negative relationship ($p=0.09$; $r^2=0.12$). The time series data showed temporal variability in salinity and acidity with an overall positive linear relationship ($p=<0.0001$; $r^2=0.52$). This preliminary work suggests that salinity and dissolved nutrients have implications for acidification in the IRL and may be useful to water quality management and shellfish restoration.

Presenter's Email: bkaiser2015@fau.edu

Macrophyte Community Response to Nitrogen Loading and Thermal Stressors: Water Residence Time Ameliorates Eutrophication Symptom Expression

James Kaldy[1*]; Cheryl Brown[1]; Walt Nelson[1]; Melanie Frazier[2]

[1]Western Ecology Division, US-EPA, [2] National Center for Ecological Analysis and Synthesis

Empirical determination of nutrient loading thresholds that negatively impact seagrass communities have been elusive due to the multitude of factors involved. Using a mesocosm system that simulated Pacific Northwest estuaries, we evaluated macrophyte metrics across gradients of NO_3 loading (0, 1.5, 3 and 6x ambient) and temperature (10 and 20 °C). Macroalgal growth, biomass, and C:N responded positively to increased NO_3 load and floating algal mats developed at 20 ºC. *Zostera japonica* metrics, including C:N, responded more to temperature than to NO_3 loading. *Z. marina* biomass exhibited a negative temperature effect and in some cases a negative NO_3 effect, while growth rate increased with temperature. Shoot survival decreased at 20 ºC but was not influenced by NO_3 loading. Wasting disease index exhibited a significant temperature by NO_3 interaction consistent with increased disease susceptibility. Community shifts observed were consistent with the nutrient loading hypothesis at 20 ºC, but there was no evidence of other eutrophication symptoms due to the short residence time. The Nutrient Pollution Index tracked the NO_3 gradient at 10 ºC but exhibited no response at 20 ºC. We suggest that systems characterized by cool temperatures, high NO_3 loads, and short residence time may be resilient to many symptoms of eutrophication.

Author contact: Kaldy.jim@epa.gov

Shoalgrass (*H. wrightii)* may not serve as a spatial-temporal habitat refuge offsetting the seasonal loss of eelgrass (*Z. marina)*

Keller, Danielle A.[1*]; Kenworthy, Matthew[1]; Puckett, Brandon[2]; Fodrie, F. Joel[1]

[1]Institute of Marine Sciences, University of North Carolina at Chapel Hill; [2] North Carolina National Estuarine Research Reserve

Changes in the species composition and structural characteristics of marine vegetated habitats in response to seasonal warming, exacerbated by climate change, may alter net habitat quality and quantity for associated fauna. The dominant seagrass in North Carolina (NC), eelgrass *Zostera marina* sits at its thermal tolerance and southern geographic limit. Increasing water temperatures in summer months (> 30 °C) decrease aboveground biomass of eelgrass to near zero. As eelgrass cover declines, shoalgrass *Halodule wrightii*, with less structural complexity, becomes relatively more prominent, but potentially supports fewer seagrass-associated fauna. We quantified the community abundance and movement of two seagrass-associated fishes (juvenile gag grouper and gulf flounder) seasonally to determine if shoalgrass can serve as a spatial-temporal habitat refuge offsetting the seasonal loss of eelgrass. In Back Sound, NC, we observed a strong decline in faunal abundance coinciding with eelgrass cover decline, even though the cover of shoalgrass increased seasonally. Furthermore, acoustically tagged fishes showed site fidelity rather than moving to nearby shoalgrass habitats after the eelgrass senescence. Synthesis of these results suggests that, in the event of continued eelgrass loss, with or without replacement by shoalgrass, important habitat functions might be lost, and secondary productivity of these ecosystems may significantly decrease.

Presenter's Email: dabbey@email.unc.edu

Regional Migration Patterns of Mature Female Blue Crabs in the Gulf of Mexico

*Kemberling, A.A; Darnell, M.Z

The University of Southern Mississippi, Gulf Coast Research Laboratory

Female blue crabs undertake a seaward spawning migration, migrating from low-salinity mating grounds to high-salinity areas where spawning takes place. While the estuarine portion of the migration has been subject of much research, little is known about movement once crabs leave the estuaries. Offshore migration patterns and spawning locations determine the ultimate settlement location of offspring, which are transported passively by currents during most of their larval period, and thus drive connectivity patterns among estuaries. In February, 2016, we began a Gulf-wide mark-recapture study to examine regional-scale migratory patterns of the Gulf of Mexico blue crab spawning stock(s). More than 6,000 mature females have been tagged throughout the Gulf States, with over 900 recaptures reported. Trawling was conducted in areas off the Louisiana coast known to be spawning habitat for female blue crabs, providing information on offshore movements. In addition to geographic data, reproductive analysis on females acquired from known estuaries is being completed to assess regional reproductive potentials. This project involves collaboration with state agencies, commercial crabbers, and educators, and results will help identify the extent of connectivity versus isolation of the Gulf of Mexico spawning stock(s), and the subsequent implications for larval dispersal and recruitment.

Presenter's Email: Adam.Kemberling@usm.edu

Living on the edge of seagrass: Can it be a good thing?

Matthew D. Kenworthy*[1]; Richard D. Mahoney[1]; Julie K. Geyer[1]; and F. Joel Fodrie[1]

[1] Institute of Marine Sciences and Department of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell Street, Morehead City, NC 28557, USA

Past research has consistently suggested that within temperate and sub-tropical seagrass habitats, organisms experience lower survivorship along habitat edges, presumably as a result of increased predation. However, these observed trends in survivorship have not consistently translated to differences in faunal densities between edge and interior regions of seagrass meadows. To test the null hypothesis that edge has no impact on predation on blue crabs or pinfish we quantified: (1) catch-per-unit-effort (CPUE) of blue crabs and pinfish; (2) distribution of acoustically tagged red drum, a recognized predator of both prey species; and (3) mortality of tethered blue crabs and pinfish. We found no statistically detectable difference in CPUE of either species, and red drum detection frequencies were statistically indistinguishable, moving from the edge toward the meadow interior. Counter to

previous work, we found that blue crab and pinfish survivorship was greater along the edge relative to seagrass interior. These findings are, in part, consistent with the dichotomy apparent in the seagrass literature with respect to edge effects, but also provide new detail on how habitat edges may affect the population ecology of larger bodied, more mobile prey species that have not received as much attention previously (i.e., higher survivorship along edges).

Presenter's Email: mkenwor@email.unc.edu

Breaking Waves for Seagrass Success

Mark Fonseca; Danielle Medellin; Deborah Kilbane*

CSA Ocean Sciences Inc.

The Bonner Bridge Seagrass Mitigation Project provides an example of how modifying existing, patchy seagrass habitat through wave disruption can be used to form more continuous, persistent seagrass cover as in-kind mitigation. Using wave forecasting techniques, CSA's team designed a 500-ft living reef wall, consisting of layered units of stacked concrete with natural rock embedded in it, to reduce wave energy and increase seagrass acreage over time. The design met all federal and state agency requirements and construction of the living reef was completed in January 2017. The living reef wall and surrounding seagrass habitat will be monitored for 5-years to evaluate the change in seagrass cover, epifaunal recruitment on the living reef, wave energy, and sediment elevations over time.

Presenter's Email: dkilbane@conshelf.com

Local and regional stressors interact to drive a salinization-induced outbreak of predators on Florida oyster reefs

Kimbro, D. L*[1]; White, J. W.[2]; Pusack, T. J.[3]; Stallings, C. D.[3]

[1] Department of Marine and Environmental Sciences, Northeastern University; [2] Department of Biology and Marine Biology, University of North Carolina Wilmington; [3]College of Marine Science, University of South Florida

Because natural systems are organized hierarchically, the study of ecological dynamics such as predator outbreaks must account for both large- and local-scale underlying stressors. We investigated whether the collapse of the Apalachicola Bay (FL) oyster fishery in the Gulf of Mexico was (1) caused proximally by a predator outbreak and (2) whether this outbreak was mediated by regional- and/or local-scale forces. By repeating experiments for four years, we found that periods of reduced water salinity inhibited massive oyster mortality due to predation. To parse the influence of regional versus local environmental factors, we simultaneously replicated the same research in a nearby bay (Ochlockonee), which shares similar rainfall conditions as Apalachicola. However, increasing freshwater withdrawals from upstream watersheds have increased salinities only in Apalachicola Bay. In Ochlockonee Bay, experiments demonstrated that the river maintained sufficiently low salinity to provide ~ 50% of oyster reefs with a predation refuge. However, in Apalachicola Bay, a predation refuge did not occur. Given that Apalachicola Bay—but not Ochlockonee—has experienced significant upstream water withdrawal and elevated salinity, it is reasonable to surmise that withdrawals exacerbated a regional drought, created the difference in predation between the two bays, and likely precipitated the oyster fishery collapse.

Presenter's Email: d.kimbro@northeastern.edu

Investigating anthropogenic impacts on mangrove food webs via population-level trophic niche analyses of *Armases cinereum* in Tampa Bay, FL.

Erin Kiskaddon*; Susan S. Bell

University of South Florida

Understanding how resource use varies with habitat quality is important for predicting the impacts of anthropogenic stressors on coastal systems, especially where trophic links may be altered. In Florida, *Armases cinereum*, is a crab that is highly abundant at the marine ecotone and may serve as an important indicator of trophic alteration. Three pairs of geographically separated populations of *Armases* in natural and anthropogenically-modified ecotones were investigated to determine whether absence of upland forest adjacent to mangrove fringe impacted trophic dynamics of *Armases*. Niche width (SEA), average trophic position (^{15}N), and diet ($\delta^{15}N/\delta^{13}C$ SIMMR) of the six populations were compared. Our results indicated that although niches of *Armases* varied widely between populations, *Armases* from modified ecotones were significantly more enriched in ^{15}N and had greater reliance on animal sources in reconstructed diets compared to populations in natural ecotones. Additional feeding experiments revealed that *Armases* preferred partially-decomposed black mangrove, *Avicennia germinans*, and *Iva frutescens* leaf material over other plant taxa, with greatest preference for animal prey. Although higher enrichment in modified habitats suggests greater *Armases* population success, observations reflected lower overall crab abundance and size in modified habitats. Habitat modification likely influences *Armases* feeding patterns which may impact broader trophic dynamics.

Presenter's Email: ekiskaddon@gmail.com

Physiological Evidence of Local Adaptation in the Massive Corals *Porites lobata* and *Goniastrea retiformis* from Ofu Island, American Samoa

Courtney N. Klepac*; Daniel J. Barshis

Old Dominion University

Corals native to variable thermal environments often resist bleaching temperatures and survive exposures that typically bleach conspecifics from cooler environments; providing promising evidence for the persistence of reefs under projected global climate change. This bleaching resistance is attributed to acclamatory or adaptive conditioning to brief, but frequent high water temperatures. Acclimatization plays an important role in modifying thermal thresholds and has been observed within 1 week and up to 2 years in *Acroporid* corals. However, it is not known how many species are capable of thermal acclimatization. This study transplanted populations of two massive corals, *Porites lobata* and *Goniastrea retiformis,* from three contrasting backreefs in Ofu Island, American Samoa, into a highly variable (HV) pool known to elicit increased bleaching tolerance. Following one week, six, and twelve months, transplanted and native coral nubbins were subject to a controlled thermal exposure. Physiological bleaching responses – zooxanthellae density, chlorophyll, and photosynthetic efficiency – were quantified to elucidate bleaching resistance. For both species, responses during and after heat stress were not indicative of thermal acclimatization gains following transplantation into the HV pool suggesting limited acclimation potential and evidence of local adaptation in the stress tolerance limits of these massive corals.

Presenter's Email: cklep001@odu.edu

Loss of surface complexity of biogenic reefs reduces potential larval encounter rates with habitat

Antony Knights[1*]; Patrick Joyce[1,2], Keri Collins[3]; Stuart Stripling[3]; Colin Whittaker[1,4]

[1]School of Biological and Marine Sciences, Plymouth University, UK; [2]School of Biological Sciences, Queen's University Belfast, UK; [3]School of Engineering, Plymouth University, UK; [4]Civil and Environmental Engineering, The University of Auckland, New Zealand

Biogenic reefs that are formed by a range of benthic organisms increase habitat heterogeneity and support greater species abundances and biodiversity than less complex habitats. Reef-forming species are often commercially valuable such that they are the target of human activities including fishing, which can lead to the damage or total loss of the physical structure of the reef. The physical structure (complexity) of a reef has been shown to alter boundary layer dynamics and alter the interaction of potential recruiting larvae with the substratum affecting recruitment and population persistence. Here, using state-of-art laser scanning technology to replicate biogenic reef habitat coupled with particle tracking velocimetry (PTV), differences in boundary layer features and their potential effects on larval recruitment between reefs of differing complexity were quantified. Near bed velocities were reduced by increased bed complexity leading to a higher probability of larval encounters (number and duration) with the reef surface. Results indicate that surface complexity enhances the likelihood of recruitment and that the complex 3-d structure of a reef is an important factor in promoting habitat resilience and recovery following disturbance.

Presenter's Email: antony.knights@plymouth.ac.uk

The role of carbonic anhydrase in regulating phytoplankton community structure in North Inlet, SC

Knotts, E. R.*[1]; Pinckney, J. L.[1,2]

[1]Department of Biological Sciences, University of South Carolina; [2]School of the Earth, Ocean and Environment, University of South Carolina

Carbon concentrating mechanisms (CCMs) are used by phytoplankton to concentrate dissolved inorganic carbon (DIC) within their cells for use in photosynthesis. However, mechanisms, such as the carbonic anhydrase enzyme (CA), are active, energy-consuming processes that may become redundant in the future due to increased concentrations of CO_2 in surface waters. Most of our knowledge of the CA enzyme is based on individual cultures or oligotrophic water samples. However, there are few studies that look at the mechanism's effects on estuarine phytoplankton communities or measured the *in situ* effects on community composition. Using bioassays of natural phytoplankton communities, our research explored how community composition is altered when the competitive advantage of the CA enzyme is reduced. This was accomplished using the CA inhibitor - ethoxyzolamide (EZ). Using discriminant analysis, communities are altered when the inhibitor is present. Additionally, these resulting communities are distinctly different in nutrient-replete versus nutrient-deplete conditions. Diatoms were the dominant taxonomic group in all of our samples; however, our results suggest a temporal effect on diatom growth in nutrient-deplete conditions. These shifts in community structure are indications that phytoplankton composition may change when the competitive advantage of the CA enzyme is removed by increasing ocean acidification.

Presenter's Email: eilea.knotts@gmail.com

Evidence of temporal linkage between settler density and gametic compatibility in a tunicate population

Kosman, E.T.[1]*; Levitan, D.[1]

[1]Florida State University

Gamete recognition proteins (GRPs) play an important role in mediating gametic compatibility. Intraspecific variation in GRPs is thought to be maintained by selection against polyspermy, as novel proteins that decrease compatibility have higher fertilization success in laboratory crosses when polyspermy is prevalent. While laboratory evidence supports this hypothesis, direct evidence linking fluctuations in population densities with fluctuations in allele frequencies is lacking. We tracked recruitment density as a proxy for gamete density every 5 weeks for 2 years in *Ciona intestinalis*, a hermaphroditic solitary tunicate. Fluctuations in egg and sperm GRP variants that have been shown to influence reproductive compatibility in laboratory crosses were examined in light of variation in recruitment density. We found that settler density experienced bi-yearly peaks and that the degree to which female GRPs deviated from expected homozygosity was positively correlated with density.

Additionally, the degree to which multilocus genotype frequencies deviated from HW expectations varied with density, indicating linkage-disequilibrium between male and female GRPs. The patterns observed matched predictions based on compatibility and sperm availability. Our results suggest assortative mating based on GRPs varies with sperm availability, offering further evidence that selection against compatible GRP genotypes may act to maintain genetic variation within populations.

Presenter's Email: etkosman@bio.fsu.edu

Confidence in connectivity: promoting indiscriminant harvest in a population sink?

Kough A.S.[1*]; Butler M.J. IV[2]

[1]Daniel P. Haerther Center for Conservation and Research, John G. Shedd Aquarium, Chicago, IL, USA; [2]Department of Biological Sciences, Old Dominion University, Norfolk, VA, USA

How confident are we in our science? Apparently enough to close off some areas to fishing, while imposing restrictions to fishing elsewhere in the interest of conserving species and sustaining fisheries. However, if we find strong evidence that an area is not contributing to population stability or replenishing the next generation, are we confident enough in our science and morally obligated to struggling fishers to advocate a "scorched-earth" policy in areas that we believe are population sinks? Should we embrace the use of "connectivity trade-offs" that open population sinks to heavy exploitation in exchange for closing population sources so as to craft a new, scientifically sound and economically friendly management policy? What might be the consequences of such policies on the larger ecosystem? Does such a dramatic plan first require a grand empirical test of these ideas? These questions are stimulated by our studies of Queen Conch and Spiny Lobster in the Caribbean in which source-sink dynamics are evident and fisheries are managed under a patchwork of regulations. We ask you to consider and debate how much evidence is needed to guide fishery management by connectivity science and the wisdom of doing so.

Presenting contact info: Andrew.kough@gmail.com

Social security and reduced immigration results in an unbalanced, aging population of Queen Conch

Kough A.S.[*1]; Cronin H.[2]; Skubel R.[3]; Belak C.A.[4]; Stoner A.W.[5]

[1]Daniel P. Haerther Center for Conservation and Research, John G. Shedd Aquarium, Chicago, IL, USA; [2]Foxboro, MA, USA; [3]Abess Center for Ecosystem Science, University of Miami, Miami, FL, USA; [4]California Department of Fish and Wildlife, Stockton, CA, USA; [5]Community Conch, Lopez Island, WA, USA

Marine Protected Areas (MPAs) are designed to conserve and preserve the species, ecosystems, and cultural resources of coastal and open oceans. In theory protected populations flourish, replenish adjacent regions, and are self-sustaining. However, larval dispersal can transcend boundaries and species with low rates of self-recruitment may not persist within a stand-alone MPA. We show that populations of the Queen Conch (*Lobatus gigas*) are sensescing in a well-established MPA, using 22 years of data on shell length, lip thickness, and aggregation distributions. Adult population densities declined and mean shell lip thickness, an estimator of age, significantly increased during repeated surveys in 1994, 2011, and 2016. While the Exuma Cays Land and Sea Park in the Bahamas is a well-enforced, old, and large MPA, it still may not be enough to save the Queen Conch, as the park population is slowly dying of old age. We hypothesize that population decline is due to a lack of larval retention within the park and a lack of exogenous larvae as potential source areas have been heavily harvested resulting in densities inadequate for conch reproduction. A network of MPAs encompassing the entire life cycle and dispersal envelope of targeted organisms is needed for proper conch-servation.

Presenter's Email: Andrew.kough@gmail.com

GHOSTS OF OYSTERS PAST? THE PUTATIVE SOURCE OF THE NORTHERN HEMISPHERE *GRACILARIA VERMICULOPHYLLA* INVASION HINTS AT *CRASSOSTREA GIGAS* EXPORTS

Stacy A. Krueger-Hadfield[1], Nicole Kollars[2], Benjamin A. Flanagan[3], Sarah Shainker[3], Allan E. Strand[3], James E. Byers[4], Ryuta Terada[5], Thomas Greig[6], Mareike Hammann[7], David Murray[3], Florian Weinberger[7], Erik E. Sotka[3]

[1] University of Alabama at Birmingham, [2] University of California, [3] College of Charleston, [4] University of Georgia, [5] Kagoshima University, [6] Center for Coastal Environmental Health and Biomolecular Research, [7] GEOMAR

The source and vector of introduced species inform its ecological and evolutionary history and may guide management policies. However, few studies exhaustively sample the native range and therefore cannot assign non-native populations to definite source regions. We used mitochondrial and microsatellite genotyping to trace the invasion of the seaweed *Gracilaria vermiculophylla* (Rhodophyta) throughout the Northern Hemisphere along the western and eastern coasts of North America and the coasts of Europe and northwest Africa. Analyzing 37 native and 53 introduced sites, we identified the Pacific coastline of northeastern Japan as the ultimate source of the invasion. Coincidentally, most exports of the oyster *Crassostrea gigas* historically originated from this region and both species often grow in close proximity. Based on genetic signatures, each of the three coastlines likely received thalli directly from Japan, as well as material from another introduced coastline (i.e., a secondary invasion). Our ability to document a source region, which was enabled by a robust sampling of locations and loci, reflected strong phylogeographic structure along native coastlines. We suggest *G. vermiculophylla* is an important representative of many species exported out of Japan by the oyster trade and its genetic signatures may be a hallmark of oyster introduction legacies.

Presenter's Email: sakh@uab.edu

Long-term effects of temperature on growth in blue crabs (*Callinectes sapidus*) and lesser blue crabs (*Callinectes similis*)

Kuhn, A. A.*; Darnell, M. Z.

School of Ocean Science and Technology, The University of Southern Mississippi

Temperature can exert strong effects on growth processes in ectotherms. For commercially harvested species, understanding these effects will become increasingly important for successful management and stock assessments in a changing climate. Previous laboratory and field experiments suggest that temperature affects both intermolt period (IMP) and growth per molt (GPM) in blue crabs. Field surveys suggest that blue crabs reach maturity at larger sizes in cooler areas, and at smaller sizes in warm areas. We investigated the effects of temperature on IMP and GPM in a laboratory experiment, using blue crabs *Callinectes sapidus* and lesser blue crabs *Callinectes similis*. Crabs were collected as megalopae and reared at two temperatures: ambient water temperature (at the collection site) and ambient + 5°C. In *C. similis*, results showed a significant effect of temperature on IMP, GPM, and size-at-stage, with crabs reaching larger sizes at each stage in the cooler treatment. Results for *C. sapidus* were not consistent, possibly due to seasonal effects as ambient water temperatures were much higher when *C. sapidus* were collected. Further experiments with both species will clarify interspecific differences. Decreased size at maturity at warmer temperatures could affect reproductive output and fishery production.

Presenter's Email: abigail.kuhn@usm.edu

Soft-vegetative and hard-bottomed biogenic habitats alter the foraging efficiency of predators in a species-dependent manner

Kulp, R. E.*; Peterson, B. J.

School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY

The size, foraging strategy, and morphology of predators may affect the way in which habitat type influences their foraging efficiency. Previous experiments have shown that the attack rate of the crustacean mesopredator *Dyspanopeus sayi* on *Mytilus edulis* is no different when foraging in soft-vegetative *Zostera marina* compared to unstructured habitat, but is diminished in hard-bottomed *Crepidula fornicata* shell hash habitat. We conducted a follow-up study to determine whether this habitat-linked change in attack rate is a species-specific effect or a feature generalizable to other small crustaceans. We looked for an effect of habitat-type when *Callinectes sapidus* and *D. sayi* foraged for *M. edulis* in unstructured, *Z. marina* or *C. fornicata* habitats. Since prey density could affect structure effects, *M. edulis* prey was either limiting or saturated. Additionally, we tested whether predator size alters the habitat-type effect; the same habitat and prey density treatments were used with a larger-sized *C. sapidus*. We found that habitat structure does not affect the total consumption rate of either the small or large *C. sapidus*. This indicates that the different habitat-type effects on *D. sayi*'s attack rate are species-dependent and not size-dependent.

Presenter's Email: Rebecca.Kulp@stonybrook.edu

Variable responses of Giant kelp (*Macrocystis pyrifera*) individuals and populations to warming

Kurman M.D.*; ter Horst C.P.

Department of Biology, California State University, Northridge

Foundation species create structure in a community, and understanding their evolutionary response to climate change is of utmost importance. *Macrocystis pyrifera,* giant kelp, is a significant foundation species, supporting a diverse ecosystem that contributes to recreational fisheries, tourism, and industry. *M. pyrifera* has shown decreased abundance in years with warmer-than-average temperatures, but no study has examined the variation of this response. This project aims to determine if individuals exhibit similar zoospore settlement and gametogenesis success in warming waters. I expected decreased settlement and success with increasing temperature, but variable responses both within and among populations. Fertile *M. pyrifera* sporophyll blades were collected at three distinct sites along the California coast (Los Angeles, Santa Barbara, Monterey), and zoospores were released in the lab. Spores were allowed to settle on microscope slides at three temperatures (16, 20, 22 ^{o}C), and mature for one month. Slides were imaged weekly, and all data was collected using image analysis. The response to temperature varied significantly both within and among sites. These results may indicate that some individuals are more resilient to warming waters than others, and therefore may help preserve future populations despite a changing climate.

Presenter's Email: melissa.kurman.819@my.csun.edu

The death assemblage as an indicator of habitat usage and climate change: Surfclams and ocean quahogs on Georges Bank

Eric N. Powell; Kelsey M. Kuykendall*; Paula Moreno

The University of Southern Mississippi Gulf Coast Research Laboratory

We utilize a comprehensive dataset for Georges Bank to assess the reliability of the death assemblage in tracking the living community and in recording changes in distributional patterns as a consequence of climate change at large spatial scales. Extensive datasets exist on the distribution of the living population and death assemblage for *Spisula solidissima* (SC) and *Arctica islandica* (OQ). For both species, the distribution of shells tracked the distribution of live animals closely and the presence of shells was an indicator of occupation at some point by live animals. Shell dispersion within habitat was greater for SC than OQ either due to spatial time averaging, animals not continuously occupying all habitable areas, or within-habitat shell redistribution. The regional shell distribution differed from the distribution of live animals, for both species, in a way indicative of range shifts due to warming of the northwest Atlantic. Present-day overlap of locations where live SC with very little or no shell and live OQ were found supports that SC are moving into deeper water in response to the recent warming trend.

The presence of OQ shells at shallower depths than live OQ offers evidence of a range shift before the initiation of routine surveys.

Presenter's Email: Kelsey.kuykendall@usm.edu

Temporal shifts in genetic composition and kinship of eastern oyster spat *Crassostrea virginica*

Claire E. Lack*; Stephanie J. Kamel

University of North Carolina Wilmington

The Eastern oyster, *Crassostrea virginica,* is an ecologically and economically important species and provides a multitude of ecosystem services. Successful management of this species depends critically on knowledge about population connectivity and larval dispersal. Previous research using molecular markers found that reef patches within tidal creeks in North Carolina contained localized kin aggregations. Here I investigate the underlying process generating this pattern by characterizing the genetic composition of newly settled spat over the course of the reproductive season. Spat were collected at five time points in two tidal creeks in NC, for a total of 916 individuals genotyped at 22 neutral microsatellite loci. Our results support many other recent findings of kin aggregation of larvae despite moderately long pelagic larval duration (PLD) and physical oceanographic processes. Percentage of loci in linkage disequilibrium shifted over time, ranging from 1.7 to 92.2%, suggesting that related aggregations settle together. Results from kinship analysis support this pattern, with significantly higher kinship found within settled cohorts than among them. This provides further evidence of larval cohesion during the pelagic dispersal phase with important implications for the spatial management of this species.

Presenter's Email: cer6562@uncw.edu

Seasonal recruitment of epibenthic organisms on the hard bottom at Five Mile Ledge in Onslow Bay, North Carolina

Melissa LaCroce[1*]; Zachary Long[2]; D. Wilson Freshwater[1]

[1]Center for Marine Science, University of North Carolina Wilmington; [2]Biology and Marine Biology, University of North Carolina Wilmington

Natural and unnatural disturbance events change benthic marine habitats by dislodging and smothering sessile species. The increasing frequency and magnitude of storm events, intensity of grazing activity, and anthropogenic sand displacement projects will affect epibenthic marine communities, like those of the hard bottom ledges in Onslow Bay, NC. When a disturbance occurs, epibenthic species are removed and substrate is exposed or excess sand covers existing life suppressing its development. This combined with the warming waters of the eastern North Atlantic creates an opportunity for species previously found at different sites and depths, and non-native benthic organisms to colonize the exposed area. Onslow Bay's unique geographical location makes it the northern and southern limit for many marine organisms. Therefore, the composition and dynamics of this epibenthic community could be a proxy for the future structure of more northern marine habitats along the East coast as water temperatures rise. This study's objective is to determine the seasonal dynamics and spatial scales of epibenthic species recruitment on North Carolina hard bottoms. Seasonal collections and photos of control and seasonally cleared quadrats from three replicate sites within a nearshore hard bottom ledge system in Onslow Bay, NC, are being analyzed.

Presenter's Email: mel8007@uncw.edu

BEM-SEERS 2017 Oral Presentation Abstracts

Recruitment and survival of congeneric octocoral species in The Bahamas: it depends.

Lasker, H.R.*[1,2]

[1] Department of Geology, University at Buffalo, State University of New York; [2] Graduate Program in Evolution, Ecology and Behavior, University at Buffalo, State University of New York

Settlement and survival of *Antillogorgia* spp. was followed at 6 sites on the Little Bahamas Bank over 4 years. At each site 60 100 x 25 cm areas were monitored and recruits collected from a third of the areas at 1-2, 7-8, or 13-14 months after Nov./Dec. spawning events. Recruits, many of which were single polyps, were identified to species using microsatellites. *Antillogorgia acerosa, A. americana,* and *A. rigida* had markedly lower initial recruitment rates than *A. bipinnata, A. elisabethae* and *A. hystrix.* That pattern is consistent with the species' reproductive modes. *A. americana* broadcast spawns. *A. bipinnata,* and *A. elisabethae* surface brood. *A. hystrix* broods its larvae. Survivorship was estimated from changes in the number of recruits collected in the different months. Sufficient recruits of *A. bipinnata, A. elisabethae* and *A. hystrix* were collected to allow comparisons between sites, years and species, all of which affected recruitment. Survival also varied between species and sites and did not match abundances of established colonies.

Presenter's Email: hlasker@buffalo.edu

Importance of benthic algae in the functioning of coastal food webs. Evidences from stable isotope and fatty acid analyses.

Lebreton, Benoit*[1]; Beseres Pollack, Jennifer[2]; Haraldsson, Matilda[1]; Montagna, Paul[3]; Guillou, Gaël[1]; Palmer, Terry[2,3]; Blomberg, Brittany[3]; Wang, Yujue[4]; Gräfe, Claudia[4]; Han, Qingxi[4]; Liu, Dongyan[4]; Asmus, Harald[5]; Asmus, Ragnhild[5]

UMR Littoral, Environment et Societies, CNRS - University of La Rochelle, France; [2]Departent of Life Sciences, Texas A&M University – Corpus Christi, USA; [3] Harte Research Institute for Gulf of Mexico Studies, Texas A&M University – Corpus Christi, USA; [4]Yantai Institute of Coastal Zone Research, Chinese Academy of Science, P.R.China; [5]Alfred-Wegener-Institut Helmholtz-Zentrum für Polar und Meeresforschung, Wattenmeerstation Sylt, Germany

Benthic microalgae have been identified as a very important food source fueling coastal food webs in European bare mudflats. Aim of this presentation is to demonstrate that the important role of benthic microalgae is not only limited to European bare mudflats. We studied several food webs around the world, in United-States, France, Germany and China, focusing on different coastal habitats, with different tidal characteristics (i.e., intertidal and subtidal) and fueled by very different food sources, from systems dominated by high production of vascular plants (i.e., salt marshes, seagrass beds) to bare habitats (muflats, sandflats) and oyster reefs. The trophodynamics in these habitats were studied using trophic markers (stable isotopes, fatty acids) and theoretical modelling. In most of these habitats, we observed that benthic microalgae have an important role in the functioning of food webs. Aim of this presentation is thus to suggest that researchers should take benthic microalgae into account when assessing the functioning of coastal ecosystems, even if the role of microalgae is difficult to assess due to their microscopical size.

Presenter's Email: benoit.lebreton@univ-lr.fr

Habitat structure and fish foraging: effects of eelgrass epibionts

Ledbetter, J.F.*; Hovel, K.A.

Coastal and Marine Institute, San Diego State University

Seagrass beds provide important habitat structure for juvenile fish and seagrass structural complexity can have significant impacts on the predator-prey relationships of the organisms that utilize this habitat. Seagrass structural complexity previously has been quantified using metrics of shoot density, biomass, or shoot length and width. However, seagrasses serve as substratum for a variety of attached organisms, and the presence of these epibionts can fundamentally change structural complexity. In San Diego Bay, California, the bryozoan *Thalamoporella californica* is a common epibionts of eelgrass (*Zostera marina*) and creates a complex branching structure attached to eelgrass blades. We conducted lab and field experiment to determine how varying amounts of eelgrass and bryozoan structure affect juvenile giant kelpfish (*Heterostichus rostratus*) foraging behavior and the mortality of their prey, the grass shrimp (*Hippolyte californiensis*). Animal behaviors were recorded as the number of prey detections, attacks, successes, and prey escapes observed in 30-minute trials. We observed a decrease in attacks but an increase in capture success with increasing structure, which combined resulted in an overall decrease in foraging ability. Assessing habitat structure in a new way can reveal different effects of structure on important ecological processes.

Presenter's Email: julia.f.ledbetter@gmail.com

Multi-stressors impacts of climate change on shellfish: implications for reef functioning and species management

Anaëlle J. Lemasson*[1,2]; Stephen Fletcher[2,3]; Jason M Hall-Spencer[1]; Antony M. Knights[1]

[1]Marine Biology and Ecology Research Centre, Plymouth University**;** [2]Centre for Marine and Coastal Policy Research Plymouth University; [3]UNEP World Conservation Monitoring Centre

Oyster reefs provide numerous ecosystem services (ES) of societal importance, such as food provision and improvement of water quality, but these are reliant on healthy, resilient and functioning reefs. A key sustainability challenge is understanding how climate change will impact on reef functioning and the continued provision of oyster-related ESs. In a comparative study of native (*Ostrea edulis*) and invasive (*Crassostrea gigas*) oyster species, we assessed how ocean acidification and warming (OAW) scenarios affect key physiological processes (i.e. metabolic rate, feeding rate, condition, and energy allocation). Our findings indicate that OAW conditions predicted for 2050 and 2100 will have differing impacts on both species. Importantly and contrary to expectations, the invasive *C. gigas* experienced a higher level of stress and reduced feeding abilities compared to the native *O. edulis*. This was reflected by a decreased condition index and a reallocation of energetic resources. Given the industry shift toward *C. gigas* due to faster growth, disease resilience, and increasing geographic distribution under current environmental condition, the negative effects of OWA on this species are predicted to have significant ecosystem functioning implications, coupled with a loss of ecosystem services including reduced water quality and food biosecurity in the future.

Presenter's Email: anaelle.lemasson@plymouth.ac.uk

Can Plastic Die? Use of live and 3D printed models to study responses of fiddler crabs to heat stress.

Jeffrey S. Levinton* and Yoshiaki Higashide

Stony Brook University, Department of Ecology and Evolution, Stony Brook NY USA 11794-5245

Fiddler crabs live under thermal stress when on the surface at low tide for most of a hot day. We are interested in understanding how they respond to stress and how such responses influence and even reduce opportunities for mating. Recent past work on the sand fiddler *Uca pugilator* shows that experimental shading in the field reduces stress and allows increased mating activity out of refuge burrows. We have also shown with laboratory experiments differential thermal performance as a function of size. We have hypothesized therefore that small sized males may avoid heated high intertidal sites because of physiological limitation and not just failure to compete with larger males in male-male contests. We here show that small males succumb to heat stress before larger ones and that heat seems to accumulate in the body at a higher rate than in the major claw. The use of 3D

scanned and printed plastic models allows testing hypotheses of heat gain as a function of size. Thermal imaging preliminary studies shows faster heat gain and likely dissipation through the claw. We compare response of living crabs and plastic models to investigate the strengths and limitations of using plastic 3D prints in the field.

Presenter's Email: jeffrey.levinton@stonybrook.edu

Do sperm compete and do eggs ever have a choice: How does adult density and gamete mixing influence selection in the sea?

Levitan, D.R.

Department of Biological Science, Florida State University

In many taxa sperm and eggs are released into the environment and their interactions mediate reproductive success. Although multiple paternity is rampant, it is unknown if sperm directly compete for the fertilization of individual eggs. The distinction between direct and indirect competition for fertilizations is critical for whether males and females have aligned interests or are in sexual conflict. I examined the prevalence of direct vs indirect competition for eggs over a range of spawning conditions in the sea urchin *Strongylocentrotus franciscanus* and find that under symmetrically crowded conditions sperm can directly compete for fertilizations, but with increasing asymmetries in the distribution of individuals, indirect competition is more prominent. Conditions of abundant sperm indirectly competing for fertilizations can lead to more rapid evolution of reproductive incompatibility, but less effective reproductive isolation via conspecific sperm precedence.

Presenter's Email: levitan@bio.fsu.edu

Plasticity of the symbiosis between the marine bryozoan *Bugula neritina* and its defensive bacterial symbiont

Lim-Fong, G.*[1]; Miller, H.[1]; Locklear, S.[2], Lopanik, N.[2,3]

[1]Department of Biology, Randolph-Macon College; [2]School of Biological Sciences, Georgia Institute of Technology; [3]School of Earth and Atmospheric Sciences, Georgia Institute of Technology

The variation of abiotic and biotic selection pressures across a wide biogeographical range could result in a plastic response in a symbiosis that is predicated on symbiotically-mediated defense. A previous small-scale haphazard sampling survey of the bryozoan *Bugula neritina* revealed that symbiosis with a vertically transmitted defensive bacterium was more frequent at lower latitudes than at higher latitudes. This gradient of symbiosis could possibly be explained by biotic factors, such as predation pressure on host larvae, and/or abiotic parameters, such as temperature. In this study, we conducted a systematic survey of the sessile invertebrate community of floating docks commonly inhabited by *B. neritina* and assessed the frequency of symbiosis in *B. neritina* across ~9^{o} of latitude. We found that potential predators of host larvae, such as hydroids and anemones, were differentially distributed across the *B. neritina* range. We also found that symbiotic frequency was significantly correlated with latitude and salinity but not temperature. Preliminary transplant experiments suggest that symbiont growth is either inhibited at higher latitudes or enhanced at lower latitudes. Taken together, these findings suggest that both biotic (predation) and abiotic (salinity) factors can shape a symbiotic partnership that span a wide biogeographic range.

Presenter's Email: glim@rmc.edu

Unintended catch: the rate and reason for discards in the Louisiana blue crab fishery

Lively, J.*

School of Renewable Natural Resources, Louisiana State University Agricultural Center

While bycatch is often studied in a fishery, discards can also have a significant impact on a population. In Louisiana, the blue crab (*Callinectes sapidus*) commercial fishery lands approximately 19,000 metric tons annually in traps. Escape rings are designed to limit undersize discards and bycatch, but discards still result due to economic and legal forces. In Louisiana, discards of blue crabs often result due to size, maturity, ovigerous state, injury, and disease. The rate and reason for discards were investigated across seasons and locations using fishery dependent and independent sampling. In fishery independent sampling, sublegal and ovigerous were the most common reasons for an individual to be discarded with rates (percentage of landed catch) of 4.5% to 106.3% (sublegal) and 0% to 65.9% (ovigerous). Injury or disease was always less than 5%. Fishery dependent sampling was only able to measure discard rate, regardless of reason. The average rate of discards across season and location was 38% of landed catch with a max of 300%. The mortality rates of discards are unknown, but lethal and sublethal effects, such as disease transmission, could have an impact on the crab population.

Presenter's Email: janderson@agcenter.lsu.edu

Seasonal and spatial structure of hardbottom benthic communities

Zachary Long*; Jennifer Idol; Wilson Freshwater

University of North Carolina Wilmington

Community assembly can affect species coexistence through mechanisms that range from stochastic processes (e.g., demographic variability, dispersal) through deterministic interactions. In this study, we investigated how offshore benthic hardbottom communities varied among five different sites along a depth gradient (15-40m) and through time (2 years) in Onslow Bay, North Carolina, to determine how stochastic and deterministic processes affected the seasonal development of the community. We found that all five sites converged on a similar composition in winter and diverged during the growing season. Community composition was determined primarily by deterministic interactions. Our results suggest that there are constraints on community membership within this area especially caused by depth and distance from shore / proximity to the Gulf Stream and composition is not random. The differences between the community composition of the sites we observed may be maintained by limited dispersal among the hardbottom habitat islands.

Presenter's Email: longz@uncw.edu

Modulating pCO_2 *in situ*: A novel approach for a complex world

Lowell, A.V.*[1] Peterson, B.J.[1]

[1]School of Marine and Atmospheric Sciences, Stony Brook University

Anthropogenic CO_2 has concentrated in the Earth's atmosphere to an astounding 400 ppm with the world's oceans absorbing over 25% of CO_2 emissions. The IPCC predicts a corresponding decrease in pH ranging from 0.06 to 0.32 units by 2100. The Free Ocean Carbon Enrichment (FOCE) experimental system has been designed and optimized by a team of scientists to precisely alter ambient pH to projected IPCC standards *in situ* over an extended period of time (weeks to months). FOCE systems are partially open to the environment incorporating local conditions like light, turbidity, sediment, bacterial and planktonic communities. The power of this method is in its ability to investigate trophic interactions of multispecies assemblages within intact communities, and, thus, provide realistic data for ecologists to model future scenarios. The method itself can be logistically complicated,

but is being optimized to ensure greater workability and instrumentation for temperature and dissolved oxygen manipulation. The remaining question is: where do you want to take FOCE?

Presenter's Email: Alyson.lowell@stonybrook.edu

Salinity or Sediment: Which problem defines the health of the St. Lucie Estuary?

Jessica Lunt[1,*]; Michelle Stephens[1]; Katrina Bayliss[1]; Sherry Reed[1]

[1]Smithsonian Marine Station at Fort Pierce

The St. Lucie Estuary, FL experiences periodic freshwater releases primarily through the C44 canal as part of the mitigation of water levels for Lake Okeechobee and the agricultural lands of central Florida. The RECOVER science program was initiated to monitor the affected ecosystems and determine their recovery as water inflow patterns change. The Smithsonian Marine Station Benthic Ecology monitors the benthic infaunal communities of the St Lucie Estuary. A transect study to examine the dependence of sample composition on sediment characteristics revealed that sediment type sampled was the predominant factor in the health of a sample. Transects were sampled with a petite Ponar grab and Ogeechee corer along a depth gradient between 0.5m and 2.5m at low tide. Salinity and sediment type were both factors in the community composition of infauna in samples, but overall diversity was determined by sediment type. "Muck" sediments prevent community development, with very few individuals present in these samples. Muck is generally found throughout the center channel of the estuary and is thought to develop as a result of freshwater discharges.

Presenter's Email: luntj@si.edu

Assessing links between genomic and environmental variation in a population of bivalves from the Gulf of Maine

Luzzio, A.[1,2]*; Ozmon, I.[2]; Dobbs, K.[2]; Eckert, S.[2]; Norton, E.[2]; Nixon, M.[2]; Carlon, D.[1]; Kingston, S.[1]

[1]Bowdoin College, Department of Biology and Coastal Studies Center; [2]Maine Coastal Mapping Initiative, Department of Agriculture, Conservation and Forestry

Bivalves are integral members of the benthic community in both estuarine and oceanic environments. Changes in water quality and chemistry can impact population health, in particular, because these bivalves are marine calcifiers. In the Gulf of Maine, bivalves are important fisheries (both wild and aquacultured) and assessing the impacts of the effect water quality has on bivalve populations is imperative. In coastal Maine, bivalves were sampled from Boothbay Harbor to the Kennebec River region using a grab sampler; a water quality sonde was used to assess spatial variation in water quality. Linear models were applied to determine correlations between environmental variables (salinity, pH, temperature, and dissolved oxygen) and bivalve abundance; the abundant species are *Nucula proxima* and *Arctica islandica.* Further, a Next Generation Sequencing assay was applied across *N. proxima* populations to investigate correlations between highly multilocus genotype and environmental parameters. This powerful genome survey will help to assess the impact variation in water quality has on the population composition of these bivalves.

Presenter's Email: aluzzio@bowdoin.edu

Do Soundscape Characteristics Reflect Fish Biodiversity and Habitat Complexity in Concrete Block Artificial Reefs?

Lyon, R.P.*[1]; Eggleston, D.B.[1]; Bohnenstiehl, D.R.[1]; Layman, C.A.[2]

[1]Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University; [2]Department of Applied Ecology, North Carolina State University

Coral reef degradation and destruction has led to restoration efforts to mitigate impacts on habitat and ecosystem services. An artificial reef may replace destroyed habitat and provide some substitute for coral reef function. Traditional methods to assess the success of artificial reef projects, such as visual fish surveys, fall short in describing communities over long temporal scales or at night. Passive acoustic monitoring of underwater sounds may serve as a useful tool for monitoring artificial reef habitats because recordings can be taken continuously over long periods of time with limited effort. The goal of this study was to quantify relationships between acoustic metrics and measures of habitat complexity, fish biodiversity, and environmental variables on concrete block reefs in a shallow, seagrass-dominated embayment. Seven passive recorders were deployed from February through August 2016 at sites in the Bight of Old Robinson, Abaco Island, the Bahamas. Initial analysis indicates no correlations between acoustic metrics and the size and structure of these sites. Although fish biodiversity increased during the deployment period, correlations with acoustic metrics remain elusive. This study is among the first to evaluate passive acoustic monitoring as a tool for estimating restoration success of concrete block artificial reefs.

Presenter's Email: rplyon@ncsu.edu

Gut content of *Fundulus heteroclitus* as a measure of restored marsh maturation

Madison Lytle*; Martin Posey; Troy Alphin

[1]Department of Biology and Marine Biology, University of North Carolina Wilmington; [2]Center for Marine Science, University of North Carolina Wilmington; [3]Department of Biology and Marine Biology, University of North Carolina Wilmington

Coastal development impacts estuarine environments, through marsh erosion, eutrophication, and direct exploitation of resources and fisheries (Levin et al. 2001 and Lotze 2006). Efforts to restore lost marsh habitat have yielded mixed results relative to restoration success. The Poplar Island Environmental Restoration Project (PIERP), located in mid-Chesapeake Bay, is a large scale restoration project designed to replace ~1700 acres of eroded marsh habitat. This project was designed in stages so that each marsh incorporates lessons learned from the previous restoration. This project focuses on evaluating marsh functionality among sites of different ages, using the critical marsh resident species *Fundulus heteroclitus*. Marsh sites were evaluated by comparing the health and diet (prey richness, total abundance, diversity and dominance) of *F. heteroclitus* among sites during two sampling seasons, spring and summer of 2014. During the summer *F. heteroclitus* at the youngest site (2yr) had a significantly lower health indices and gut volume at the 2year marsh. Prey diversity was also lower in the 2yr old marsh compared to the 5yr old and reference marshes. These findings suggest that while the fish will continue to forage, prey quality may play a significant role when determining success of restored marshes.

Presenter's Email: mal6582@uncw.edu

Spatial and temporal trends in populations of the green porcelain crab, *Petrolisthes armatus* within the species' northernmost invaded range

Mack, K.*[1]; Shervette, V.[2]; Fowler, A.[3] ; Podolsky, R.D.[1] ; Wilber, D.[1]

[1]Graduate Program in Marine Biology, College of Charleston; [2]Department of Biology and Geology, University of South Carolina; [3]Department of Environmental Science and Policy, George Mason University

The green porcelain crab, *Petrolisthes armatus* is an anomuran native to intertidal waters south of the Indian River, FL. It was recorded in Charleston, SC, in the mid 1990's and has since established invasive populations as far north as Wilmington, NC. The crab occurs in aggregations of up to 11,000 m^{-2} in GA, with densities decreasing with increasing latitude. The poleward extent of the species' range appears limited by cold temperature

tolerance, and winter cold snap events have drastically reduced population densities. I examined seasonal trends in population densities, sex ratios, and size distributions at five locations from Savannah, GA, to Wilmington, NC. *Petrolisthes armatus* densities were highest in the summer (maximum >9,000 adult crabs m^{-2}) and decreased from southern to northern locations. The species consistently occurred in all seasons as far north as Baruch, SC, and occurred in Wilmington, NC, but not in the winter. Sex ratios varied seasonally; becoming male biased in the fall, suggesting a decline in females following the reproductive season. Additionally, high *P. armatus* abundance was associated with lowered abundance, but larger size in the native crab, *Panopeus herbstii*, indicating that the invaders may influence at least one resident crab species' population structure.

Presenter's Email: mackk1@g.cofc.edu

Monogamy and sexual dimorphism in the shrimp *Periclemenes rathbunae*, living in symbiosis with the sun sea anemone *Stychodactyla helianthus*

Major*[1], Rami. M; Baeza[1], J. Antonio

[1]Department of Biological Sciences, Clemson University

Symbiotic relationships are common in the marine environment, but little is known about the social behavior of symbiotic species. Frequently, symbiotic species have been found living in pairs monogamously. This idea was tested in *Periclemenes rathbunae*, a shrimp species living on the sun sea anemone *Stychodactyla helianthus* collected from three sites in the Mesoamerican Coral Reef track, Belize. Of the 62 anemones found with shrimps, 48.39% contained shrimps living in pairs. Only two pairs of shrimp occupying the same anemone were of the same sex. 71.43% of the females living in heterosexual pairs were brooding. Additional observations indicated reverse sexual dimorphism; females were, on average, larger than males. However, in males, the major cheliped growth was positively allometric with respect to body size, while it was negatively allometric in females, indicating that cheliped size increases with carapace length until both sexes reach a larger size, where males are always bigger than females. Second pleuron length was negatively allometric for both sexes, showing that it increases with carapace length, but has a more dramatic effect at smaller sizes, with females having a longer pleuron length than males. This data indicates that *P. Rathbunae* is a monogamous species.

Presenter's Email: ramim@g.clemson.edu

Secrets of constructed wetlands and detention ponds - Revelations

Michael A. Mallin[1]*; Jade M. Burtchett[1]; Bongkeun Song[2]

[1]University of North Carolina Wilmington, Center for Marine Sciences, Wilmington, N.C. 28409; [2]Department of Biological Sciences, Virginia Institute of Marine Science, College of William & Mary, Gloucester Point, VA 23062

Nutrients and fecal microbes are the major pollutants from stormwater runoff in the coastal zone. To protect waterways, wet detention ponds are the most common form of aquatic best management practice (BMP), but an increasing number of constructed wetlands are coming on line. Planted aquatic macrophyte vegetation is a key to improving the control of both nutrients and fecal microbial pollution. Macrophyte vegetation absorbs some amount of nitrogen and phosphorus into its tissues, but a primary mechanism for moving nitrogen out of the system is denitrification, and its related process ANAMMOX. Experiments have demonstrated that rates of denitrification and ANAMMOX differ significantly among individual macrophyte species. Regarding fecal bacteria, recent research has demonstrated that a considerable amount of fecal bacteria are removed through grazing by microzooplankton, primarily colorless or myxotrophic flagellates, ciliates, and amoebae. The vast amount of such grazing occurs by micro-zooplankton <20 Âµm in size. This was determined by using two different types of experiments, conducted in a constructed wetland and a wet detention pond, and within and outside of plant beds, with results indicating both greater grazing and higher amounts of microzooplankton among macrophytes than in open water.

Presenter's Email: mallinm@uncw.edu

Differential effects of wounding and ocean acidification on tropical crustose coralline algae

Manning, J.C.*[1] and Carpenter, R.C.[1]

[1]California State University, Northridge

Ocean acidification (OA) is expected to negatively affect a number of calcifying marine organisms, including crustose coralline algae (CCA) that are important to coral reef communities. In this study, I tested the combined effects of OA and wounding on net calcification rates of two tropical CCA (*Porolithon onkodes* and *Lithophyllum insipidum*) using a regression design with four pCO_2 levels (~400, 700, 1000, and 1300 µatm). To mimic parrotfish grazing, half of the samples in each pCO_2 treatment were grazed artificially to a depth of ~300 µm. Net calcification was measured using the buoyant weight technique after 29 days and normalized to the initial planar surface area of each individual. Vertical regeneration within the wounds also was quantified for *P. onkodes* using scanning electron microscopy. Net calcification in *P. onkodes* decreased with increasing pCO_2, while there was no significant effect on *L. insipidum*. However, wounding significantly affected net calcification in *L. insipidum*. The rate of vertical regeneration within the wounds of *P. onkodes* was significantly reduced by elevated pCO_2. The species-specific responses to OA, and the effect of OA on wound regeneration found here could have implications for the ecologically important roles they play on coral reefs.

Presenter's Email: joshua.manning.43@my.csun.edu

Palatability of variably defended Caribbean sponge species is unrelated to predator abundance

Marty, Micah J.*; Blum, James; Pawlik, Joseph R.

Center for Marine Science, University of North Carolina Wilmington

The antipredatory chemical ecology of Caribbean reef sponges has been well studied, with two distinct ecological strategies described: defended species use secondary metabolites to deter predators, while undefended species lack chemical defenses, but grow, reproduce, or recruit fast enough to persist despite predation. While most palatable sponge species are consistently undefended from fish predators in laboratory feeding assays, a few species exhibit inter- and intra-site variation ranging from undefended to defended. We set out to test the dual hypotheses that variably defended sponges from reefs without sponge predators would be (1) more palatable, and (2) exhibit greater variability in chemical defenses than the same species from reefs where predators are abundant. Laboratory feeding assays using the bluehead wrasse confirmed intraspecific variability of chemical defenses for the seven sponge species examined. Surprisingly, logistic regression models relating levels of sponge chemical defense to a site-specific index of spongivorous fish abundance offered little support for the hypothesis that predator abundance alters palatability for these variably defended sponge species. While the selective effect of predation has segregated most species of Caribbean reef sponges into chemically defended and undefended categories, our results indicate that the situation is more complex for variably defended sponge species.

Presenter's Email: martym@uncw.edu

Underwater forests restoration: 'Operation crayweed'

Marzinelli, E. M.*[1,2]; Campbell, A. H.[1]; Vergés, A.[1]; Coleman, M. A.[3]; Steinberg, P. D.[1,2]

[1]Centre for Marine Bio-Innovation, School of BEES, University of New South Wales, Australia; [2]Singapore Centre for Environmental Life Sciences Engineering, Nanyang Technological University; [3]Department of Primary Industries, NSW Fisheries, Australia

Seaweeds are important habitat-forming organisms that support diverse communities and underpin a wide range of ecosystem functions and services in temperate coastlines around the world. Key species of seaweeds are, however, declining in many places around the world. While conservation in a preventative sense is a partial solution to the challenge of habitat degradation, the status of many of the world's ecosystems clearly demonstrates that it is not sufficient by itself. We use the seaweed *Phyllospora comosa*, or "crayweed", which disappeared from the Sydney coastline in the early 1980's, as an example of the potential of marine habitat restoration. We have been doing research on the ecological restoration of this species for the past 5 years and we have shown that the conditions in Sydney are now suitable for the re-establishment of crayweed populations and its associated biodiversity. Restored sites resemble reference sites with regards to multiple components of biodiversity. We have now scaled-up and initiated restoration of this crucial habitat at the scale of the degradation – which is rarely done in marine systems. Most importantly, we believe that this is a great project to involve the general public and enhance people awareness of important issues affecting their "backyard".

Presenter's Email: e.marzinelli@unsw.edu.au

Predation risk affects intraspecific competition at intermediate and basal trophic levels

Matassa, C. M.*[,1]; Ewanchuk, P. J.[2]; Trussell, G. C.[1]

[1]Marine Science Center, Northeastern University; [2]Department of Biology, Providence College

Predation can influence competition among prey through consumptive and nonconsumptive pathways. By consuming prey, predators reduce the density of competing individuals and increase the relative availability of limiting resources. Nonconsumptive predator effects on prey traits, such as feeding activity, can also reduce competition among prey by weakening the strength of prey-resource interactions. Using a 3-level rocky intertidal food chain, we examined the effects of a top predator (the green crab, *Carcinus maenas*) on intraspecific competition at intermediate (the dogwhelk, *Nucella lapillus*) and basal (acorn barnacles, *Semibalanus balanoides*) trophic levels. Green crab predation risk reduced intraspecific competition among *Nucella* and enhanced intraspecific competition among barnacles by reducing *Nucella* per capita foraging rates. Increased barnacle density did not reduce intraspecific competition among *Nucella* but enhanced intraspecific competition among barnacles, which developed hummocking morphologies as competition for space increased. The formation of barnacle hummocks increased as the cumulative foraging impact of *Nucella* decreased, due to reductions in *Nucella* density and/or per capita foraging rates. Our results indicate that top predators can have indirect effects on both the abundance and morphology of basal resources. The consequences of these interactions for rocky shore community dynamics will likely depend on environmental context.

Presenter's Email: c.matassa@northeastern.edu

Patterns of phytoplankton biomass in a manipulated estuary with an uncertain future

A. Loren Mathews[1]*; Risa Cohen[1]; Jessica M. Reichmuth[2]

[1]Georgia Southern University; [2]Augusta University

Eight artificial cuts were made through the marshlands of the Satilla River Estuary, Georgia (USA) in the early 1900s to improve navigation and facilitate timber transport, although they are no longer maintained for their original purposes. Of these, Noyes Cut has been identified as the likely cause of increased sedimentation, disturbed salinity gradients, and decreased water quality in the Dover-Umbrella-Parsons Creek system that it connects to the Satilla River. These hydrological and physical-chemical changes likely influence the abundance and distribution of phytoplankton, which serve as an important food source for commercially and recreationally valued fish, crabs, and shrimp. The goal of this study was to identify spatial and temporal patterns in phytoplankton abundance (as chlorophyll a concentration) at sites impacted by the artificial cuts and compare them to an unimpacted reference site. Monthly integrated water samples have been collected and analyzed

fluorometrically since June 2014. Preliminary data indicate that phytoplankton abundance is higher on average in the summer and fall with the largest peaks occurring at different sites in different years. This study is part of a collaborative holistic assessment of the ecological effects of Noyes Cut, which is being considered for closure and restoration by state and federal agencies.

Presenter's Email: amathews@georgiasouthern.edu

Can living shorelines work well in high wave intensity estuaries?

Jennifer H. Mattei[1]*; Chris A. Hauser[2]; LaTina Steele[1]; Jo-Marie Kasinak[1]

[1]Biology Department, Sacred Heart University; [2]Virginia Institute of Marine Science

Global climate change, coastal habitat degradation, and coastal erosion by human development ultimately result in a decline in estuarine ecosystem services. One example of this has occurred in Stratford, Connecticut. Historically, Stratford Point supported a large tidal marsh and a mosaic of upland coastal habitats. Over the past century, the site has been subject to substantial habitat alteration. The freshwater wetlands were filled; the upland bluff cut back, heavy metals deposited across the site, and marsh and upland vegetation removed during remediation. Since 2001, the shoreline has moved inland by 24m and dropped by 1m. We are investigating different methods of wave abatement to arrest the erosive forces and allow for sediment deposition. In 2014, a 49m living shoreline pilot project was constructed in the intertidal zone to abate erosion. The living shoreline consists of an artificial reef constructed with concrete reef balls, and planted saltmarsh grasses. Over 30 cm. of sediment accumulated behind the reef and within the growing saltmarsh. Wave attenuation was 30% and benthic biodiversity increased. In 2016, the living shoreline was expanded across an additional 228m along the Housatonic River shoreline leading into Long Island Sound. Future plans will be discussed.

Presenter's Email: matteij@sacredheart.edu

Effects of intertidal exposure on ingestion rate and energy assimilation of the intertidal bivalve *Mytilus edulis*

Matzelle, A.*, Helmuth, B.

Department of Marine and Environmental Sciences, Northeastern University

Mussels living in intertidal zones are exposed to large fluctuations in environmental conditions along wave exposure gradients. Frequent exposure to the terrestrial environment limits their access to food and oxygenated water, and exposes them to conditions that often cause thermal stress. Thus, the growth and survival of organisms living in intertidal zones is dependent on their ability to pay increased maintenance costs, theoretically including those for anaerobic respiration and the repair of damaged proteins from heat stress. Indeed, the net energy available to intertidal organisms depends on the amount of food available in their environment and how efficiently they ingest and assimilate energy from food. To investigate whether intertidal mussels have different energy acquisition and processing strategies than subtidal conspecifics, we quantified ingestion rates and assimilation efficiencies of *M. edulis* acclimated to intertidal and subtidal conditions in the lab. Mussels acclimated to intertidal conditions had lower clearance and ingestion rates when compared with those acclimated to subtidal conditions. However, intertidally acclimated mussels had higher assimilation efficiencies than the subtidally acclimated treatment. Our results indicate that intertidal mussels compensate for bioenergetic stressors by exhibiting yield-maximization acquisition strategies (lower ingestion and higher assimilation), potentially to increase or maintain the total energy budget.

Presenter's Email: matzelle.a@husky.neu.edu

Can we increase services provided by coastal infrastructure with eco-engineering?

Mayer-Pinto, M*[1,2]; Bugnot, A[1,2]; Potts, J[3]; Ushiama, S[1]; Scanes, P[3]; Strain, E[2]; Glasby, T[4]; Airoldi, L[5]; Johnston, E[1]; Dafforn, K[1,2]

[1]Evolution and Ecology Research Centre, School of Biological, Earth and Environmental Sciences, University of New South Wales; [2]Sydney Institute of Marine Sciences; [3]NSW Office of Environment and Heritage; [4]NSW Department of Primary Industries, Port Stephens Fisheries Institute; [5]Dipartimento di Scienze Biologiche, Geologiche e Ambientali & Centro Interdipartimentale di Ricerca per le Scienze Ambientali, Università di Bologna

Urbanisation in terrestrial systems has driven architects, planners, ecologists and engineers to collaborate on the design and creation of more sustainable structures. Examples include the development of 'green' buildings and the introduction of wildlife corridors that mitigate urban stressors and provide positive ecological outcomes. In contrast, efforts to minimise the impacts of urban developments on the marine environment have been restricted in both extent and scope, usually limited to the assessment of structural changes, e.g. number and abundance of species, rather than functional ones, e.g. productivity. New eco-engineering approaches are emerging that seek to mitigate environmental impacts and recover neglected ecosystem services by integrating knowledge of ecosystem process and function into urban design practices. In Sydney Harbour, Australia, intertidal seawalls were eco-engineered by adding concrete tiles with 5cm deep crevices and seeded with a native local habitat-former oyster or coralline algae or both. Structural and functional aspects, e.g. filtration rates of oysters and primary productivity, of enhanced and control tiles were measured to assess whether eco-engineering efforts were successful in increasing diversity and functioning of seawalls, therefore potentially increasing important services, such as local water quality.

Presenter's Email: m.mayerpinto@unsw.edu.au

Fishing and Flow: Modeling the Impact of Seasonal Closures and Freshwater Flow on the Blue Crab Fishery in the Ashley River, Charleston, SC

McClellan, K.M.[1]*; Fowler, A.E. [2]; Childress, M.J. [3]

[1]College of Charleston, Charleston, SC 29401, [2]George Mason University, VA 22030, [3]Clemson University, Clemson, SC 29634

Blue crabs are an important commercial fishery in South Carolina, but landings have decreased over the past 15 years. It is unclear whether this decline is more related to drought or changes in fishing effort. Our objective for this study is to determine the impact of recreational fishing pressure on the commercial fishery, and how this interaction changes with flow conditions and hypothetical seasonal closures for female harvest. Using a spatially-explicit individual-based population model (SCBCRABS-ASHLEY) we compared the efficiency of commercial versus recreational traps during periods of flood, normal and drought conditions, and during hypothetical seasonal closures (no harvest of females, no harvest of females during full spawning season, partial harvest of females during spawning season). Under drought conditions and when recreational and commercial traps were in equal abundance, their efficiencies were not significantly different. Recreational traps out-fished commercial traps during flood conditions and when they accounted for a smaller proportion of the total effort. When seasonal restrictions were equally enforced for both the recreational and commercial fisheries, the commercial sector outperformed the recreational sector. This study demonstrates the influence of altered hydrological cycles on the fishery, and delivers new information to managers about the importance of regulating female harvest.

Presenter's Email: klmcclel@g.cofc.edu

Cultivating the carbon cycle: population growth alters carbon flux for the Caribbean giant barrel sponge *Xestospongia muta*

Steven E. McMurray*; Joseph R. Pawlik; Christopher M. Finelli

Department of Biology and Marine Biology, Center for Marine Science, UNC Wilmington

The dynamics and size structure of populations influence the functional roles of species. Long-term monitoring has documented significant changes in the abundance of many functionally important benthic species; however, demographic data for such species are often lacking, as they are costly to collect relative to other metrics of population status (e.g. percent cover). For 20 years, we have annually monitored sponges (*Xestospongia muta*) in plots across 3 depths and 2 reef sites off the Florida Keys. All individuals within each plot are tagged; therefore, particularly good estimates of demographic vital rates have been derived. We leveraged this dataset, along with measurements of sponge filtration rates, to parameterize a stage-based model to investigate the demographic mechanisms that change benthic-pelagic coupling. Population-mediated carbon flux increased over time with increasing sponge density and volume. Elasticity analysis revealed that the growth of sponges in all stages, the survival of sponges in the two largest stages, and the production of new recruits by the largest sponges had the greatest influence on changes in carbon flux. Projections indicated that carbon flux will more than double by 2024; thus, *X. muta* is expected to play an even larger role in benthic-pelagic coupling on Caribbean coral reefs.

Presenter's Email: mcmurrays@uncw.edu

Effects of water flow and ocean acidification on calcification for different morphologies of coralline algae

Merolla, S. A.*; Carpenter, R. C.

Department of Biology, California State University, Northridge

Ocean acidification (OA) is a threat to many marine organisms, particularly calcifers such as coralline algae that play important roles in coral reef ecosystems. However, it is expected that the effects of OA on coralline algae will vary depending on environmental factors, such as water flow. In this study, calcification was used to investigate the effects of water flow and OA on coralline algae. Coralline algal species were selected to represent a range of morphologies, including *Hydrolithon reinboldii*, *Neogoniolithon frutescens*, and *Lithophyllum kotschyanum.* In a field study, algal samples were placed in mesh containers with varying opening sizes to create different water flow environments and were maintained for one month in the back reef of Moorea, French Polynesia. In a mesocosm study, samples of *L. kotschyanum* were placed in different treatments of pCO_2 and water flow for a month. Rates of calcification were measured for each sample using total alkalinity anomaly techniques. In both studies increased water flow resulted in increased net calcification for *L. kotschyanum*, but was unable to completely mitigate the negative effects of OA in the mesocosm study. These results enhance our understanding of how water flow may influence the responses of coralline algae to future OA.

Presenter's Email: sarah.merolla.848@my.csun.edu

Quantifying genotypic disease resistance in nursery-cultured *Acropora* spp. genotypes

Miller, MW*[1]; Pontes E[2]; Williams DE[1,2], Pausch RE[1,2], Bright AJ[1,2]

[1]NOAA/NMFS Southeast Fisheries Science Center; [2]Univ of Miami, Cooperative Institute for Marine and Atmospheric Studies

Disease mortality has been a primary driver of population declines and the threatened status of foundational Caribbean corals, *Acropora palmata* and *A. cervicornis*. There remain few tools to effectively manage coral disease. Substantial investment is flowing into *in situ* culture and population enhancement efforts, while disease takes a variable but sometimes high toll in restored populations. If genetic resistance to disease can be identified

in these corals, it could be leveraged to improve resistance in restored populations and possibly lead to effective diagnostic tests and disease treatments. We have described a standard protocol for field disease resistance assays, based on direct-graft challenge, to encourage and enable broader efforts to quantify this important trait in cultured stocks throughout their range. Field tests of cultured genotypes of both species from two field nurseries in the Florida Keys revealed significant genotypic variation in disease resistance measured both as risk of transmission (% of exposed fragments that displayed tissue loss) and as the rate of tissue loss (cm^2 d^{-1}) in transmitted fragments. These assay results provide a measure of relative disease resistance which can be incorporated, along with consideration of other important traits such as growth and reproductive success, in restoring more resilient populations.

Presenter's Email: margaret.w.miller@Noaa.gov

Crepidula fornicata shell beds as a potential spatial refuge for bay scallops, *Argopecten irradians irradians*, in the Peconic Bays, New York

Kayla M. Mladinich*; Stephen T. Tettelbach

Long Island University-Post

Peconic bay scallop, *Argopecten irradians irradians*, populations have increased greatly since 2008 due to restoration efforts. The preferred scallop habitat of eelgrass, *Zostera marina*, has declined dramatically over several decades, but scallop populations have nevertheless continued to grow. Therefore, it is logical that scallops are utilizing other suitable habitats in place of eelgrass. *Crepidula fornicata* form dense shell beds and offer scallops a dynamic structure for attachment. Scallops ranging from 5 mm to 23 mm have been observed to attach to *C. fornicata* shells in the field and many are seen living in the shell beds. Mud crabs, *Dyspanopeus sayi*, and scup, *Stenotomus chrysops*, were used in laboratory predation trials to explore how different predation methods (chemical and visual) impacted survival of juvenile scallops attached to *C. fornicata* shells in different spatial positions (i.e. on dorsal and ventral surfaces). Tethering was done in the field to compare survival of these different attachment positions between sand and shell beds. A planting experiment explored the difference in survival between groups of scallops, which were either free planted or attach to *C. fornicata* shells. Results of these experiments and implications for ongoing restoration efforts will be discussed.

Author contact: kayla.mladinich@gmail.com

Hydrological Restoration of Benthos in a Hydrologically Stressed Estuary

Montagna, P.A.*; Palmer, T.; Turner, E.

Harte Research Institute, Texas A&M University-Corpus Christi

Water resource development has diverted fresh water from estuaries in all parts of the world. The Nueces Estuary, Texas, USA is historically disturbed by such diversions. A hydrological restoration has supplemented freshwater inflow via anthropogenic pumping since 2009. Continuous long-term sampling of benthic macroinfauna, epifauna, and water quality in the main tributary, Rincon Bayou, was used to determine the extent supplemental freshwater inflow altered ecosystem health. The salinity can fluctuate from fresh to hypersaline to fresh in very short time periods. The pumping did alleviate salinity stress in the estuary, and nutrients are high when salinity is low. Species diversity was significantly correlated to freshwater inflow increases. Conversely, sustained high salinity (> 35 PSU) increases the biomass and abundance of a single opportunistic benthic macroinfauna species *Strelospio benedicti*. Although supplemental inflow increased overall estuary health, Rincon Bayou remains a disturbed system due to the volatile salinity regime changes that are partially caused by the timing and delivery of freshwater inflow via pumping. This study demonstrates that hydrological restoration can have positive benefits, but that adaptive management of the restoration is needed to maximize the benefits.

Presenter's Email: paul.montagna@tamucc.edu

402 questions for the Federal Aviation Administration: Activities of the Environmental Issues Subcommittee of the Spaceport Camden Steering Committee

Clay L. Montague

University of Florida & Camden County, Georgia

Spaceport Camden proposes to construct a commercial spaceport alongside an estuary in Camden County, Georgia vertical launches, medium payload, liquid-fueled rockets, landing pad. The plan: FAA licenses the Camden County Board of Commissioners as launch site operator on land formerly used to manufacture rocket fuels and pesticides 10 km W of Cumberland Island. FAAs environmental impact statement (EIS) is underway. Commissioners formed the ten-member Environmental Issues Subcommittee to help citizens and leaders participate effectively in environmental aspects of licensing. Members include environmental nonprofits, environmental managers, and property owners on islands immediately downrange. During public scoping, the subcommittee translated concerns into questions for FAAs technical experts 402 under 29 topics. Names of 42 professionals with helpful local knowledge were offered. Questions of launch safety, hazardous wastes, noise, economic risk, regional development, fish and wildlife, archeological resources, night lighting, traffic, recreational restrictions, and future disposition of the industrial site whether or not a spaceport is built. Some questions may remain unanswered in the EIS, some until further stages of the licensing process, others requiring additional effort. A complete set of answers would provide much information for basing a good decision. The next step is public review of the draft EIS, due soon.

Presenter's Email: montague@ufl.edu

The estuarine soundscape of the May River, a deep tidal river in South Carolina

Eric W. Montie*; Agnieszka Monczak; Claire Mueller; Bradshaw McKinney; Jamileh Soueidan; Ashlee Seder; Debra Albanese; Joshua Himes; Shaneel Bivek

Department of Natural Sciences, University of South Carolina Beaufort

The marine soundscape is made up of all the biological, physical, geological, and anthropogenic sounds in a specific area, habitat, or ecosystem. Biologically, soundscape studies can be helpful in inferring the presence of species, their relative population size, and their behavior. In addition, characterizing soundscapes may allow us to infer habitat quality. Very few studies have focused on understanding the temporal patterns of soundscapes of deep tidal rivers, which dominate coastal estuaries along the Southeast United States. To study these patterns, we have deployed longterm acoustic recorders at locations from the source to the mouth of the May River, South Carolina (i.e., from 2013 to present). Spatially, we found that the highest species diversity was detected at the mouth of the May River, and the lowest diversity at the source. We observed that the acoustic behavior of snapping shrimp, sciaenids, and bottlenose dolphins was more frequent at the mouth compared to the source. In addition, we have discovered finely tuned seasonal, lunar, and daily patterns of snapping shrimp acoustic behavior and fish courtship sounds. These data are providing baseline patterns that will help us determine how climate change, stormwater runoff, and anthropogenic noise affects the estuarine soundscape.

Presenter's Email: emontie@uscb.edu

Barren gonads: a non-lethal method of assessing sea urchin condition in a temperate kelp forest system.

Kyle P. Mooers* [1]; Joshua G. Smith[2]; Mark H. Carr[2]

[1]California State University, Monterey Bay; [2]Department of Ecology and Evolutionary Biology, University of California Santa Cruz

We developed a non-lethal method of measuring the quality (i.e., reproductive condition) of purple sea urchins (*Strongylocentrotus purpuratus*) and how urchin density and food availability influence condition. Urchins were collected from three sites around Monterey Bay, California, which featured three distinct habitat categories: non-barren, front-of-barren, and middle-of-barren. Quantitative relationships between urchin biomass and two measures of urchin size (test diameter, volume) were used to categorize urchins as high or low condition. Urchins were sacrificed to determine whether individuals with large or small gonads predictably fell above or below the relationship, respectively. Deviations from the predicted biomass-size relationships were examined by assessing the relative contributions of algal cover, habitat category, and urchin density around each sampled individual. Analyses of Covariance and Analyses of Variance tests indicated a significant difference in gonad dry mass and gonad index (GI; ratio of gonad mass to test diameter) between habitat categories, and that gonad dry mass and GI from urchins in the middle of the barren were greater than those of the other categories (front-of-barren, non-barren sites). These relationships provide researchers with an efficient and timely non-lethal method to assess urchin quality in the field, and to identifying ecological correlates with urchin condition.

Presenter's Email: kmooers@csumb.edu

Cannibalism as a potential factor limiting population growth in the invasive Asian shore crab, *Hemigrapsus sanguineus*

Moritzen, L. C.*; O'Connor, N. J.

Department of Biology, University of Massachusetts Dartmouth

The invasive Asian shore crab is rapidly expanding its range and becoming the dominant intertidal crab species in southern New England. But little is known about the factors that may help regulate its population size. Our study investigated the occurrence of cannibalism in this species under various conditions of crab size and food availability to estimate its role as a potential factor limiting population growth. We measured cannibalism rates for various size class combinations of predator and prey crabs in the presence and absence of food. Additionally, we compared cannibalism rates for prey that had previously experienced a predator cue versus those that had not, cannibalism at high versus low prey densities, and cannibalism on laboratory-reared versus wild-caught prey. Cannibalism occurred under all conditions tested, increasing as predator size increased and prey size decreased. Rates were higher in the absence of food, and were not significantly affected by prey experience, density, or origin (lab-reared vs. wild-caught). Cannibalism rates were highest with adults as predators and megalopae as prey in the absence of food (mean = 98.33%). If cannibalism of recruiting megalopae occurs similarly in the field, then cannibalism may help limit population growth in this invasive species.

Presenter's Email: lmoritzen@umassd.edu

PARASITES ENHANCE ECOSYSTEM FUNCTIONS AND RESISTANCE TO DROUGHT IN A COASTAL ECOSYSTEM

Joseph P. Morton [1]*, Brian R. Silliman[1], Charles H. Peterson [2]

[1]Duke University Marine Lab, Duke University Marine Lab; [2]University of North Carolina at Chapel Hill (UNC) Institute of Marine Sciences

Parasites are more diverse and numerous than the organisms they feed upon, yet we know little about the ecosystem-level effects of parasitism. In salt marsh ecosystems of the southeastern U.S., increasing drought stress interacts synergistically with keystone grazing by marsh periwinkles to generate marsh die-offs. Field manipulation of digenean trematode parasite prevalence within the marsh food web under both drought and non-drought conditions revealed that parasites, by suppressing keystone grazing, can sustain multiple ecosystem functions and help prevent climate-induced die-off of foundational plants. Subsequent manipulations of parasite prevalence along actively expanding marsh die-off borders demonstrated that parasites could slow the rate of die-off border retreat. A survey along 1000km of coastline showed that trematodes parasitism is common in marsh

periwinkles and that increased infection prevalence along marsh die-off borders is correlated with decreased per capita grazing. Combined, these results demonstrate that parasites can simultaneously regulate both the functioning of an ecosystem and its ability to resist die-off in the face of drought.

Presenter's Email: jpm45@duke.edu

Color variation, gamete compatibility and spawning behavior resulting in Assortative Mating in the sea urchin *Lytechinus variegatus.*

Jose A. Moscoso*; Don R. Levitan

Department of Biological Science, Florida State University.

Assortative mating can maintain alternative phenotypes and potentially lead to reproductive isolation and speciation. The sea urchin *Lytechinus variegatus* is known to exhibit variation in color within populations. Here we examine patterns of reproductive compatibility, aggregation and color variation. Results indicate that laboratory crosses of urchins within color morphs yielded higher fertilization success than crosses between color morphs. Field surveys determined that these urchins are aggregating by color at times of their reproductive season when they are more likely to spawn. Paternal success in broadcast spawners is largely determined by the proximity of males to spawning females and the compatibility between them at the time they release their gametes. Selection is predicted to favor traits and behaviors that increase the likelihood of spawning near a more compatible neighbor. These results provide strong evidence for assortative mating and an explanation for the maintenance of color variation in this species. We are currently exploring why color predicts patterns of reproductive compatibility.

Presenter's Email: jmoscoso@fsu.edu

The relative importance of parrotfish and *Diadema* grazing in the recovery of elkhorn coral

Mudge, L.*; Bruno, J.

Department of Biology, University of North Carolina at Chapel Hill

A disease outbreak in the 1980s decimated populations of elkhorn coral (*Acropora palmata*) across the Caribbean, from which recovery has been isolated and patchy. Sheeting regrowth of elkhorn tissue over standing dead skeletons was observed along reefs in the Yucatán Peninsula; yet, little is known about the ecological factors influencing this regrowth. Since herbivory facilitates coral recovery by suppressing macroalgae growth, we tested the hypothesis that the recovery of elkhorn coral is related to local herbivore density. Elkhorn tissue area, sea urchin (*Diadema antillarum*) density, parrotfish biomass and density, and benthic cover were measured on 11 spur and groove reef sites in Akumal, Mexico where elkhorn recovery was observed. Linear mixed effects models were used to evaluate the relationship between the live area index (LAI) of elkhorn coral and herbivore density and biomass. *Diadema* density was positively correlated to the LAI of elkhorn coral, while parrotfish density and biomass were not. This result suggests that *Diadema* grazing may be influencing the recovery of ecologically important coral species. Much focus has been placed on increasing herbivorous fish populations to control macroalgae cover; however, we might be underestimating the relative importance of herbivory from urchins on contemporary Caribbean reefs.

Presenter's Email: lmudge@live.unc.edu

Ontogenetic variation in diet and the implications of prey selection in an anadromous fish species

Murphy, Robert*; Grabowski, Jonathan

Department of Marine and Environmental Sciences, Marine Science Center, Northeastern University

Accounting for the effects of ontogenetic diet shifts on food-web interactions, especially among fisheries, is vital to the development of ecosystem-based fisheries management. Given that prey selection can influence the growth, condition, and fecundity of a predator, ontogenetic shifts in diet may reflect tradeoffs that affect the predator's fitness. In addition, diet ontogeny likely modifies the strength of predation pressure on prey populations. This study investigated the diets and condition of Striped Bass collected in northern Massachusetts to examine ontogenetic variation in diet and, if present, its implications. We collected individuals from 2012-2015 (n=127) and utilized stomach content and stable isotope analysis to address three questions: What prey items are most important to Striped Bass; do ontogenetic shifts in diet occur; and does prey selection have implications for Striped Bass condition? Overall, smaller Striped Bass were mostly piscivorous, while larger individuals consumed more benthic invertebrates, such as the economically important American Lobster. Examining Striped Bass condition revealed an energetic advantage derived from this ontogenetic switch in diet, while gravid females were found to be exclusively benthivorous. Our results suggest that efforts to model and assess the Striped Bass and American Lobster fisheries could benefit from incorporating their size-specific predator-prey interactions.

Presenter's Email: murphy.rob@husky.neu.edu

Effects of ocean acidification on juvenile golden king crabs *Lithodes aequispinus*

Nardone J. A.*[1]; Karra, L.[1]; Long, W. C.[2]; Swiney, K. M.[2]; Foy, R. J.[2]; Dickinson, G. H.[1]

[1]Department of Biology, The College of New Jersey; [2] NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center, Resource Assessment and Conservation Engineering Division, Kodiak Laboratory

Ocean acidification (OA) is a decrease in seawater pH due to increased atmospheric CO_2 levels that leads to reduced carbonate availability. This study assessed the effects of OA on cuticle hardness (resistance to permanent or plastic deformation), thickness, structure, and elemental composition in golden king crabs, *Lithodes aequispinus*. Juvenile golden king crabs were exposed to one of three levels of pH, 7.5, 7.8, or 8.0 (ambient), for 1 year. Measurements were made on the cuticle of the right claw and the carapace following exposure. Endocuticle hardness tended to decrease with decreasing pH in the claw. Hardness of the carapace endocuticle was not affected by pH. Endocuticle thickness was not affected by pH in the claw, but in the carapace, the endocuticle was significantly thinner in crabs exposed to pH 7.5 as compared to those at 8.0. Claw and carapace exocuticle thickness were not affected by pH. Calcium content of the endocuticle did not vary among pH treatments within claw or carapace samples. Magnesium content of the carapace, but not the claw, was reduced at pH 7.5 as compared to crabs raised at pH 7.8. Altered cuticle properties could affect functionality in terms of defense, feeding or mobility.

Presenter's Email: nardonj1@tcnj.edu

Assessing the rate and extent of transgenerational adaptation and acclimation to ocean warming

Abby Nease*; Joana Figueiredo

Department of Marine and Environmental Sciences, Nova Southeastern University

Most climate change studies focus on a single life stage or generation. As a result, current projections of species persistence through climate change are likely to overestimate species extinction. This study aims to overcome these shortcomings by evaluating the rate and extent in which adaptation and transgenerational acclimation may allow a species to persist through climate change. Marine rotifers, *Brachionus plicatilis*, were reared for 32

generations at: i) Optimal temperature (25°C), ii) Optimal temperature with weekly sub-lethal shocks (35°C), iii) Maximum temperature (33°C), iv) Maximum temperature with weekly sub-lethal shocks. Changes in population composition, rotifer size, population growth rates and aerobic performance were assessed over time. While the proportion of egg-bearing females did not differ between treatments, population growth under elevated temperatures was higher. Aerobic performance decreased in the most thermally stressed treatment. Rotifer size decreased in treatments reared at elevated temperature, but when returned to optimal conditions, size reverted back to normal. This suggests acclimation and selection of thermally-tolerant individuals occurred over multiple generations, and thus species with short life cycles may be better able to keep up with the pace of climate change.

Presenter's Email: an591@nova.edu

Update on the Asian shore crab invasion in southeastern New England: Lessons learned from re-visiting sampling sites

O'Connor, N.J.*

Department of Biology, University of Massachusetts Dartmouth

The Asian shore crab *Hemigrapsus sanguineus* is an established invader in the rocky intertidal zone (RIT) of southeastern New England. Prior work followed the invasion from 1999-2011 at two coastal sites and one estuarine site. The abundance of *H. sanguineus* at all three sites showed a dramatic increase with a concomitant decline in abundance of resident species (the green crab *Carcinus maenas* at the coastal sites and mud crabs in the family Panopeidae at the estuarine site.) All three sites were revisited in the spring and fall of 2016 and similar areas in the lower RIT were searched for crabs using the same methods as before. At both coastal sites, *H. sanguineus* density decreased whereas the resident species *C. maenas* showed a slight increase, likely through continued recruitment. In contrast, *H. sanguineus* abundance increased at the estuarine site, reaching densities >300/m^2 in both spring and fall, while native mud crabs persisted there. These data show continued existence of resident species in the RIT in the presence of *H. sanguineus*, even where invader densities are extremely high. The impact of *H. sanguineus* on resident crab species might not be as negative as initially hypothesized.

Presenter's Email: noconnor@umassd.edu

Female blue crab sperm storage from mating to the second spawning season

M. B. Ogburn*; K. D. Richie; A. H. Hines

Smithsonian Environmental Research Center

Mature female blue crabs, *Callinectes sapidus*, receive their lifetime supply of sperm during mating at the time of their molt to maturity, and use this stored sperm to produce multiple broods of offspring during one or more spawning seasons. Male-biased blue crab harvest has the potential to alter the operational sex ratio and reduce reproductive output due to sperm limitation, but a lack of information on changes in sperm quantity during long-term storage inhibits our ability to evaluate whether sperm limitation occurs in Chesapeake Bay. We used a large scale mark-recapture study to study sperm storage in the field. In fall 2014, 5190 recently-mated mature female blue crabs were tagged and released in 12 locations throughout Chesapeake Bay. Initial sperm stores were quantified for additional crabs obtained at the time of tagging. The sperm stores of recaptured crabs were compared to expected initial sperm stores. Results indicated that sperm quantity declined more than 90% from the time of mating to fertilization of the first brood, with subsequent declines likely related to fertilization. This decline is much greater than observed in laboratory studies (50%), and highlights the importance of underpinning sustainable fisheries management with rigorous studies of reproductive biology.

Presenter's Email: ogburnm@si.edu

Migratory Movements and Fishing Mortality of the Louisiana Blue Crab Spawning Stock

Olmi, H.D.*; Darnell, M.Z.

School of Ocean Science and Technology, University of Southern Mississippi

Blue crabs, *Callinectes sapidus*, support one of our nation's most valuable fisheries; Louisiana has led the nation in blue crab landings for 8 of the last 11 years. Fishery-independent estimates of abundance have indicated a decline in recent years and in 2015, the spawning stock biomass reached the lowest point ever recorded in Louisiana. Management efforts are hindered by incomplete knowledge of migration patterns and fishing mortality. In March 2016, we began a mark-recapture study to examine these trends in Terrebonne, Pontchartrain, and Barataria basins. In collaboration with local fishermen, we have tagged over 4,000 female blue crabs and will continue to tag through 2017. Recapture data are obtained from commercial and recreational crabbers and shrimpers, state agencies, and the public. Generally, tagged female blue crabs move seaward, consistent with our understanding of spawning migration from similar Atlantic Coast studies. Recapture rates are being used to assess spatial and temporal patterns in fishing mortality. The sperm stores of recently molted females from each tagging area will be examined to determine if male-focused fishing effort affects sperm abundance and thus, reproductive success. This information, combined with tag-recapture results, will be directly applicable to Louisiana blue crab management plans and stock assessments.

Presenter's Email: helen.olmi@usm.edu

Multi-decadal growth histories of *Siderastrea siderea* and *Pseudodiploria strigosa* throughout the Bocas del Toro Archipelago, Panama

Olmo L*[1]; Fisher K*[1]; Rippe JP[1]; Castillo KD[1,2]

[1]Department of Marine Sciences, University of North Carolina at Chapel Hill; [2]Curriculum for the Environment and Ecology, University of North Carolina at Chapel Hill

Global climate change poses a significant threat to coral reef communities across the greater Caribbean Sea. Previous studies suggest that inshore corals are less impacted by ocean warming than offshore counterparts due to their history of exposure to highly variable environmental conditions. By examining the slow-growing calcium carbonate skeletons of long-lived corals, we are able to quantify how calcification rates have changed in response to decades of differing environmental conditions. We extracted cores from *Siderastrea siderea* (n=39) and *Pseudodiploria strigosa* (n=22), two abundant and widespread massive Caribbean reef-building corals, to investigate coral growth rates. In 2015, cores of each species were collected from inshore and offshore reef sites within the Bocas del Toro Archipelago, Panama. Using 3-dimensional computerized tomography, skeletal growth parameters were quantified by delineating high- and low-density annual growth bands. This investigation will allow us to compare multi-decadal scale inshore-offshore coral growth trajectories to better understand growth differences for corals across a reef system as they respond to a changing climate.

Presenter's Email: lilyolmo@live.unc.edu

Prevalence of somatic mutations is a function of clone size and depth in reef-building corals of the *Orbicella* species complex

Olsen, K.C.*; Moscoso J. A.; Levitan D.R.

Department of Biological Science, Florida State University

In modular organisms, the propagation of somatic mutations within a clonal unit can lead to the establishment of individual genetic mosaics and can alter the scale at which ecological and evolutionary processes operate. We assessed the prevalence of somatic mutations and potential mechanisms influencing the degree of genetic

mosaicism in the reef corals *Orbicella franksi* and *Orbicella annularis*. Clones of both species encompassing a range of coral sizes and depths were sampled multiply and genotyped at microsatellite loci to detect somatic mutations. Genetic mosaicism was detected in 41% of corals evaluated and mutation frequency was found to be positively related with clone size and negatively associated with coral depth. We suggest that larger clones experience a greater number of somatic cell divisions and consequently have an elevated potential to accumulate mutations. Furthermore, corals at shallower depths may be exposed to abiotic conditions such as elevated ultraviolet radiation and/or thermal regimes which promote increased mutation rates. The results highlight potential biotic and abiotic mechanisms generating genetic mosaicism in reef-building corals and have implications for the physiological units containing genetic variation in modular organisms.

Presenter's Email: kolsen@bio.fsu.edu

The World Harbour Project and eco-engineering of coastal infrastructure: a design for life

O'Shaughnessy, K. A.*[1]; Lunt, P. H.[2]; Hanley, M. E.[1]; Thompson, R. C.[1]; Hawkins, S. J.[3,4]; Strain, E.[5]; Johnston, E.[5,6]; Bishop, M.[7]; Firth, L. B.[1]

[1]School of Biological and Marine Sciences, Plymouth University; [2]School of Geography, Earth and Environmental Sciences, Plymouth University; [3]National Oceanography Centre, University of Southampton; [4]Marine Biological Association of the United Kingdom; [5]Sydney Institute of Marine Science; [6]University of New South Wales; [7]Department of Biological Sciences, Macquarie University

In response sea level rise, natural habitats along urban coastlines across the globe are being replaced by artificial structures. Many of these structures, such as seawalls and jetties, are homogenous in design, lacking complex macro- and microhabitats characteristic of natural rocky shores. Artificial structures generally support reduced biodiversity compared to adjacent natural habitats and can promote the spread of non-native species. To mitigate the negative effects of hardening coastlines, ecological engineering techniques – practices that modify homogenous artificial structures by the addition of natural or eco-friendly structural features – have emerged in the last decade. The World Harbour Project (WHP) is a global initiative aimed at building ecologically stable and resilient harbours in over 20 urbanised port cities by facilitating investigations into ecosystem rehabilitation, and developing and implementing best-management practices. Local WHP experiments in Plymouth Sound, UK included seeding the important habitat-forming blue mussel *(Mytilus* spp.*)* on 'eco-friendly' concrete tiles (25 x 25 cm) of three complexity treatments and adhering tiles to vertical seawalls in the intertidal zone for 12 months. The experiment has been running since August 2016, with preliminary results indicating no clear and significant effect of treatment, but trends show biological preference for complex tiles compared to flat tiles.

Presenter's Email: kathryn.oshaughnessy@plymouth.ac.uk

Testing robustness of the northern Gulf of Mexico trophic dynamics using social network analysis

Oshima, M.C.*[1], Leaf, R.T.[1]

[1] Division of Coastal Sciences, School of Ocean Science and Technology, The University of Southern Mississippi

Trophic webs can be modeled using social networks and multi-taxa network's response to perturbation can be evaluated through simulation. We synthesized the diet composition information from 136 papers containing 12,335 unique predator-prey interactions from the northern Gulf of Mexico (nGOM). From these data we generated trophic networks that differed in structure based on the diet metric and the taxonomic resolution of the predators and prey. We then simulated perturbation to each network by removing individual taxa and evaluating how network metrics, link density and connectivity, were impacted. We found that connectivity, a measure of how connected groups are to one another, did not change in any of the networks when taxonomic components were randomly removed nor was this metric impacted when removing, in a targeted way, the most highly connected components of the networks for those composed of taxa identified to family level or lower. However, connectivity decreased to zero when 10 to 20% of the components were removed in networks of prey identified to

class or order level. The simulations indicated that the nGOM trophic web is robust to taxa removal, but connectivity and link density are sensitive to taxonomic resolution, necessitating detailed prey identification.

Presenter's Email: megumi.oshima@usm.edu

Effects of the biomedical bleeding process on the behavior and physiology of the American horseshoe crab, *Limulus polyphemus*

Meghan Owings*[1]; Win Watson[1]; Chris Chabot[2]

[1]Department of Biological Sciences, University of New Hampshire; [2]Department of Biological Sciences, Plymouth State University

The hemolymph from the American horseshoe crab, *Limulus polyphemus*, is used to produce *Limulus* Amebocyte Lysate (LAL), which tests medical devices for Gram-negative bacteria. A 10-30% mortality rate and sublethal impacts have been previously documented. The goals of this study were to: 1) investigate the effects of the bleeding procedure on the behavior of horseshoe crabs in their natural environment and; 2) determine which bleeding process stressors (blood loss, air exposure, or increased temperature) has the most deleterious effects. In the field, 14 control and 14 bled animals were fitted with ultrasonic transmitters and released into Great Bay, NH; and their depth preferences and locomotor activity were recorded from May-December of 2016. Lab experiments were conducted in outdoor tanks where animals were exposed to combinations of stressors. Accelerometers were attached to 64 animals to measure activity; and blood samples were repeatedly drawn to monitor hemocyanin levels. The telemetry study showed that control and bled animals exhibited similar activity patterns and seasonal migrations. In the lab, hemocyanin concentrations and activity were significantly impacted by a combination of stressors, rather than individual stressors. This study is currently ongoing, and findings from this investigation can be utilized to sustainably bleed horseshoe crabs.

Presenter's Email: mwowings1@gmail.com

Effects of increasing bottom water temperature on growth rates of ocean quahogs throughout the Mid-Atlantic

Pace, S. M.*[1]; Powell, E. N.[1]; Mann, R.[2]; Klinck, J.[3]

[1]Gulf Coast Research Laboratory, University of Southern Mississippi; [2]Virginia Institute of Marine Science; [3]Old Dominion University

Ocean quahogs (*Arctica islandica*) are the longest-lived, non-colonial animal known today, with maximum life span estimates exceeding 500 years. Ocean quahogs are a commercially important bivalve, inhabiting the continental shelf of the North Atlantic basin. We examined the age of ocean quahogs that were fully recruited to the commercial fishery (>80 mm shell length) from four sites covering the range of the stock within the US exclusive economic zone (EEZ) through analysis of annual growth lines in the hinge plate. The growth of several clams from each site was assessed using three models (von Bertalanffy, Gompertz, and Tanaka's ALOG curve). The ALOG curve provided the best fit to growth at all sites. There has been a substantive increase in growth rates at two sites in the southern portion of the stock since initial colonization, likely in response to increasing bottom water temperatures. That is, ALOG growth curve parameter values vary with birth date at the southern sites, with younger animals growing at a much faster rate than those born many decades ago, while the northern sites, changes in growth rates through time are limited or not present.

Presenter's Email: sara.pace@usm.edu

Importance of coral reef community composition and benthic metabolism to seawater carbonate chemistry: implications for ocean acidification

Heather N. Page*[1]; Andreas J. Andersson[1]; Travis A. Courtney[1]; Eric H. DeCarlo[2]; Irina Koester[1]; Noah Howins[2]

[1]Scripps Institution of Oceanography, University of California San Diego; [2]Department of Oceanography, University of Hawaii at Manoa

The ability of many coral reefs to maintain ecosystem goods and services has diminished as they face stressors including ocean warming and acidification. However, the extent of ocean acidification experienced on coral reefs partly depends on benthic metabolism, which has a large influence on seawater pH in these shallow, coastal ecosystems. A better understanding of the links between diel seawater pH, benthic metabolism, and reef community composition has been developed through a combination of research approaches (mesocosm experiments and field studies) across functional and spatial scales. In mesocosm experiments, fleshy macroalgae and calcifying communities had similar influences on seawater pH at night. In contrast, fleshy macroalgae elevates daytime seawater pH more than calcifying communities due to higher rates of organic carbon production and absence of calcification. Additional experiments reveal that benthic metabolic rates and subsequent influences on seawater pH do not scale proportionally to changes in coral density. Consequently, large differences in reef community composition may not lead to predictable influences on seawater pH. Here, we discuss the mesocosm results in light of recent field studies of benthic community composition and seawater carbonate chemistry from Kaneohe Bay, Hawaii, to evaluate whether the mesocosm results hold true for the natural environment.

Presenter's Email: hnpage@ucsd.edu

Modeling food choice in the two suspension-feeding bivalves, *Crassostrea virginica* and *Mytilus edulis*

Pales Espinosa, E.*; Cerrato, R.; Allam, B.

School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook

Suspension-feeding bivalves are able to sort and select food particles from a complex mixture. Recent reports have indicated that this selection is mediated by interactions between lectins present in mucus covering the feeding organs and carbohydrates associated with the surface of microalgae. In this study, several statistical methods were evaluated to predict the likelihood for a microalga to be ingested or rejected based upon its cell-surface carbohydrate signature. First, the carbohydrate signatures of 16 microalgae were characterized using 10 different lectins. A subset of microalgae (12 species) was then used in feeding experiments where different pairs of microalgae were presented to oysters (*Crassostrea virginica*) and mussels (*Mytilus edulis*) to evaluate selection. Results show that cell-surface carbohydrates are good predictors for particle fate. Specifically, microalgae rich in glucose/mannose residues were preferentially selected by both bivalves. Statistical methods for predicting the likelihood of an alga being ingested or rejected were evaluated, and a decision tree that accurately models selection in the two bivalves is proposed even though the model warrants further validation (different species, various seasons). Overall, these findings provide a promising predictive tool that could be used to assess bivalve performance and benthic-pelagic coupling under ecological or aquaculture contexts.

Presenter's Email: Emmanuelle.palesespinosa@stonybrook.edu

Linking hydrography to black drum in a hypersaline estuary; Baffin Bay, Texas

Palmer, T.A.[1*]; Mendenhall-Rubio, K.S.[1]; Lebreton, B.[2]; Ajemian, M.[1,3]; Beseres Pollack, J.[1]

[1]Texas A&M University-Corpus Christi; [2]CNRS - University of La Rochelle; [3]Florida Atlantic University Harbor Branch

Black drum (*Pogonias cromis*) is a large-bodied sciaenid species that is abundant in subtropical estuaries, including estuaries in Texas. Baffin Bay, Texas is a part of a larger hypersaline estuarine complex that supports the largest population of black drum in Texas. In late 2012, a black drum emaciation event occurred, which was anecdotally caused by a decrease in food availability combined with simultaneous large populations of black drum. A hydrographical and ecological monitoring project was initiated in this under-researched estuary in March 2014 to investigate potential causes of this emaciation event. A spatio-temporal survey of benthic macrofauna and hydrography over five quarterly sampling events revealed dissolved oxygen was positively correlated with macrobenthic diversity and biomass, and salinity was positively correlated with macrobenthic diversity. Black drum gut contents surveyed over the same period consisted almost entirely of benthic prey, although black drum preferentially selected molluscs. Stable isotope analyses and black drum acoustic tracking determined that black drum predominantly stay and feed in Baffin Bay rather than in the only outlet to the bay, the Laguna Madre. Therefore black drum in Baffin Bay are vulnerable to any changes in benthic macrofauna, and indirectly water quality, that may occur.

Presenter's Email: terry.palmer@tamucc.edu

Effect of wind on the distribution of planktonic larvae and spats of Bivalves in a tidal environment

Paulin, A.*; Miron, G.

Département de biologie, Université de Moncton Campus de Moncton

The interaction between hydrodynamics and larval behavior is largely responsible for the horizontal dispersal of larvae and their initial deposition site on the substrate. Hydrodynamics, particularly for surface waters, is related to wind direction and speed. These wind parameters may in turn affect abundances of early-stages in coastal waters. In this context, this study describes the distribution of bivalve planktonic larvae and spats taking into account local wind direction and speed in the intertidal zone of two contrasted tidal regions of Eastern Canada (Bay of Fundy and Northumberland Strait). The distribution of spats in the intertidal zone was determined using larval passive traps at 3 intertidal levels (high, mid and low). The distribution of planktonic larvae was determined at high tide by collecting plankton samples with a pump. Portable meteorological stations were installed in study sites for local weather information. Preliminary results suggest that various wind characteristics (speed, direction, speed and direction variabilities) may influence the abundance of early-stages of bivalves species. Permutational MANOVA models suggest that the latter wind characteristics and their interactions explained 16.5 % of the abundance variability for the studied bivalve larvae.

Presenter's Email: eap6922@umoncton.ca

The vicious circle hypothesis for the relative lack of resilience of Caribbean coral reefs

Pawlik, Joseph R.*

Department of Biology and Marine Biology and Center for Marine Science, UNC Wilmington, NC, 28409

Coral reefs have suffered unprecedented losses of corals in the recent past. Why have Caribbean reefs in particular transitioned to coral-depleted systems and exhibited less coral resilience? A synthesis of recent research from diverse sources provides novel insights into the reciprocal interactions among sponges, seaweeds, and microbes. The **vicious circle hypothesis** proposes that coral loss resulted in more abundant seaweeds that release dissolved organic carbon (DOC), which is consumed by sponges. Sponges return carbon to the reef, but also release nutrients that further enhance seaweed growth. Both seaweeds and sponges compete for space with the remaining corals, and the cycling of carbon and nutrients alters microbial activity, with negative consequences for the coral microbiome. Adding to these interactions are geographic factors that enhance nutrients and DOC on Caribbean reefs, such as river discharge and windblown dust. Relatively higher abundances of sponges and the absence of phototrophic species suggest that sponge communities on Caribbean reefs have adapted to a different nutritional environment than is present on reefs elsewhere in the tropics.

Presenter's Email: pawlikj@uncw.edu

Artificial and natural reefs are not created equal: subtropical and tropical fish prefer deep artificial reefs; temperate fish prefer natural reefs

Paxton, A. B.*[1,2]; Peterson, C. H.[1,2]; Taylor, J. C.[3]; Adler, A. M.[1]; Pickering, E. A.[1]

[1]Institute of Marine Sciences, University of North Carolina at Chapel Hill; [2]Department of Biology, University of North Carolina at Chapel Hill; [3]National Ocean Service, National Centers for Coastal Ocean Science, National Oceanic and Atmospheric Administration

Increasing numbers of human-made, artificial reefs are deployed to enhance fish habitat and mimic natural reefs. Understanding whether artificial and natural reefs provide equivalent habitat for fish with different thermal affinities is important for predicting effects of future marine urbanization and for guiding future installation of human-made structures. We conducted diver-surveys of thirty temperate reefs located on the southeastern US continental shelf to contrast ecological functions of artificial and natural reefs. We tested if and how each reef type provided habitat for fish species of different climate ranges: temperate, subtropical, and tropical. We found that demersal reef fish with different zoogeographic ranges exhibited distinct numerical preferences for reef types. Temperate fish preferred naturally occurring rocky reefs, whereas subtropical and tropical fish at deep depths (25-35 m) preferred human-made structures. Subtropical and tropical species that rarely occur as far north as our study sites contributed to these patterns, with those inhabiting artificial reefs consuming zooplankton and nekton and those occupying natural reefs consuming macroalgae. Our findings suggest that as marine urbanization continues world-wide, introduction of human-made structures will likely affect temperate, subtropical, and tropical species differently and that artificial reefs may facilitate movement of subtropical and tropical fish poleward.

Presenter's Email: abpaxton@live.unc.edu

A regulatory perspective on seagrass monitoring: documenting impacts and determining mitigation success

Jennifer Peterson

Beaches Inlets and Ports Program, Division of Water Resource Management, Florida Department of Environmental Protection, Tallahassee, Florida

Coastal construction, including dredge and fill activities to maintain navigation channels and restore beaches, can impact seagrass communities. Direct impacts (complete loss of seagrass) within the project footprint typically are estimated prior to construction, and compensatory mitigation is provided as required by regulatory permits. However, secondary impacts (e.g., adverse effects caused by project-generated sedimentation) outside of the project footprint can also occur, resulting in temporary or permanent loss and/or degradation of seagrass. Therefore, regulatory agencies typically require monitoring of seagrass resources in the project area to demonstrate that direct impacts were predicted accurately and identify any unpermitted impacts so they may be mitigated. Monitoring is also required to ensure mitigation activities (e.g., planting) are completed in compliance with the permit and success criteria (e.g., spatial coverage and density of seagrass) are achieved. Biological monitoring plans are tailored to specific projects, but there are general approaches and survey techniques that can be used in many scenarios. Biologists at the Florida Department of Environmental Protection are developing guidance to improve seagrass monitoring by reducing subjectivity and making regulatory requirements clear and consistent across projects to streamline permitting. Department staff will present recommendations for permit-required seagrass surveys.

Presenter's Email: Jennifer.M.Peterson@dep.state.fl.us

Emergence and resilience of a new alternative state in the Gulf of Maine

Petraitis, P.S.[1*]; Dudgeon, S.R.[2]

[1]Dept. of Biology, University of Pennsylvania; [2]Dept. of Biology, California State University, Northridge

Historically, sheltered shores in the Gulf of Maine contained mussel beds and stands of the rockweed, *Ascophyllum nodosum* as alternative states, but recently mussels have disappeared and been replaced by the rockweed *Fucus vesiculosus*. Here we use long-term (1996-2016) data to examine the dynamics of this new state. Clearings were established during winter 1996-1997 and half were re-scraped during winter 2010-2011. Before (1997-2010) and after (2011-2016) data were used to examine the development and resilience of rockweed states. K-means clustering using the Before data identified three rockweed states: *Ascophyllum*, slow-growing *Fucus*, and fast-growing *Fucus*. A discriminant function was then used to assess resilience of each state using the After data. All *Ascophyllum* stands were assigned as *Ascophyllum* stands after re-clearing. Median time for re-establishment (>10% cover) was 6-7 years and full recovery (>90% cover) took 15-20 years. In contrast, recovery of *Fucus* stands was not as certain; only 22% of slow-growing *Fucus* stands and 80% of fast-growing *Fucus* stands were assigned to *Fucus* after re-clearing. However, median recovery time of *Fucus* was rapid (<3 years). It appears elasticity is the key to the resilience of *Fucus* stands but inhibition is the key for *Ascophyllum* stands.

Presenter's Email: ppetrait@sas.upenn.edu

Crab grazing fronts facilitate landscape scale top-down control of salt marsh communities

Thomas Pettengill*[1]; Sinead Crotty[2]; Christine Angelini[2]; Mark Bertness[1]

[1]Department of Ecology and Evolutionary Biology, Brown Univ., Providence, RI; [2]Department of Environmental Engineering Science, University of Florida, Gainesville, FL

Site variation in top-down control and physical stress is known to control community composition, but we generally lack an understanding of how these factors impact landscape-scale patterns. In coastal wetlands, tall-form cordgrass typically lines tidal creeks, obstructing nekton predator access to marsh platforms. In Georgia, high-density fronts of herbivorous crabs (*Sesarma reticulatum*) can remove cordgrass from creeks and interact with physical and biological stresses to structure communities. To quantify these potential effects, we investigated how predation, recruitment, and community structure differ across southeastern US salt marsh platforms fed by grazed and ungrazed creeks. Mussel and snail tethering revealed that at low elevations, predation on grazed creeks is 6.5- and 7-times higher, respectively. Additionally, recruitment assays show that mussel and snail recruitment on grazed creeks is 108- and 1.6-times lower, respectively. At high elevations, heat and desiccation on grazed creeks further increased snail and mussel mortality. Surveys of 6 sites across 150 km of coastline reveal that invertebrate density and diversity are regionally depressed on platforms fed by grazed creeks. Thus, crab grazing exacerbates top down predator and physical stress control, generating landscape scale depression of biodiversity that will decrease productivity and lead to the damage and loss of these ecosystems.

Presenter's Email: Thomas_Pettengill@brown.edu

Triclosan alterations of estuarine phytoplankton community structure

James L. Pinckney*; Laura Thompson; Sarah Hylton

Baruch Institute and School of the Earth, Ocean, and Environment

Antimicrobial additives in pharmaceutical and personal care products are a major environmental concern due to their potential ecological impacts on aquatic ecosystems. Triclosan (TCS) has been used as an antiseptic, disinfectant, and preservative in various media. The sublethal and lethal effects of TCS on estuarine phytoplankton community composition were investigated using bioassays of natural phytoplankton communities to measure phytoplankton responses to different concentrations of TCS ranging from 1 – 200 µg l^{-1}. Phytoplankton groups (diatoms, chlorophytes, cryptophytes) examined in this study exhibited EC_{50} values ranging from 10.7 to 113.8 µg TCS l^{-1}. Exposures resulted in major shifts in phytoplankton community composition at concentrations as low as 1.0 µg TCS l^{-1}. This study demonstrates the sensitivity to TCS exposure and highlights

the more sinister effects of alterations in phytoplankton community composition at what are typically environmental concentrations of TCS in urbanized estuaries.

Presenter's Email: pinckney@sc.edu

Importance of functional success criteria for restoration monitoring

Jennifer Beseres Pollack[1*]; Danielle Aguilar[1]; Brittany Blomberg[2]; Kevin De Santiago[1]; Patrick Graham[2]; Benoit Lebreton[3]; Terry Palmer[1]; Ryan Rezek[1]

[1]Texas A&M University-Corpus Christi; [2]Dauphin Island Sea Lab; [3]Institut du Littoral et de l'Environnement, Université de La Rochelle

Oyster reef restoration seeks to ameliorate the loss of ecological functions and ecosystem services associated with habitat degradation. Common restoration goals include creating or expanding reef habitat, enhancing oyster production and harvests, and improving water quality and clarity. Despite an exponential increase in restoration efforts over the past 2 decades, there is still a need to develop clear and measurable targets for structure and function against which to assess project success. For the past 7 years, we have monitored over 70 acres of restored subtidal oyster reef in Texas to measure project performance and determine whether modification of efforts is necessary. Using a combination of long-term data and reference habitats, we have developed quantitative structural and functional criteria to evaluate restoration success. Although it is first important to ensure that monitoring occur and that data sharing follows, it is equally important to develop project-scale success criteria to inform goal setting and evaluate restoration outcomes.

Presenter's Email: Jennifer.pollack@tamucc.edu

Eastern oyster, *Crassostrea virginica,* valve gape behavior under diel-cycling hypoxia

Porter, E. T.[1*]; and Breitburg, D. L.[2]

1 Yale Gordon College of Arts and Sciences, University of Baltimore; [2]Smithsonian Environmental Research Center

Hypoxia and anoxia in many estuaries worldwide can cause a wide range of negative effects on animals that are directly exposed or indirectly influenced by food-web interactions. Valve gape of 1-year old eastern oysters, *Crassostrea virginica*, from Maryland, USA, was continuously measured while exposed to diel-cycling dissolved oxygen [DO] in aquaria during normoxic, hypoxic and supersaturated phases of the cycle over several 2-d periods (July–August 2012). Severe hypoxia (0.6 mg DO L^{-1}) induced oysters to close for significantly longer times than normoxic (7.3 mg DO L^{-1}) conditions. Oysters exposed to mild hypoxia (1.7 mg DO L^{-1}) closed for a similar amount of time as oysters held at normoxia and severe hypoxia. At severe hypoxia, more than one third of the oysters closed simultaneously and closed immediately when they encountered severe hypoxia while oysters at mild hypoxia often closed later in the low oxygen phase of the cycles. When normoxia was reintroduced after severe hypoxia, most oysters opened immediately and gaped throughout the period. The results indicate that while one-year old oysters responded negatively to diel-cycling low [DO], especially to severe hypoxia, they rapidly opened during the normoxic period that followed, potentially reducing any negative effects of a fluctuating environment.

Presenter's Email: eporter@ubalt.edu

Can we estimate molluscan abundance and biomass on the continental shelf?

Powell, E.N.[1]*; Mann, R.[2]; Kuykendall, K.M.[1]; Long, M.C.[2]

[1]Department of Coastal Sciences, University of Southern Mississippi; [2]Virginia Institute of Marine Science, College of William and Mary

We consider the implications of suboptimal sampling on estimated abundance and size-frequency for a principal carbonate producer of the Mid-Atlantic continental shelf, the surfclam, *Spisula solidissima*. A field evaluation of the influence of sample density reveals that, as sample density declines, the probability of a survey availability event, defined as a survey index >125% or <75% of the true population abundance, increases and that increase is disproportionately biased towards underestimates at sufficiently low sample density. Thus, the influence of sampling sufficiency interjects a series of incremental challenges. At woefully inadequate sampling intensity, the probability of a biased low survey index substantially exceeds the probability of a biased high index. The survey time series returns a long-term signal that underestimates true stock abundance. As sampling intensity is increased, the frequency of biased high and low indices gradually balances. Incrementing sample number thereafter steadily reduces the likelihood of bias; however, a sample density necessary to reduce the frequency of survey availability events to a preferred level may be high. Moreover, certain size classes will be disproportionately susceptible to such events and the impact on size frequency may be species specific, depending on the relative dispersion of the size classes.

Presenter's Email: eric.n.powell@usm.edu

Sediment Characteristics as an Environmental Control on the Success of free-living *Symbiodinium*

Powers, C.C.[1*]; Zeeman, S.I.[1]; Fox, J.[1]; Brazeau, D.[1]

[1] The University of New England, Department of Marine Sciences, Biddeford, Maine

Due to recent mass coral bleaching, research on the health of coral reef ecosystems has become a major priority. The response of the coral holobiont to bleaching conditions is well-covered in the current literature; however, this research primarily focuses on the ecology of corals and their symbionts and may miss some of the indirect influences of the environment on the system. The ecology of a successful coral reef ecosystem may be further understood by studying free-living zooxanthellae, as well as symbiotic. Many corals acquire zooxanthellae through horizontal transmission, so neglecting aposymbiotic zooxanthellae leads to an incomplete understanding of coral reef recovery after bleaching events. The current understanding of the ecology of aposymbiotic zooxanthellae indicates that they are benthic algae and that the presence or absence of a sediment has been shown to have a significant influence on the stress response of these algae. The relationships between different sediment characteristics and the success of *Symbiodinium* has not been well established. By varying qualitative traits of the sediment, we have shown that both particle grain size and mineral composition have significant effects on the success of zooxanthellae and may act as environmental controls.

Presenter's Email: cpowers8@une.edu

Septic Tank Nutrient Groundwater Monitoring at Waterfront Residences on Florida's East Coast

Thomas L. Price Jr.* and Thomas V. Belanger

Kennedy Space Center and Florida Institute of Technology

Studies of Onsite Sewage Treatment and Disposal Systems (OSTDS) or "septic tanks", were conducted to assess the potential for impact to adjacent surface waters. Investigations involved groundwater and surface water monitoring at 28 volunteer residential households served by septic systems in the lower St. Johns River and the Indian River Lagoon basins. Sampling typically consisted of monitoring numerous (>10) groundwater sampling

locations at each residence, located between the septic system drainfield and receiving water. Sampling was conducted four times annually, in wet and dry seasons, over the course of one to two years. In half of sites studied, plumes were sufficiently well defined to calculate plume length; and, at several sites plume length exceeded the distance from drainfield to surface water indicating nutrient contribution to the surface water. Values for nutrient loading to surface water were lower than those calculated by ArcNLET, an alternate GIS based model designed to simulate groundwater nitrate transport from septic tank to surface water. When extrapolated for comparison to TMDL driven nitrogen reduction goals for the Indian River, the values calculated by this study suggests that septic tanks provide a small contribution to the excess nitrogen input to the IRL.

Presenter's email: thomas.l.price@nasa.gov

Red drum ontogenetic shifts in prey network structure and individual specialization mediate persistent organic pollutant accumulation.

Kimberly Prince*[1]; Christine Angelini[1]

[1]University of Florida Department of Environmental Engineering Sciences

Once widely used as a dielectric or coolant, polychlorinated biphenyls (PCBs) are now known as one of the most pervasive persistent organic pollutants to contaminate aquatic environments. Although banned in 1979, PCBs are still recorded in high levels, especially in top marine predators, and are linked to impaired reproduction among these species, emphasizing the need to identify the mechanisms by which PCBs continue to accumulate. To advance knowledge and inform coastal management, we test how life stage, trophic position, and prey network structure of a high profile and economically valuable coastal predator, red drum (*Sciaenops ocellatus*) influences PCB accumulation. Preliminary results demonstrate that total PCB concentration increases with life stage, and that stable isotope signatures of individual specialization correspond strongly with high variance in total PCB concentration among sub-adult and adult fish. Ontogenetic stage drove significant variation in homolog and congener profiles as well further emphasizing the effect of expanding prey network size and complexity on driving shifts in PCB accumulation. After analyzing stable isotope, gut content, and age (otolith) data, this study will reveal how red drum trophic level ($\delta^{15}N$), prey network structure, and relative PCB concentration shift as individuals mature, and whether or not the strongest trophic links are key pathways for PCB accumulation. Results will inform management strategies by identifying the life stage at which red drum accumulate PCBs the fastest and the prey species that are essential to PCB accumulation.

Presenter's Email: Kprince@ufl.edu

A regional comparison of Florida Gulf Coast intertidal oyster reef characteristics, oyster size-frequencies and abundances, and associated assemblages

Proffitt, C.E.*[1]; Coen; L.[2], Geiger, S.[3]; Kimbro, D.[4]

[1]Department of Life Sciences, Texas A&M University – Corpus Christi; [2]Harbor Branch Oceanographic Institute, Florida Atlantic University; [3]Florida Fish and Wildlife Conservation Commission; [4]Marine Science Center, Northeastern University

For >500 km of Florida's Gulf coast, using a nested design we compared 4 regions, 3 sites within each region, and sampled 5 reefs within a given site for intertidal oyster reef characteristics, oyster population parameters, and the composition and diversity of associated invertebrate assemblages. We mapped reef area and determined rugosity and topographic relief, mean oyster sizes and densities, and abundances of other molluscs, and decapod crabs, totaling 100 species and >17,000 individuals. Mean reef area varied significantly among region: N to S, Big Bend=1,144 m^2; Tampa Bay=333 m^2; Pine Island Sound=673 m^2; and Rookery Bay=265 m^2. Reef slope, relief and rugosity also all varied by region, but only relief differed by site(region). Oyster abundance ranged from 142-6,722 m^2 among all reefs. Oyster densities were greatest in Pine Island Sound (Ft. Myers area) and lowest in the Big Bend. Dominant mussels in the north were *Brachidontes exustus* and *Ischadeum recurvum* were largely

replaced as numerical dominants in the south by *Gukensia cf. demissa* and *Geukensia granosissima*. Similarly, the mud crab *Eurypanopeus depressus* was dominant on northern reefs, but far less abundant at other regions. Taxanomic similarities, analyzed by permanova, also differed by region, time, and site(region).

Presenter's Email: ed.proffitt@tamucc.edu

Grazing Potential of the Bucktooth Parrotfish, *Sparisoma radians,* on Turtle Grass, *Thalassia testudinum*, and the Invasive Seagrass, *Halophila stipulacea,* in St. John, USVI

Pudlak, E.*; Bologna, P.

Marine Biology and Coastal Sciences Program, Montclair State University

Seagrass beds are essential habitats that provide ecosystem services including sediment stabilization and carbon sequestration. Additionally, grazing provides a fundamental trophic link. The invasive seagrass, *Halophila stipulacea*, is expanding throughout the Caribbean. The presence of this invasive macrophyte could result in a shift in habitat and community structure, and impact trophic pathways. Bucktooth parrotfish are dominant grazers on the native seagrass *Thalassia testudinum*. Field and laboratory experiments were conducted to assess potential herbivory of *S. radians*. Results showed that *S. radians* significantly consumed more *T. testudinum* in both lab and field experiments. However, there were more bites per blade on the invasive seagrass, suggesting that *S. radians* may use compensatory feeding on *H. stipulacea.* Field experiments showed *T. testudinum* was favored, especially in mixed beds, but seemingly suppressed in monospecific beds of each species. This might reflect an avoidance of *H. stipulacea* as both food and habitat by *S. radians* with a preference for *T. testudinum* when readily available. As such, if native seagrasses decline within the region, the expansion of *H. stipulacea* may provide a food source to herbivores and contribute to trophic transfer in these regions, but may not provide the same structural habitat of *T. testudinum*.

Presenter's Email: Pudlake1@montclair.edu

Temperate rocky shore cryptic species and ecological implications

Pujdak, C.*[1]; Dudgeon, S.R.[1]

[1]Department of Biology, California State University Northridge

Ecologists' perceptions about the processes that organize communities are strongly influenced by the delimitation of species in number and their ecological similarity. The recent advent of rapid and inexpensive DNA sequencing has allowed for cryptic species to be differentiated. Criteria by which clusters of individuals are distinguished as species rather than populations are often poorly defined and the incidence of asexuality complicates species delimitation. Many cryptic species in the genus *Mastocarpus* from the Northeast Pacific have been identified, but asexual reproduction is rampant in all species studied. To explore the use of a more standardized method of species level distinction using only sexual individuals, we employed the K/Θ metric of population genetic theory to determine phylogenetic relationships within the eastern pacific *Mastocarpus* species complex using DNA sequence variations in *cox*-1 and *rbc*L. K/Θ ratios exceeded >4 for tests among most putative clades implying reciprocal monophyly. This metric is useful for delimiting cryptic species in mixed sexual and asexual populations. The likelihood of several ecologically indistinguishable cryptic species coexisting in the intertidal zone implies the existence of unappreciated ecological processes driving divergence in sympatry on small spatial scales on temperate rocky shores.

Presenter's Email: Cameron.pujdak.568@my.csun.edu

Vertical distribution of meroplankton in a well-mixed estuary in Northeast Florida

Raabe, J.*; Gilg, M.

The Biology Department, University of North Florida

The ability of larvae to migrate vertically can be crucial in strengthening dispersal potential as it can allow the larvae to modify the direction and rate of movement. Many studies have shown how vertical distribution of larvae is controlled by chemical or physical stratification of the water column, but can larvae exhibit these vertical swimming behaviors without stratification? Vertical distributions of planktonic larvae of bivalves, barnacles, gastropods, polychaetes, crabs, shrimp, and tunicates were assessed by using depth-specific sampling at two sites along the Intracoastal Waterway of Northeastern Florida. Collection cycles took place during the summer twice per month for three months, and four collections were made at each site per collection cycle to include all tides within a 24 hour period. Our preliminary results give some insight into the differing behaviors and environmental responses of various meroplankton taxa in a shallow, well-mixed estuary. For example, preliminary data show bivalves, polychaetes, gastropods, barnacles, and tunicates were most abundant near-surface at night, while crab and shrimp were found to be most abundant at midwater during the day. Other factors that could influence vertical migration were also examined, such as, tide (neap vs. spring), tidal current (ebb vs. flow), temperature, salinity, and fluorescence.

Presenter's Email: N00829564@ospreys.unf.edu

Factors controlling the abundance of the macroalgae, *Dictyota* spp. and their interactions with stony corals in St. Thomas, USVI

Tanya Ramseyer*; Dr. Tyler Smith

Center for Marine and Environmental Science, University of the Virgin Islands

Macroalgae, specifically the brown algae *Dictyota* spp., have been steadily increasing on coral reefs due to a myriad of internal and external factors. High nutrient levels and decreased herbivore populations are known to influence *Dictyota* abundance on Caribbean coral reefs. In St. Thomas, USVI the success of *Dictyota* spp. can also be attributed to the ability to fragment, and reproduce asexually and sexually. An herbivory nutrient manipulation experiment using Osmocote fertilizer and herbivore exclusion cages was performed at three sites south of St. Thomas. This experiment was conducted twice; once measuring average height (cm) of *Dictyota* for four consecutive months and once measuring the average change in biomass over two weeks. During this study, variables such as coral health, temperature, salinity, and swell were recorded at each site for comparison. Preliminary results show no significant difference between treatment type, however, there was an effect of time and location suggesting external factors such as swell and temperature may be controlling the abundance of *Dictyota.* Analysis of reproductive traits determined asexual and sexual reproduction are contributing to the success of *Dictyota*. Results highlight the importance of testing multiple variables to determine factors influencing macroalgae abundance and their subsequent interactions with stony corals.

Presenter's Email: trams005@gmail.com

An invasive foundation species enhances multifunctionality in a coastal ecosystem

Ramus, A.P.[1,*], Silliman, B.R.[2], Thomsen, M.S.[3,4], Long, Z.T.[1]

[1]Department of Biology and Marine Biology, University of North Carolina Wilmington, Wilmington, NC 28403, USA, [2]Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University, Beaufort, NC 28516, USA, [3]Marine Ecology Research Group, School of Biological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand, [4]UWA Oceans Institute and School of Plant Biology, University of Western Australia, Hackett Drive, Crawley 6009 WA, Australia

While invasive species often threaten biodiversity and human well-being, their potential to enhance functioning by off-setting loss of native habitat has rarely been considered. We manipulated the abundance of the non-native, habitat-forming seaweed *Gracilaria vermiculophylla* in large plots (25-m^2) on southeastern U.S. intertidal landscapes to assess impacts on multiple functions underlying coastal ecosystem services. We document that, in the absence of native habitat formers, this invasion has an overall positive, density-dependent impact across a diverse set of ecosystem processes (e.g., wave attenuation, fisheries production). Manipulation of invader abundance revealed both thresholds and saturations in provisioning of ecosystem functions. Combined, these findings question the focus of traditional invasion research and management which assumes negative effects of non-natives and emphasizes the need to consider context-dependence and integrative measurements when assessing an invaders' impact, including density-dependency, multifunctionality, and the status of native habitat formers. This work supports discussion of the idea that where native foundation species are thought to be permanently lost, invasive habitat formers may be considered as a source of ecosystem services.

Presenter's Email: apr2993@uncw.edu

Linking environmental and demographic variation across North America in a clade of marine snails

Ramus, A.P.*[1]; Saucedo-Ewers, C.[2]; Kamel, S.J.[1]; Grosberg, R.K.[2]

[1] Department of Biology and Marine Biology, Center for Marine Science, University of North Carolina Wilmington; [2] Center for Population Biology, Department of Ecology and Evolution, College of Biological Sciences, University of California, Davis

Environmental variation plays a key role in shaping the traits of individuals, populations, species, and communities, with many ecological and evolutionary implications. We quantified dogwhelk population demographics at 10 sites across North America and analyzed long-term buoy data to investigate correlations between environmental and demographic variation. Our preliminary results show relationships between environmental and demographic variables that manifest at large-scales and generally do not follow a latitudinal gradient. Mean and variance in local temperature, habitat type, and wave exposure showed the strongest correlations with population density and body size across *Nucella* populations. These findings suggest that a detailed understanding of these links is vital to accurately predict how threats such as climate change impact population dynamics and ecosystem function in the Anthropocene.

Presenter's Email: apr2993@uncw.edu

Parasite-induced behavior modification of *Emerita talpoida*'s circatidal rhythm

Ashley Reaume*[1]; Donovan Loh[2]; & Dr. Thomas Schultz[2]

[1]Central Michigan University; [2] Nicholas School of Environment and Earth Sciences, Duke University Marine Laboratory

Endogenous biological clocks have been adopted by many organisms through evolution to synchronize various biological functions with opportune moments in time. The mole crab, *Emerita talpoida,* exhibits a distinct circatidal rhythm that has been previously well documented. Specific genes that influence activity cycles regulate these endogenous clocks, and a previous transcriptomic analysis of these genes has suggested that the tidally-induced genes may be influenced by trematode parasites that infect the crab. This study tests the hypothesis that mole crabs that are heavily infected with trematode parasites will exhibit rhythmic behavior. The activity of the crabs was observed under constant conditions and an individual's number of ascents out of the sand per half hour was counted for 24-48 hours. Rhythmicity was determined by plotting activity over time and the crabs were dissected to determine parasite load. A significant correlation was found between rhythmicity and metacercariae load, but not between rhythmicity and acanthocephalan load. Rhythmic crabs contained a higher mean parasite load than their non-rhythmic counter parts. Larger crabs had higher metacercariae and acanthocephalan loads and

also exhibited rhythmic behavior more frequently. This study suggests a behavioral, and thus a potential molecular link between metacercariae parasites and circatidal rhythmicity in mole crabs.

Presenter's Email: reaum1a@cmich.ed

Examining coral-associated microbial assemblages of the gorgonian *Eunicea flexuosa* on Caribbean reefs experiencing varied anthropogenic disturbances

Reigel, A.M.*[1]; Hellberg, M.E.[1]

[1] Department of Biology, Louisiana State University

Corals rely on complex assemblages of symbiotic algae (*Symbiodium* spp.) and microbes for their health and survival. While recent research on coral-associated microbes has highlighted their importance in coral health, their exact roles remain elusive. This is of particular concern, as corals are under increasing pressure from anthropogenic disturbances, especially shallow reefs in close proximity to land. The ability of coral colonies to cope with these disturbances will ultimately determine whether tropical reefs persist. This research examines the effects of anthropogenic impacts on coral-associated microbial assemblages found in the tissues of the Caribbean gorgonian *Eunicea flexuosa*. Microbial DNA from sea water, sediment and tissue samples of *E. flexuosa* in both "unimpacted" (largely unaffected by anthropogenic stress) and "impacted" (history of poor water quality/close to anthropogenic activity) reefs will be extracted and amplified for 16S rRNA gene amplicon sequencing using Illumina MiSeq. Using microbial OTU abundances, individual taxa will be correlated to environmental metadata (i.e.temperature, concentrations of nutrients and heavy metals) using weighted gene co-correlation network analysis to identify indicator taxa for various conditions. These results will provide insight into which environmental variables are driving the taxon composition of gorgonian-associated assemblages and their potential roles in corals facing anthropogenic stressors.

Presenter's Email: reige012@gmail.com

Competitive intransitivity in nearshore marine benthic communities across a biogeographic gradient

Michele F. Repetto*; Amy L. Freestone

Department of Biology, Temple University, Philadelphia PA

Global biodiversity patterns are characterized by increasing species richness from the poles to the tropics. Although the underlying mechanisms of this biogeographic pattern have not been fully elucidated, the 'biotic interactions hypothesis' has strong evolutionary roots and suggests that biological interactions, such as competition and predation, serve to maintain tropical biodiversity. Despite the potentially strong effects of competition in shaping natural communities, few empirical data exist to demonstrate latitudinal interaction patterns. Intransitive competition, defined as competitive networks lacking hierarchy, may be common in nature and enhance coexistence even when species compete strongly. However, the role of intransitivity in structuring communities and the relative importance of other factors, such as predation, influencing these competition networks remains unclear. Using standardized settlement panels in nearshore habitats across three biogeographic regions spanning 47 degrees of latitude, we quantified competitive intransitivity among sessile marine invertebrate communities and tested whether predation influences intransitivity. We found that mid- and low-latitude communities were characterized by intransitive networks, while high latitude communities may demonstrate greater sensitivity to abiotic factors than to competition. Contrary to theoretical predictions, we found no discernable effect of predation on intransitivity. This work furthers our understanding of species interactions and biodiversity across global biogeographic gradients.

Presenter's Email: mrepetto@temple.edu

BEM-SEERS 2017 Oral Presentation Abstracts

Molecular Identification of Nudibranch Predation on Cnidarians

Dena J. Restaino*[1]; Paul A. X. Bologna[2]; John J. Gaynor[2]

[1]Earth and Environmental Studies, Montclair State University; [2]Department of Biology, Montclair State University

Nudibranchs represent a key predator for cnidarian polyps as they obtain not only trophic resources, but also biomechanical defenses. Through the process of kleptocnidae, nudibranchs retain the cnidocysts as a defense mechanism by translocating cnidoblasts (containing cnidocysts) to their cerata. As these cells retain their DNA, they preserve a record of nudibranch diet beyond simple digestive track analyses. We collected aeolid nudibranchs in the field and using Cnidarian primers, we amplified sequences for 16S rDNA from grouped individuals. Our results showed that cnidarian DNA was present in over half of our samples with positive identification of *Obelia bidentata*, *Moerisia inkermanica*, and *Chrysaora quinquecirrha*. While *O. bidentata* and *C. quinquecirrha* are common in this system, the identification of the non-native *M. inkermanica* is the first recorded evidence of this species in New Jersey and the western mid-Atlantic. Lastly, four of our samples showed amplification identifying two nudibranch taxa (*Tenellia* sp. and *Ercolania* sp.) using the cnidarian primers. Consequently, there is great value in using amplified 16S rDNA from nudibranch kleptocnidae as a tool to identify Cnidarian polyp populations and potentially identify non-native cnidarian species invading global coastal regions.

Presenter's Email: restainod1@montclair.edu

Wave energy reduces the abundance and size of benthic species on oyster reefs

Lunt, J.[1,2]; Reustle J.[*1]; Smee, D.L.[1]

[1]Texas A&M University- Corpus Christi, Corpus Christi, TX 78412; [2]Smithsonian Marine Station at Fort Pierce, Fort Pierce, FL 34949

Hydrodynamic forces associated with waves influence the structure and function of rocky intertidal communities, but their effects on species composition and morphology within other marine communities have not been well studied. We measured wave characteristics and current speeds with acoustic Doppler velocimeters (ADVs) at oyster reefs (*Crassostrea virginica*) in St Charles and Aransas bays, Texas. We investigated wave effects on communities at these reefs by comparing species composition, relative abundance and species morphology on windward vs. leeward sides. In addition, acorn barnacles (*Amphibalanus eburneus*) were used as biological indicators of flow because they develop larger basal diameters and shorter feeding appendages in faster flows. Waves were higher and current speed was faster on the windward sides of oyster reefs. Leeward sites had a greater abundance and diversity of species. Brachyuran crabs were significantly larger and more abundant when shielded from waves. Porcelain crabs (*Petrolisthes armatus*) were smaller and, in contrast to brachyuran crabs, more abundant at windward sites. Windward sites had fewer fish species though there was no difference in the size of fish found on either side of the reef. Barnacles settling in late spring had larger basal diameters but relatively shorter feeding appendages in windward areas, compared to leeward areas; these morphological differences mirrored ADV measurements, verified long-term differences in flow and were indicative of bigger waves and higher flow velocities in windward locations. Thus, oyster reefs can reduce wave height and slow current velocity, and influence the diversity, abundance, and morphology of associated species. The decrease in wave height can provide shoreline protection, an ecosystem service of oyster reefs often mentioned but rarely measured.

Presenter's Email: jreustle@islander.tamucc.edu

Plant genotype identity, diversity, and mesograzer species diversity interactively influence detrital consumption in eelgrass meadows

Reynolds, L.K. [1,2*]; Chan, K.M. [1] ; Huynh, E. [1]; Williams, S.L.[1,3] ;Stachowicz, J.J. [1]

[1] University of California Davis; [2] University of Florida; [3] Bodega Marine Laboratory

Seagrass meadows are among the world's most productive ecosystems, and like many other systems, genetic diversity is correlated with increased production. However, only a small fraction of seagrass production is directly consumed, and instead much of the secondary production occurs via the detrital food web. Here, we study the roles of plant genetic diversity and grazer species diversity on detrital consumption in California eelgrass (*Zostera marina*) meadows. We used three common mesograzers—an amphipod (*Ampithoe lacertosa*), an isopod (*Idotea resecata*), and a polychaete (*Platynereis bicaniculata*). Each grazer consumed detritus at rates greater than live tissue or macroalgae. This detrital consumption, however, was not spread evenly over different eelgrass clones. Palatability and consumption varied because of genotype specific differences in leaf texture, secondary metabolites (phenolics), and nutritional quality (nitrogen). Further, all grazers were not equal. Some genotypes were palatable to all grazers, while others were preferentially consumed by only one grazer species. Under monospecific grazer assemblages, plant genetic identity but not diversity influenced consumption. However, more realistic, diverse mesoconsumer communities combined with increased plant genotypic diversity resulted in greater consumption and grazer survival. These results provide a mechanism for field observations of increased mesograzer density and diversity in genetically diverse seagrass assemblages and offer a potential explanation for variation in results of resource diversity – detrital processing experiments in the literature, which often exclude macroinvertebrate taxa. More broadly, our findings support the emerging principle that biodiversity effects are strongest when diversity in both consumer and resource taxa are present.

Presenter's Email: lkreynolds@ufl.edu

Functional equivalence of offshore platforms and "Rigs-to-Reefs" artificial reef communities in the Gulf of Mexico.

Rezek R.[1]*; Lebreton B.[2]; Stunz G.W.[1]; Pollack J.[1]

[1]Department of Life Sciences, Texas A&M University Corpus Christi; [2]CNRS, University of La Rochelle

Offshore platforms provide important habitat for fish and invertebrate species in the Gulf of Mexico, and are among the most productive habitats per area of ocean due to their vertical relief. To prevent habitat loss when these platforms are decommissioned, the "Rigs-to-Reefs" program attempts to maintain this habitat by removing the top portion (~26 m) of decommissioned platforms and converting them into artificial reefs. In this study, we examine and compare the epibenthic community of 2 standing rigs at 5-m and 30-m and 3 artificial platform reefs at 30-m depths with a combination of community and stable isotope analysis to assess the functional equivalency of these habitats. We found these habitats to be dominated by Atlantic Foam Oysters (*Hyotissa mcgintyi*); forming a complex reef structure that provides habitat for diverse motile macrofauna communities. Similar bivalve biomass was found between all habitats. However, motile macrofauna and bivalve density were greater in shallow platform sites than 30-m deep artificial reef and standing platform sites. Artificial reefs supported a similar community trophic structure to standing rigs. These results are promising as they indicate that "Rigs-to-Reefs" efforts can replace ecological functions lost when decommissioned oil rigs are removed.

Presenter's Email: Ryan.rezek@tamucc.edu

Application of a Passive Acoustic, Fish Call Detection Tool to Assess Oyster Reef Restoration Success

Ricci, S.W.*[1]; Bohnenstiehl, D.R.[1]; Eggleston, D.B.[1]; Kellogg, M.L.[2]; Lyon, R.P.[1]

[1]Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University; [2]Virginia Institute of Marine Science, College of William and Mary

Evaluating ecosystem services provided by restored oyster reefs is crucial in determining restoration success. Sampling fish and benthic communities at subtidal oyster reefs can be labor-intensive, and low-visibility conditions or sampling gear restrictions can bias estimates of the animal assemblages using reefs as habitat. Passive acoustics is becoming more widely used in marine environments as a way to monitor these habitats. Processing and analyzing sound files, however, can be time-consuming and requires specific expertise. This study developed a spectrogram correlation method to automatically detect boatwhistle calls of oyster toadfish (*Opsanus tau*), a sound-producing, reef-dwelling species common in estuaries. Passive acoustic recorders were deployed at eight sites in the Harris Creek Oyster Sanctuary, Chesapeake Bay, MD, and set to record during May 2015. Fish call detections from recordings revealed significant relationships between toadfish boatwhistle characteristics and environmental variables. Most notably, there was a significant difference in call rate between restored and unrestored reefs, with restored sites having nearly twice the call rate as unrestored sites. With advances in both recording equipment and automated processing techniques, passive acoustics can provide an exciting and informative way to study marine habitats, particularly in systems that are difficult to sample otherwise.

Presenter's Email: swbrown@ncsu.edu

Characterizing skeletal growth trends for two massive reef-building corals throughout the Florida Keys Reef Tract

Rippe JP[1], De Leener DN[1], Baumann JH[1], Castillo KD[1,2]

[1]Department of Marine Sciences, University of North Carolina at Chapel Hill, Chapel Hill, NC; [2]Curriculum for Environment and Ecology, University of North Carolina at Chapel Hill, Chapel Hill, NC

Through the slow, continuous growth of their calcium carbonate skeletons, corals record invaluable information about past environmental conditions and how they may affect colony fitness. As climate warming continues to threaten coral reefs worldwide, these living archives can be used to help identify reefs that are particularly susceptible or resilient to environmental change. This study seeks to characterize and compare growth trends of inner and outer reef corals across ~200 km of the Florida Reef Tract using skeletal cores extracted from two ubiquitous mounding species, *Siderastrea siderea* and *Pseudodiploria strigosa*. In 2015, ten cores of each species were extracted from four sets of paired inner-outer reef sites spanning the entire reef tract, and growth parameters were assessed using 3-D computerized tomography. Skeletal extension rates were estimated from the thickness of semiannual growth bands and were combined with density measurements to yield calcification rate. Inner and outer reef colonies do not differ significantly in short- or long-term growth trends; however, all corals have experienced a significant decline in extension in the last 25 years. This century-scale investigation will provide critical insights into our understanding of how corals on the Florida Reef Tract are likely to respond to future climate change scenarios.

Presenter's Email: jpr6mg@gmail.com

Juvenile green sea turtle grazing and the tropicalization of the northern Gulf of Mexico

Rodriguez, A.*[1,2]; Heck, K.L.[2,1]

[1]Department of Marine Sciences, University of South Alabama; [2]Dauphin Island Sea Lab

Poleward habitat expansions are occurring at a rapid rate, increasing the need for assessments of climate change impacts to local ecosystems. The Gulf of Mexico is a prime location to study the effects of habitat expansions because of the proximity and connectivity among tropical, subtropical and warm temperate climates. With warming sea surface temperatures and effective conservation, the green sea turtle (*Chelonia mydas*) is becoming more abundant at the northern limits of its ranges. In the Gulf of Mexico green turtles feed primarily on *Thalassia testudinum* or turtlegrass. Seagrasses are a vital, globally threatened ecosystem that is well documented to provide numerous valuable ecosystem services. As the range of *C. mydas* increases into the northern Gulf of Mexico grazing pressure on turtlegrass is also increasing. The overarching goal of our work is to quantify current juvenile green sea turtle grazing rates and estimate future effects on the turtlegrass beds of Saint Joseph Bay, Florida. Given the high likelihood of continuing climate-induced increases in the northward expansion of green turtles in the coming years, it is critical that we track the changing status and deepen our understanding of how these seagrass-dominated systems will change as tropicalization continues.

Presenter's Email: arodriguez@disl.org

The Effect of the Deepwater Horizon Oil Spill on Ecosystem Services in the Northern Gulf of Mexico

Rohal, M.[1]*, Ainsworth, C.[2], Lupher, B.[1], Montanga, P.[1], Paris-Limouzy, C.[3], Perlin, N.[3], Suprenand, P.[4] and Yoskowitz, D.[1].

[1]Harte Research Institute Gulf of Mexico Studies, Texas A&M Corpus Christi; [2]University of South Florida, St. Petersburg Florida; [3]Rosenstiel School of Marine and Atmospheric Science, Miami Florida; [4]Mote Marine Laboratory, Sarasota Florida

It is likely that the Deepwater Horizon (DWH) blowout and oil spill affected ecosystem services in the Gulf of Mexico. An *Ecopath with Ecosim* model was developed to quantify the effects for the Northern Gulf of Mexico that incorporated two ecosystem services: commercial fisheries and carbon sequestration. The domain of the model ranges from 24 - 31°N latitude to 80 - 98°W longitude with depths ranging from 0 - 2000 m. The model predicted an overall decrease in both services investigated. Changes in commercial fisheries and carbon sequestration were valued by linking service model outputs to monetary valuation models. The change in commercial fisheries yield resulted in monetary changes ranging from an increase of $65 to a loss of $5.1 million in one year. Investigation of carbon sequestration predicted up to an $8.8 thousand loss in the ability of the Northern Gulf of Mexico offshore environment to sequester carbon. This value was calculated by multiplying the IWGSCC (2015) social cost of carbon by the amount detritus, a proxy for carbon that is buried offshore. These methods and estimates of ecosystem services provided by the Gulf of Mexico and changes of those services as a result of the DWH accident can be useful to evaluate the ecological and socioeconomic impacts of oil spills and other anthropogenic disturbances in general.

Presenter's Email: Melissa.rohal@tamucc.edu

Factors Affecting Ghost Crab (*Ocypode quadrata)* Populations and Burrow Characteristics Along the Grand Strand

Rosch, E.*

Department of Marine Science, Coastal Carolina University

There is little doubt that the development of coastlines can have adverse effects on the local habitat and organisms. Assessing the impact of human activities, however, can be elusive. By examining the population structure of upper trophic level endemic species that exhibit strong site fidelity, one may be able to broadly assess the consequences of human development and activities on coastal environments. Ghost crabs, *Ocypode quadrata*, represent an ideal organism to assess the relative health of beach environments due to their function as beach predators and scavengers and easily identifiable burrows. Counts and characteristics of ghost crab burrows were

surveyed at locations with varying degrees of coastal development and foot traffic. The results indicate that increased human activity was associated with lower ghost crab abundance and may have had an effect on burrow architecture. Low-impact beaches showed a nearly ten-fold increase in burrow counts compared to heavily trafficked areas. Sand compaction was also shown to differ among beaches, even when taking into account burrow location in different beach zones. These results suggests that examining ghost crab burrows can be a useful tool to quickly and accurately assess the overall impact of human activities on beach ecosystems.

Presenter's Email: erosch@coastal.edu

FFish use of reef structures and surrounding sand flats: implications for buffer zones between existing and new artificial reefs

Rosemond, R.C.*[,1]; Paxton, A.B.[1,2]; Lemoine, H.R.[1]; Peterson, C.H.[1,2]

[1]Institute of Marine Sciences, University of North Carolina at Chapel Hill; [2]Department of Biology, University of North Carolina at Chapel Hill

Artificial reefs are deployed world-wide to enhance fisheries. Placement of new artificial reefs relative to nearby existing reefs influences fish communities, yet no quantitative guidelines exist for buffer distances between reefs. We determined buffer zones around reefs where placement of new reef structures should be avoided. We sampled fish communities and environmental variables on twenty-four temperate reefs, including artificial and natural reefs. We surveyed 30 m on reefs and along three transects of increasing distance away from reefs into contiguous sand habitat: 0-30 m, 30-60 m, and 60-90 m away from reefs. Fish abundance, biomass, species diversity, species richness, and species evenness decreased significantly from reefs to 30-60 m away from reefs and remained low 60-90 m away from reefs. Fish community composition shifted gradually, with the community composition on-reefs most dissimilar to the community composition on sand habitat farthest from the reefs. A buffer of 60 m (30 m around existing reefs plus 30 m around new reefs) and 120 m (60 m plus 60 m) between reefs would encompass ~80% and ~91%, respectively, of fishes occupying contiguous sand habitat around each reef. Future artificial reef deployment should include these buffer zones between reefs to more effectively enhance fisheries.

Presenter's Email: rclairer@ad.unc.edu

Investigating how changing environmental conditions may affect the chemosensory abilities of benthic crustaceans: the Caribbean spiny lobster model

Ross, E.[1]; Behringer, D.[1,2]

School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences, [1]Univesity of Florida, Gainesville FL.; [2]Emerging Pathogens Institute, [1]Univesity of Florida, Gainesville FL.

Coastal ecosystems are some of most important ecosystems on the planet, however, they are on the frontlines of environmental change. They are often an essential nursery habitat for valuable fisheries such as the Caribbean spiny lobster, *Panulirus argus*. In Florida Bay, extreme seasonal weather events combined with rising temperatures, ocean acidification, and loss of habitat increase stress on spiny lobsters. While we have a growing understanding of the effect of these environmental changes on the survival, movement, and growth, the effect on their chemosensory abilities has not yet been documented. Lobsters rely heavily on chemical cues for many biological and ecological activities. This study aimed to determine the effect of environmental changes on the sheltering preference in *P. argus*. In control conditions, spiny lobsters used chemical cues from conspecifics to identify suitable shelter and used cues from competitors and diseased individuals to identify shelters to avoid. In altered environmental conditions, lobsters did not significantly differentiate between conspecific, diseased conspecific, or competitor shelters. Globally, environmental conditions may change gradually, permitting a degree of adaptation, however, extreme events alter the chemosensory abilities of crustaceans. These effects may be more prominent for nearshore crustaceans, where extreme events are more pronounced and frequent.

Presenter's Email: epross@ufl.edu

Orange is the New Dead: Parasitization Alters Predation Rates in Salt Marsh Amphipods

Michael S. Roy[1]*; David Samuel Johnson[2]; Jarrett E. K. Byrnes[1]

[1]University of Massachusetts Boston; [2]Virginia Institute of Marine Science, College of William and Mary

Parasites impact their hosts' fitness in a variety of ways, including behavioral alterations, castration, sex switching, and increased vulnerability to predation. The trematode *Levinseniella byrdii* changes the external color of its amphipod host *Orchestia grillus* from brown to orange, and eliminates the host's ability to detect light and dark (i.e. phototaxis). We hypothesized that this change increases host mortality and facilitates trophic transmission to a bird predator. To test the effect of color change on the predation rate of amphipods, we conducted tethering trials in summer 2016 in the Plum Island Estuary (PIE), Massachusetts. We compared predation rates of tethered prey in five amphipod treatments: parasitized (orange), unparasitized (brown), unparasitized individuals painted orange, parasitized individuals painted brown, and a caged control (n = 5 per trial). After 13 trials, orange amphipods were consumed nearly twice as frequently as brown. We suggest that this parasite could influence the flow of energy through the Plum Island Marsh food web and broad scale community dynamics. Further, we know that nutrient loading increases parasite prevalence due to increased abundance of the parasite's first gastropod host. Therefore, we suggest these parasites are a bellwether to altered New England salt marsh dynamics resulting from long-term eutrophication.

Presenter's Email: Michael.Roy002@umb.edu

Investigation of trophic ecology in Newfoundland cold water deep-sea corals using lipid class and fatty acid analyses

Salvo, F.*[1]; Hamoutene, D.[1]; Wareham V. E.[1]; Edinger E. N.[2]; Parrish C.C.[3]

[1]Fisheries and Oceans Canada, St John's, NL; [2]Department of Geography, Memorial University of Newfoundland; [3]Department of Ocean Sciences, Memorial University of Newfoundland

We explored the potential diet of corals using fatty acid and lipid analyses to better understand the effect of location, taxa, and species on the trophic behavior of cold water corals (CWC). Our findings show differences in diet between CWC taxa groups, and in some instances between coral species not related to differences in depth or geographic location. Soft corals and gorgonians had higher amounts of 20:4ω6 fatty acids, likely relying on phytodetritus resulting from algae, macrophytes and/or foraminifera while sea pens consumed more diatoms and/or zooplankton consuming diatoms. Antipatharians and stony corals were found to be rich in an intermediary product (22:5ω3) between eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) and despite low carnivory ratios, their diets included zooplankton derived food. Some antipatharians were found to have a lower content in structural lipids than the other corals, likely due to slower growth rates, as documented by other authors. Variation in trophic ecology within taxa groups appeared at the species level, highlighting the evolutionary strategy to diversify food sources within the same clade in deep-sea habitats where access to food is limited.

Presenter's Email: Flora.Salvo@dfo-mpo.gc.ca

Pick your poison: Resource ecology trade-offs influence parasitism in an invertebrate system.

Sanchez, K. F.*; Duffy, M.A.; Hunter M. D.

Ecology and Evolutionary Biology Department, University of Michigan

Understanding the causes and consequences of disease outbreaks in organisms requires understanding the role of the environment in shaping parasite-host interactions. *Daphnia* are exposed to a wide array of phytoplankton and parasites in freshwater ecosystems, and this exposure can vary both spatially and temporally. Plankton also vary both in nutrient quality and secondary metabolites. The chemical arsenal of phytoplankton can confer benefits such as defense against herbivory and other microbes, therefore raising the question whether these metabolites have an effect on *Daphnia* parasites. We investigated the role of food quality on disease emergence and transmission, as well as the consequences of toxic food consumption by *Daphnia* on host and parasite fitness. Results shows that both toxins and nutrient quality can influence disease in *Daphnia*, but that these effects differ between parasite species. Diet influenced prevalence of *Metschniknowia* infections with *Anabaena* and *Microcystis* diets preventing infections. Pasteuria prevalence was not influenced by diet. Conversely, spore fitness was not impacted by diet for *Metschnikowia* infections, whereas diet influenced the number of spores produced in *Pasteuria* infections. This research shows that consumption of resources that contain toxins can strongly influence herbivore fitness in the presence of parasites.

Presenter's Email: Kfsanche@umich.edu

Oyster Pathogens as Bioindicators of Freshwater Inflow Needs for the Texas Coast

Savage, K. *; T.A. Palmer; P.A. Montagna; J.B. Pollack

Department of Life Sciences, Texas A&M University - Corpus Christi

Long-term changes in freshwater inflows over a climatic gradient along the Texas coast have provided an opportunity to examine relationships between inflows and oyster dynamics; specifically, the oysters' relationship with the oyster pathogen Dermo (*Perkinsus marinus*). The eastern oyster (*Crassostrea virginica*) is used in this study as a bioindicator to identify the environmental conditions needed to regulate Dermo disease on a regional scale and a local scale. On a regional scale, 10+ years of oyster disease, climate indices, freshwater inflow, and salinity data from 6 Texas estuaries have been compiled to determine freshwater needs across a climatic gradient, and to link climate variability to salinity regimes and oyster disease dynamics. Climate-driven wet conditions across Texas estuaries promote significantly less severe infections and lower concentrations of Dermo disease. Estuaries in the southwest have significantly higher concentrations and more severe Dermo disease then estuaries in the northeast, with the exception of Trinity-San Jacinto estuary. Salinity, temperature, and Dermo disease have significantly increased over time in the southernmost estuaries. These results indicate that Dermo disease and thus estuarine health is being driven by climatic conditions and Texas estuaries in the southwest are more vulnerable to changes in climate. This study provides a more comprehensive understanding of freshwater inflow needs to Texas estuaries for supporting oyster populations, which is especially important with a predicted hotter drier future.

Presenter's Email: ksavage1@islander.tamucc.edu

Using absorption spectroscopy to map the distribution of water column properties in estuarine waters

Savidge, W. B.*; Doyle, K. R.

Skidaway Institute of Oceanography

In situ absorbance spectroscopy is a flexible optical technique for quantifying and characterizing dissolved constituents in natural waters. We coupled an S::CAN absorbance spectrometer to a continuous underway sampling system in order to characterize seasonal patterns in the abundance and distribution of organic and inorganic nutrients in the Ogeechee River estuary from the estuary mouth to ~0 ppt salinity. Eight riverine transects were run over four seasons between August 2015 and April 2016. Partial least squares regression was used to relate continuous underway absorption spectra to water samples collected from periodic bottle samples and from data collected by dedicated sondes. Using the spectrometer we were able to map the distributions of surface water properties at O(100m) spatial scales. In most instances partial least squares regression analysis of

absorption spectra agreed well with independent sonde data, and could reveal, for example, patterns of nitrate distribution that existed on spatial scales less than could be revealed by bottle sampling. Maps of absorbance properties could be somewhat noisy, making the technique better suited for establishing large to moderate scale distribution of water column properties rather than for precise quantification at any given sampling location.

Presenter's Email: william.savidge@skio.uga.edu

Biodiversity of wetland plants and resistance to disturbance: The Deepwater Horizon example

Scheffel, W.A.[*,1]; Heck, K.L.[1,2]; Hughes, A.R.[3]; Cebrian, J.[1,2]; Goff, J.[1]; Zerebecki, R.A.

[1]Dauphin Island Sea Lab; [2]Department of Marine Sciences, University of South Alabama; [3]Department of Marine and Environmental Sciences, Northeastern University

Biodiversity can positively influence ecosystem functioning, and its effects may be strongest in the presence of disturbance. In the aftermath of the disastrous Deepwater Horizon oil spill, we predicted that the positive effects of increased wetland biodiversity on ecosystem processes would be more prominent in oiled areas. We tested this prediction in a yearlong experiment in 3,785 L mesocosms and examined the interactive effects of oil exposure, and plant genetic and species diversity on key ecosystem processes. Experimental tubs within mesocosms (n=24-25 per) were assigned to a no plant control or one of five plant diversity treatments: *Spartina alterniflora* (*SA*) genotypic monoculture, *SA* genotypic polyculture, *SA* genotypic monoculture + *Avicennia germinans* (*AG*), *SA* genotypic polyculture + *AG*, or *AG* only. In two repetitively dosed mesocosms each tub received 1 L m^{-2} of a 1:1 oil-water mixture. In two non-oiled mesocosms, only seawater was added using the same procedure. We quantified plant growth, morphology, and flowering as a function of plant diversity and oiling. Results indicated negative impacts of oiling on *Spartina* survival, growth and flowering, and *Avicennia* leaf number and canopy area. However, the magnitude of oiling effects on *Spartina* and *Avicennia* was reduced in mixed species and polyculture treatments.

Presenter's Email: wscheffel@disl.org

The effects of seagrass wasting disease on *Zostera marina* morphology and growth

Schenck, F. R.*; Hughes, A. R.

Department of Environmental and Marine Sciences, Northeastern University

Geographic mosaics of selection are increasingly recognized as important in shaping species interactions in the ocean. Host-pathogen interactions are an integral component of many marine communities, yet how spatially variable selection on host-pathogen interactions influences marine communities is relatively unknown. Along the Atlantic coast of North America the seagrass *Zostera marina* experiences chronic wasting disease infections caused by protists of the genus *Labyrinthula*. We investigated spatial variation in the susceptibility of *Z. marina* to wasting disease by comparing the response of *Z. marina* from four geographically distinct sites in Massachusetts to *Labyrinthula* infection. In mesocosms, we exposed shoots from each site to either *Labyrinthula* from axenic cultures or control vectors (i.e. no disease). Infected *Z. marina* from all sites showed greater signs of disease than plants exposed to control vectors. Infections decreased leaf growth and leaf turnover similarly among all sites. However, the effects of infection on rhizome growth and biomass production varied among sites. Results suggest greater consideration of the variation in wasting disease susceptibility among of *Z. marina* populations by seagrass managers and restoration practitioners may be warranted, especially given the potential for disease outbreaks to cause rapid and dramatic declines of *Z. marina*.

Presenter's Email: schenck.f@husky.neu.edu

Predator diet effects on prey defensive responses: A review of the field and case study in the eastern oyster *Crassostrea virginica*

Scherer AE*; Smee DL

Texas A&M University-Corpus Christi

Numerous studies have examined how predator diets influence prey responses to predation risk, but the role predator diet plays in modulating prey responses remains equivocal. In a recent publication, we reviewed 405 predator–prey studies in 109 published articles that investigated changes in prey responses when predators consumed different prey items. In 54 % of reviewed studies, prey responses were influenced by predator diet, suggesting factors, such as the predictability of predator foraging habitats, determine the value of these cues for responding prey organisms. I will present an overview of predator diet research, including tested dietary differences as well as patterns and factors which may influence the cost or benefits of diet cue use by prey. This review will be presented in conjunction with primary research conducted on diet cue use in the induction of morphological defenses of the eastern oyster *Crassostrea virginica*, including use of a novel dietary difference, consumed tissue age. To conclude, I will address important directions for future diet cue studies which will advance our understanding of the role of diet cues in regulating nonconsumptive predator effects.

Presenter's Email: avery.scherer@tamucc.edu

Dazed & Confused: How pesticide mixtures affect adult and juvenile blue crabs

K. Schroeder-Spain*; D.L. Smee

Marine Ecology Laboratory, Department of Life Sciences, Texas A&M University – Corpus Christi, TX

Organisms are often simultaneously exposed to multiple forms of pollution, yet, experiments are usually designed to measure effects of a single substance at varying concentrations. Blue crabs are an important ecological and economic estuarine species that may be inadvertently exposed to pesticide mixtures at concentrations that increase mortality and alter behaviors critical to survival (e.g., predator escape, foraging, mating). Here, we investigated the effects of three commonly used insecticides (malathion, carbaryl, resmethrin) + a synergist (PBO) individually and in combination at 4 concentrations (0 µg/L, 1 µg/L, 3.33 µg/L, and 10 µg/L) on juvenile and adult blue crab survival and neuromuscular functioning by measuring increases in righting time (RT). All mixture treatments significantly reduced survival and increased RT in both life-stages. Effects in mixture treatments peaked within 12-24 hours, with most deaths occurring < 36 h, and effects on RT persisted for 7 days. Compared to individual exposures, mixture effects were the same as the worst pesticide combination, Resmethrin + PBO. Thus, exposures to low concentrations of pesticide mixtures may reduce blue crab survival and alter behaviors necessary for predator avoidance and foraging, affecting estuarine food webs and commercial fisheries.

Presenter's Email: Kaitlyn.Schroeder@tamucc.edu

Off the deep end: Patterns of sponge cover with depth through the mesophotic zone on Caribbean reefs

Scott, Alexander R.*[1]; Battista, Timothy[2]; Pawlik, Joseph R.[1]

[1]Department of Biology and Marine Biology and Center for Marine Science, UNC Wilmington; [2]National Oceanic and Atmospheric Administration, U.S. Department of Commerce

The primary goal of ecology is to understand what drives patterns of distribution and abundance of organisms, but before drivers can be identified, patterns must be accurately characterized. There has been recent debate over the pattern of sponge cover with increasing depth in the Caribbean. Some researchers have proposed that sponges throughout the Caribbean show a repeatable pattern of increasing biomass with depth to 150 m, while others have documented alternative patterns. We used photographs taken by remote operated vehicles (ROVs) off the coasts

of Puerto Rico and St. Thomas (USVI) to quantify sponge cover over the range of 30-180 m. Although highly variable, mean sponge cover was ~12% at 30 m, increased gradually to ~17% at 110 m, then decreased steadily and rapidly to zero cover at 170 m. The factors influencing sponge cover with depth likely include competition, predation, food availability, and substratum type, although the abrupt decline in sponge cover below 100 m appears to be associated with a concomitant decrease in coralline algae.

Presenter's Email: ars6634@uncw.edu

Effects of the invasive foundation species, *Watersipora subtorquata*, on fouling community structure are environmentally dependent

Scott, Z. R.*; ter Horst, C. P.

California State University, Northridge

Both foundation species and invasive species have exceptional influence on community diversity and structure, though they have historically been thought to have opposite effects. However, when invasive species can provide novel habitat within a community, their benefit to the community as a foundation species may outweigh their cost as an invader. The magnitude or direction of species interactions may depend on the environment, and thus the net effect of invasive foundation species may vary across different environmental factors. We conducted a settlement tile experiment on the fouling communities of California harbors to determine whether the effects of a widespread invasive bryozoan, *Watersipora subtorquata*, vary throughout its California range. Treatments with live and dead colonies and two sizes of blank tiles were used to evaluate the effects of colony structure and available bare substrate on the community. We found that while mobile invertebrate composition across *W. subtorquata* and other treatments differed similarly between regions, species richness and abundance across treatments were dependent on region. Both the diversity and community structure of sessile invertebrates across treatments differed significantly between regions, highlighting the potential for *W. subtorquata* to influence the community with different net effects throughout its invasive range as a foundation species.

Presenter's Email: zoe.scott.923@my.csun.edu

Disturbance, Predation and Community Assembly – Paine-less ecology?

Sebens, Kenneth P.[1]

[1]Department of Biology, SAFS, Friday Harbor Laboratories, University of Washington

The effect of disturbance, defined as space clearing by physical or biological means, has become a cornerstone (even a keystone) of community ecology. Strong interactions among dominant competitors, their predators, and physical disturbance allow coexistence of multiple species sharing a single resource, two dimensional space. Nonetheless, it is has also become abundantly clear that stochastic processes, including recruitment from regional pools of high or low diversity, also contribute substantially to the suite of species in short or long term coexistence within marine subtidal and intertidal communities. Do these processes interact in predictable ways, and how important are they in communities that have been extensively studied? Examples from long-term studies of subtidal communities along the east and west coast of North America are used to examine this question. Recent developments in our understanding of community assembly in both terrestrial and marine communities provide a framework to address this critical question. The contributions of Robert T. Paine, specifically addressing temporal and spatial mosaics and incorporating strongly interacting species, are considered in light of recent evidence that local diversity is strongly influenced by regional species pools.

Presenter's Email: sebens@uw.edu

Temperature and salinity effects on *Stuckenia pectinata* traits and susceptibility to grazing

Serina S. Sebilian*; Katharyn E. Boyer

Romberg Tiburon Center for Environmental Studies, San Francisco State University

This research examined the effects of temperature (20, 25, and 30°C) and salinity (0, 6, and 12) on the plant traits of the aquatic macrophyte, *Stuckenia pectinata*, and how changes in these traits influence herbivory by invertebrate grazers. The highest temperatures showed positive effects (e.g., leaf %N, leaf area and protein content), counter to my predictions, while the highest salinity tended to have negative effects, as expected. Thus, the coolest temperature (20°C) and highest salinity (12), presumably the most stressful treatment for the plants, tended to lower %C, %N, protein content, and phenolic concentrations, while salinities of 0 at this same temperature tended toward higher phenolics, C:N, and %C. Salinities of 12 at 30°C had the highest %N and %P content; however, this treatment also suffered the highest herbivory from the amphipod, *Ampithoe valida*. Herbivory in salinity treatments of 12 with increasing temperature was negatively correlated with C:N, and positively correlated with %N, %P, and protein content. These results can inform future management, conservation and restoration efforts.

Presenter's Email: ssebilia@mail.sfsu.edu

A bad break-up? Linkages between marsh fragmentation, prey availability, and blue crab (*Callinectes sapidus*) abundance, growth, and mortality

Shakeri, L.M.*[1]; Darnell, K.M.[1]; Carruthers, T.J.B.[2]; Darnell M.Z.[1]

[1]Division of Coastal Sciences, School of Ocean Science and Technology, University of Southern Mississippi; [2]The Water Institute of the Gulf

Louisiana is losing coastal marsh at an unprecedented rate due to subsidence, erosion, and climate change. In addition to loss of marsh area, marsh fragmentation is occurring with large continuous marshes breaking up into smaller marsh patches. As marsh is lost, it creates the opportunity for submerged aquatic vegetation (SAV) succession in areas where the coastal marsh disappeared. These salt marshes and near-shore seagrass beds provide vital nursery habitat for many species including juvenile blue crab, *Callinectes sapidus*. Blue crab comprises one of the largest commercial fisheries in Louisiana, worth over $60 million in 2014. We are studying the linkages between marsh fragmentation, SAV cover, benthic prey availability, and blue crab abundance, growth, and mortality due to predation. We have quantified marsh fragmentation and SAV cover across a range of fragmentation levels. We conducted monthly crab surveys, sampled the benthic invertebrate communities as a measure of food availability and conducted field experiments on juvenile blue crab mortality due to predation. We will conduct field experiments on juvenile blue crab growth rates. These data will ultimately be used to update the blue crab habitat sustainability index model that informs the Louisiana Coastal Master Plan for conservation and restoration of the coast.

Presenter's Email: lennah.shakeri@usm.edu

Landscape-scale drivers of feral hog disturbance and mechanisms of resilience in southeastern US salt marshes

Sean J Sharp*; Christine Angelini

Engineering School of Sustainable Infrastructure and Environment, University of Florida

Many large consumers engineer their environment through their physical effects on soils and plants and disrupt provisioning of valuable ecosystem services. In southeastern US salt marshes, feral hogs (*Sus scrofa*) trample, root, and wallow, actions that flatten and uproot vegetation and create small depressions that pool water. Here we quantify variation in size and type of disturbances feral hogs create in a survey of 53 southeastern salt marsh sites

and use regression trees to evaluate the relative importance of different terrestrial and salt marsh characteristics in mediating disturbance extent. We also present results from a year-long field experiment to examine marsh plant, infauna and soil chemistry resistance and recovery to wallowing, rooting, and trampling disturbance types. We discovered the spatial extent of hog disturbance increases positively with adjacent upland hardwood cover and with decreasing plant canopy height and that hog wallowing precipitates the largest and most persistent reductions in plant and invertebrate densities, and largest shifts in soil chemistry. These results suggest that managers can utilize a few, key terrestrial and wetland features to identify areas for culling to mitigate hog effects on marshes and should prioritize marshes damaged by intensive wallowing for restoration due to their low resilience.

Presenter's Email: seanjsharp@ufl.edu

Predator density exponentially increases coral tissue loss and increases the severity of heat-induced coral bleaching

Elizabeth C. Shaver[1]*, Deron E. Burkepile[2], Brian R. Silliman[1]

[1]Duke University

In recent years, the coupling of intense consumer pressure with physical stress caused by climate change and anthropogenic disturbance has caused devastating losses of foundation species and their associated communities. In Caribbean coral reef ecosystems, the coral-eating snail, *Coralliophila abbreviata*, is a widespread predator of many reef-building corals. Our surveys in the Florida Keys reveal that *C. abbreviata* can be highly abundant, preying on 27-58% of colonies belonging to the four common Caribbean 'brain' coral species. To examine how predator density can affect coral tissue loss (e.g., negative, positive, or no density dependence), we manipulated *C. abbreviata* density on 30 colonies of *Pseudodiploria strigosa* and *Diploria labrynthiformes* and tracked tissue loss over 2 months in the summer of 2014. We found an exponential increase in coral tissue loss with increasing *C. abbreviata* density, which explained 72% of the variation in tissue loss. During a warm temperature event that occurred at the end of this experiment, *C. abbreviata* density also significantly affected the severity of coral bleaching, particularly with corals that bleached most severity (90-100%). This research reveals that partial predation by *C. abbreviata* can severely affect coral health and potentially increase coral mortality when combined with intense physical stress. As biological factors like predation may be easier to manage at a local level than physical factors related to climate change, our results highlight the need to understand interacting factors to effectively protect coral reef ecosystems under future climate regimes.

Presenter's Email: elizabeth.schrack@duke.edu

Short-term effects of a nutrient pulse on crustose coralline algae under ocean acidification

Shayka, B.F.*; Carpenter, R.C.

California State University, Northridge

Coral reefs are affected by many human-induced changes to ocean water chemistry, including ocean acidification (OA) and coastal nutrient runoff events. Crustose coralline algae (CCA), important reef organisms that reinforce the reef structure and induce coral larval settlement, are affected by both of these changes. This study tested the short-term response of *Lithophyllum kotschyanum* to an 8-hour nutrient pulse after growth in one of two pCO_2 treatments (400 and 1000 μatm) for 9 days. Photosynthetic rates were measured at 0, 1, 2, 4, and 8 hours after the pulse, and short-term calcification rates were measured at 0 and 4 hours. The results showed that nutrient addition decreased short-term calcification rates in 4 hours, but photosynthetic rates were entirely driven by the amount of time since sunrise. There were no effects of pCO_2 treatment on calcification or photosynthesis. Therefore, nutrient addition negatively affects short-term calcification, but not photosynthesis, on short time scales. Also, time of day, with respect to the amount of time since sunrise, drives photosynthetic rates. These results suggest that nutrient runoff can impact CCA within the time of a single runoff event and that diurnal light patterns may be important in determining how CCA respond to nutrient pulses.

Presenter's Email: bridget.shayka.682@my.csun.edu

Examining the interactive effects of salinity and ocean acidification on the physiology of the barnacle Amphi*balanus amphitrite*

Kyle R. Siegel[1]*; Nardone, J.A.[1]; Tedesco, D.[1]; Patel, S.[1]; Karra, L.[1]; Orihuela, B.[2]; Rittschof, D.[2]; Dickinson, G.H.[1]

[1]Department of Biology, The College of New Jersey; [2]Duke University Marine Laboratory, Marine Science and Conservation Beaufort, NC USA

Ocean acidification (OA), the decrease in seawater pH due to anthropogenic CO_2 emissions, will greatly impact marine life. Changes in other environmental factors, such as salinity, could exacerbate or mitigate the effects of OA. Here, we assessed the physiological response of the acorn barnacle *Amphibalanus amphitrite* to exposure to decreased pH and decreased salinity. Larvae cultured from adults (salinity ~36 psu) were settled on T2 silicone coated glass panels. Animals were acclimated to four combinations of pH_T (8.02 and 7.5) and salinity (35 and 15), and exposed for 16 weeks. Growth of the base plate was measured biweekly for the duration of the experiment. Base plate area, adhesion strength (in shear), and shell mass were assessed at the conclusion of the experiment. Adhesion strength was not affected by pH, salinity, or their interaction. Both pH and salinity significantly affected base plate area, although the interaction of these variables was not significant. Barnacles tended to be smaller at lower salinity and higher pH. The effects of salinity observed here run counter to previous assessments, suggesting larval batch specific responses. Rearing of larvae from an F2 generation of these barnacles is ongoing. Authors acknowledge support from the Office of Naval Research.

Presenter's Email: siegelk2@tcnj.edu

Symbionts as taxonomic tools: Cryptic lineages of the of the colonial ascidian *Distaplia bermudensis* host unique microbial communities

Hendra F. Sihaloho*, Patrick M. Erwin, and Susanna López-Legentil

Department of Biology and Marine Biology, Center for Marine Science, University of North Carolina Wilmington, 5600 Marvin K. Moss Lane, Wilmington NC 28409, USA

Color variation is a widespread phenomenon among marine invertebrates and typically ascribed to intra-specific variability. However, the use of molecular tools to investigate the genetic basis of color variation has uncovered many instances of cryptic speciation. The colonial ascidian *Distaplia bermudensis* occurs in different color morphologies, ranging from all white to a dark blue tunic with yellow siphon apertures; yet careful observations of zooid morphology have not revealed any significant differences among these morphotypes. In this study, we sampled 12 color morphs of *D. bermudensis* from Wilmington, North Carolina (NC, USA) and sequenced fragments of the mitochondrial Cytochrome C Oxidase Subunit I (COI) and 18S rRNA genes. In addition, we characterized symbiotic microbial communities for all samples by high-throughput sequencing of partial 16S rRNA genes. Two distinct, well-supported lineages of *D. bermudensis* were revealed by analyses of both the COI and 18S rRNA genes and shown to harbor unique symbiont communities that differenced significantly in diversity (Shannon and Simpson, $P<0.05$) and structure (PERMANOVA, $P<0.05$) among lineages. Symbiont characterization was a useful tool to distinguish closely related lineages of *D. bermudensis* and may aid resolving the taxonomic status of other morphologically plastic ascidians.

Presenter's Email: hfs8562@uncw.edu

Are the ghosts of nature's past haunting conservation today?

Brian R. Silliman*[1]; Brent B. Hughes[1,2]; Lindsay C. Gaskins[1]; Qiang He[1]; M. Tim Tinker[2,3]; Andrew Read[1]; James Nifong[4]; Rick Stepp[5];

[1]Nicholas School of the Environment, Duke University; [2]Department of Ecology and Evolutionary Biology, University of California; [3]United States Geological Survey, Western Ecology Research Center; [4]Department of Fisheries, University of Florida; [5] Department of Anthropology, University of Florida.

Humans have suppressed large consumer populations and their impacts worldwide, yet how their habitat breadth has been constrained is poorly understood. Here, we show that following long-term protection, sea otters along the northeast Pacific coast expand into salt marshes and seagrasses, and alligators on the US east coast expand into marine ecosystems, ecosystems presently thought beyond their niche space. There is also evidence seals have expanded into subtropical climates, mountain lions into grasslands, grey whales into lagoons, orangutans into disturbed forests, and wolves into the rocky intertidal. Historical records, surveys of protected areas, and patterns of animals moving into habitats that were former hotspots for hunting indicate that rather than occupying them for the first time, most of these animals are recolonizing ecosystems. Recognizing that many large consumers naturally occur across a greater diversity of ecosystems has implications for endangered species recovery plans and reveals much more space is available for large-consumer refugia from climate-induced threats.

Presenter's Email: Brian.Silliman@duke.edu

Influence of farmer and non-farmer damselfishes on coral transplant success

Sims, R.*; Towe, A.; Rolfe, S.; Smith, K.

Department of Biological Sciences, Clemson University

Damselfish are herbivorous reef fishes that potentially influence the abundance of macroalgae on coral reefs. Previous studies have suggested that some damselfish (farmers) actually harm corals by removal of live tissue to stimulate more macroalgal growth. However, this behavior has not been observed for other damselfish species (non-farmers). In this study, we compared the differences in aggression between farmer (dusky and cocoa) and non-farmer (bicolor) damselfishes and their impact on macroalgae and corals. We used both diver-recorded and video-recorded observations of damselfish behaviors on seven reefs that contained transplanted coral fragments. Substrate cover and measures of coral health were analyzed by pictures taken at the beginning and end of the one year study, and analyzed by the species of damselfish present. Both farmer and non-farmer damselfish showed similarly high levels of aggression toward intruding fishes, but differed in their responses toward damselfishes and parrotfishes. Cocoa damselfish were more aggressive toward damselfishes whereas Dusky damselfish were more aggressive toward parrotfishes. While farmer damselfish territories had relatively higher levels of macroalgae and more algae-coral contact, there was no evidence that transplanted corals had a deceased area of live tissue or were negatively influenced by the presence of any species of damselfish.

Presenter's Email: rsims@clemson.edu

Evaluating the performance of hardened versus living shorelines during Hurricane Matthew

Carter Smith[1]*; Brandon Puckett[2]; Charles Peterson[1]

[1]Institute of Marine Sciences, University of North Carolina at Chapel Hill; [2]North Carolina National Estuarine Research Reserve

One of the most pressing environmental management concerns on a global scale is reducing coastal erosion and attendant property damage in the face of climate change. The most prevalent response to this threat is the erection of hard engineered structures (e.g. bulkheads, seawalls); however, these structures have been shown to have adverse effects on wetland habitat sustainability and they often do not live up to the expectation of superior erosion protection. In response to this challenge, scientists and environmental advocates have supported the use of more ecosystem-compatible shoreline stabilization strategies, termed living shorelines. There is mounting evidence regarding the ecological benefits of living shorelines, but many questions remain about their ability to prevent erosion, particularly during hurricane events. We present a field study of 9 coupled living shoreline,

natural marsh, and bulkhead sites across the coast of North Carolina that were sampled before and after Hurricane Matthew (2016). Preliminary results suggest that living shorelines consistently outperform natural marshes, and that they incur significantly less seaward and landward scour than bulkheads. In order to promote the use of living shorelines to homeowners and coastal managers, it is necessary to demonstrate not just their ecological benefits, but also their superior performance.

Presenter's Email: scarters@live.unc.edu

Testing trophic cascades: Top-down versus bottom-up regulation of corals in the Florida Keys

Smith, K. M.*; Childress, M. J.

Clemson University

Caribbean coral reefs have drastically changed over the past 35 years with declines in coral cover and herbivore abundance. In order to regulate increasing competitive macroalgae, protecting the remaining reef herbivores has become a primary conservation goal throughout the Caribbean. However, this assumes that corals are limited primarily by the top-down indirect effect of herbivores on macroalgae. To test the predictions of this herbivore cascade hypothesis, along with alterative bottom-up hypotheses, we surveyed the reef community structure (parrotfish abundance and substrate cover) of 34 reefs in the middle region of the Florida Keys National Marine Sanctuary. We estimated the major influences on percent coral cover using both multiple regression analysis and structural equation modelling. Both methods suggest that there are positive top-down (parrotfish), negative bottom-up (reef structure) and negative competitive (fleshy algae) influences on coral. However, the structural equation models suggest that these are not driven by strong negative interactions of parrotfish on turf or fleshy algae. We also discovered drastically different patterns in communities located nearshore compared to reefs located offshore. These results suggest that hard corals of the middle Florida Keys may be regulated by a complex interaction of top-down and bottom-up influences independent of parrotfish herbivory.

Presenter's Email: Kylie4@clemson.edu

Recruitment patterns of the estuarine crab, *Panopeus herbstii*, in Tampa Bay: proximate roles of light and gravity

Nancy F. Smith[1]*; Talene Yeghissian[2]; Kevin J. Mack[3]

[1]Eckerd College; [2]University of Delaware; [3]College of Charleston

Brachyurans possess complex life cycles in which zoea spend weeks in coastal or estuarine waters before recruiting back to the adult benthic habitat as megalopae. In this study, we used passive, artificial collectors to survey the recruitment patterns of Atlantic mud crab megalopae, Panopeus herbstii, over two years in Tampa Bay, Florida. Recruitment varied seasonally with peak abundances occurring during spring and fall months. Megalopae recruited more frequently at night and on bottom collectors. To test whether these distributions are behavioral responses to exogenous cues, we conducted laboratory experiments to determine the role of light and gravity on swimming behavior. We found that dark-adapted megalopae did not orient towards a directional light source in a horizontal trough when exposed to various light intensities. Further, megalopae displayed strong positive geotaxis in darkness, which resulted in frequent bottom crawling. Thus, Panopeus herbstii megalopae orient towards the Earthâ€™s gravitational field and lack a phototactic response, which can facilitate their recruitment to the adult benthic habitat

Presenter's Email: smithnf@eckerd.edu

Engineering your competitor's expansion: context-dependent effects of saltmarsh wrack on mangrove establishment

Smith, R. S.*[1]; Osborne, T. Z.[2]; Byers, J. E.[1]

[1]Odum School of Ecology, University of Georgia; [2]Whitney Laboratory for Marine BioScience, University of Florida

Black mangroves are expanding into native saltmarshes in Florida, replacing the dominant saltmarsh species, *Spartina alterniflora*. Rate of mangrove expansion is influenced by interactions with both live standing *Spartina* and subsidies of dead *Spartina* wrack. On high tides, extensive mats of *Spartina* wrack are stranded in coastal wetlands, frequently coinciding with the stranding of hydrochorous mangrove propagules. We were interested in how wrack and mangrove propagule co-occurrence affects propagule establishment. We hypothesized that wrack presence could have both positive and negative effects on propagule establishment, depending on wrack microposition and inundation regime as a result of altered desiccation and light conditions. To test these hypotheses, we performed an outdoor mesocosm experiment where we placed mangrove propagules in soil both under and on top of wrack, and without wrack and left them to grow under two inundation regimes that mimicked neap and spring tides. We observed propagule survival and performance over time, and wrack presence facilitated propagules when they were underneath wrack, yet hindered growth when propagules were on top of wrack. These effects were strongest in the neap tidal regime relative to the spring. Effects of wrack on mangrove propagules are context-dependent and vary with propagule orientation and tidal regime.

Presenter's Email: Rssmith218@gmail.com

Ocean acidification and algal contact cause significant shifts in coral microbiomes

Sneed, J.M.*; Campbell, J. E.; Paul, V.J.

Smithsonian Marine Station at Fort Pierce, Ft. Pierce, FL 34949

Both macroalgal presence and ocean acidification have detrimental impacts on the heath of adult corals and on the recruitment of future generations, however, these stressors will not occur in isolation and understanding the implications of these factors in combination is critical. Short term (4 weeks) exposure to the common green alga *Halimeda opuntia* and ocean acidification demonstrated that *H. opuntia* has species specific effects on the health of corals (*Porites astreoides*, *Orbicella faveolata*, and *Acropora cervicornis*). Here we investigated individual and combined effects of exposure to *H. opuntia* and ocean acidification on the surface microbiomes of *P. astreoides*, *O. faveolata*, and *A. cervicornis*. Both stressors caused significant changes in the surface microbiomes of the corals that did not always correspond directly to measurable changes in photosynthetic efficiency or bleaching. Coral microbiomes are critical to the functioning of the coral holobiont and effects of stressors on these microbiomes could be detrimental to the health of the coral.

Presenter's Email: sneedj@si.edu

Linking reproductive physiology, temperature, and larval recruitment: A classic competitive story rewritten by climate

Maeve K. Snyder*; Jesse M. Turner; David S. Wethey; Thomas J. Hilbish

Department of Biological Sciences, University of South Carolina

Climate change has been observed to alter temperature-mediated life history traits and ecological processes in many organisms, with consequences for ecosystem functioning, biogeography, and biodiversity. We used a classic competitive interaction between the barnacles *Semibalanus balanoides* and *Chthamalus spp.* to investigate

the hypothesis that temperature is an important influence on competition and, therefore, community structure. Percent cover analyses of rocky intertidal habitats across a latitudinal gradient of the United Kingdom revealed that *S. balanoides* is unable to competitively exclude *C. montagui* from the mid-intertidal in southwest England, in contrast to the competitive outcome found at higher latitudes. We found a correlation between low recruitment and competitive outcome, indicating that recruitment may be mechanistically linked to competition. We previously established that winter sea surface temperature (SST) above 10^{o}C interferes with embryonic brooding and consistently results in low recruitment levels in *S. balanoides.* Thus, two possible explanations for this breakdown of competition are based on a temperature-dependent physiological threshold: loss of overgrowth or preemptive competition. These competitive mechanisms only become relevant in communities with high recruitment input. It is likely that warming SST has the potential to restructure biological communities by altering competitive interactions and may contribute to shifts in species distributions.

Presenter's Email: mksnyder@email.sc.edu

Sandification vs. muddification of tidal flats by benthic ecosystem engineers: a flume study

Soissons, L. M.*[1]; Gomes da Conceiçâo, T.[1]; Cozzoli F.[1]; van Dalen, J.[1]; Bouma, T.J.[1]

[1] Department of Estuarine and Delta Systems, Royal Netherlands Institute for Sea Research

Macro benthic animals can act as ecosystem engineers: by their presence and/or activity, they can modify the environment to make it suitable for their own development and the establishment of other organisms. Some benthic organisms stabilize the sediment by attenuating the effect of waves and currents or by trapping sediment. Others decrease sediment erosion thresholds by re-working the sediment. The latter are referred to as bioturbators and contribute greatly to tidal flats stability and sediment erodibility. By means of several annular flume experiments in controlled conditions, we aimed to better understand the role of benthic organisms and how their presence can affect sediment erodibility and properties.
Our results show how bioturbating benthic animals modify the sediment properties over a tidal cycle. By their activity, macro benthic animals were capable of adding silt to a sandy sediment (i.e., 'muddification') whereas they removed silt from a muddy sediment (i.e., 'sandification'). These bio-physical interactions thus play a substantial role in determining sediment properties, depending on the bioturbator body size and density. Overall, our results have strong implications for tidal flat stability and the spread of sand nourishments, as often used to remediate to coastal erosion.

Presenter's Email: laura.soissons@nioz.nl

Negative impacts of plastic exposure and microplastic ingestion on juvenile eastern oysters (*Crassostrea virginica*)

Rylinn Sorini*[1], Laura Eierman[2]

[1]St. Mary's College of Maryland; [2]State University of New York Cortland

Plastic pollution is an increasingly large problem in marine systems and is detrimental to the survival and health of wildlife at all trophic levels. *Crassostrea virginca,* the eastern oyster, is a sessile bivalve that is susceptible to the damaging effects of plastic, with the potential for ecosystem-wide cascading impacts as a keystone species. Two experiments were conducted to explore the breadth of plastic's potential impacts on oysters. First, we measured the survival and growth of juvenile oysters grown on polyethylene terephthalate plastic and exposed to the chemicals that leach as plastic degrades. Newly settled oysters exposed to plastic showed significantly higher mortality rates (Wilcox rank sum test, $P < 0.001$) and slower growth rates (Wilcox rank sum test, $P= 0.001$) than those grown on shell. Second, oysters were held in water that contained fluorescent microplastic beads. Beads were observed in the oysters' gills and intestinal tracts, despite their ability to selectively filter inorganic particles. These findings suggest that exposure to plastic may lead to decreased survival and growth in oysters along with

other negative health impacts via ingestion. The already stressed populations of eastern oysters in estuaries along the Western Atlantic may be suffering negative fitness consequences as a result.

Presenter's Email: resorini@smcm.edu

Rapid evolution of stress tolerance facilitates the invasion of an ecosystem engineer

Sotka; E.E.[1]*; A.W. Baumgardner[1]; P. Bippus[1]; C. Destombe[2]; E. Duermit[1]; H. Endo[3]; B.A. Flanagan[1]; M. Kamiya[4]; L. Lees[1]; C.J. Murren[1]; M. Nakaoka[5]; S. Shainker[1]; A.E. Strand[1]; R. Terada[3]; M. Valero[2]; F. Weinberger[7]; S.A. Krueger-Hadfield[8]

[1]Grice Marine Laboratory and Department of Biology, College of Charleston, USA.; [2]CNRS, Sorbonne Universités, UPMC, UCCh, UACH, Station Biologique de Roscoff, France.; [3]United Graduate School of Agricultural Sciences, Kagoshima University, Japan; [4]Faculty of Marine Bioscience, Fukui Prefectural University, Japan; [5]Akkeshi Marine Station, Hokkaido University, Japan; [7]Helmholtz-Zentrum für Ozeanforschung GEOMAR, Germany; [8]Department of Biology, University of Alabama at Birmingham, USA.

Microevolution of introduced species can facilitate invasion success, but there is less empirical support for its frequency and magnitude relative to the well-documented effects of demographic and ecological processes. This gap is particularly acute for introduced marine species, 1000s of which are transported daily. Here, we provide evidence that tolerance for abiotic stresses rapidly evolved during the introduction of the red seaweed *Gracilaria vermiculophylla* from its native Japan to North American and European shorelines. Using 935 field-collected and 325 common-garden thalli from across 40 locations, we found that introduced populations have greater survivorship under extreme heat, cold and low-salinity stresses relative to Japanese source populations. The invasion of *G. vermiculophylla* was also accompanied by local adaptation within eastern North America, as populations from warmer, lower-latitude estuaries had greater heat tolerance than did populations from colder, higher-latitude estuaries. This cline recapitulates a parallel decline in native Japan and was generated at a remarkable rate, given that the introduction occurred within the last few decades. Our results indicate that rapid evolution plays an important role in facilitating the invasion success of this and likely other marine species and reinforces the threat that introductions represent to nearshore ecosystems.

Presenter's Email: SotkaE@cofc.edu

Rapid organic matter deposition in sediments at a constructed oyster reef

Melissa Southwell*; Jessica Veenstra; Cody Burns; Tim Mullen; Jillian Hudson-Jackson; Charlie Lewis

Flagler College

Marshes, seagrass beds, and mangroves store large amounts of carbon in sediments due to their ability to accrete vertically and facilitate sediment deposition. Oyster reefs exhibit these same characteristics, and so may serve as carbon sinks on a similar scale to vegetated coastal ecosystems. We have been measuring sediment characteristics at an oyster reef restoration site at the GTM NERR in NE FL since its inception in 2012, and we have monitored the deposition of distinctly finer, more organic-rich sediment in the intertidal area shoreward of the reef. Here we estimate the total amount of carbon stored in this newly deposited layer and examine down-core and cross-shore changes in OM and particle size. In its first 4 years of existence, the sediments at our site exceeded areal C storage rates reported for vegetated intertidal systems. This rate will likely slow as the reefs reach their maximum height, but oyster reefs also serve as barriers protecting marshes from wave energy. Therefore, their C storage function is both as a localized organic C sink and as prevention of organic C losses from marsh erosion.

Presenter's Email: msouthwell@flagler.edu

The bigger picture: cascading effects of the Caribbean King Crab on the community structure of coral patch reefs

A. Jason Spadaro*; Mark J. Butler, IV

Department of Biological Sciences, Old Dominion University

Coral reefs are on a trajectory of decline. Recent mass-bleaching and mortality events have only highlighted the need for their conservation and management. In the Caribbean, reefs may have degraded beyond the point of natural recovery, thus direct restoration may be the only viable means of preserving these ecosystems. Although coral transplantation has shown promise in increasing the abundance and distribution of a few species of coral on degraded Caribbean reefs, the overgrowth of macroalgae still poses a bottleneck to the ultimate success of these efforts. Competition between algae and corals is a persistent threat to coral recovery in the Caribbean, exacerbated by a historic decline in herbivores due to disease, fishing, and declining water quality. We previously reported our preliminary success in mediating algal overgrowth of coral patch reefs by manipulating the density of the Caribbean King Crab, *Maguimithrax spinosissimus*. Here we report the cascading effects of our manipulation of crab density on the fish and coral communities of coral patch reefs in the Florida Keys. Increased crab density resulted in a significant increase in both the richness and abundance of reef fishes. Similarly, increased crab density resulted in a 2- to 3-fold increase in coral recruitment. These striking results demonstrate that stock enhancement of these herbivorous crabs can help restore coral reefs plagued by the overgrowth of macroalgae.

Presenter's Email: aspad001@odu.edu

Mating system and reproductive performance in the isopod *Parabopyrella lata,* a parasitic castrator of the caridean shrimp *Lysmata boggessi*

Sarah Steedman*[1]; Sanjeevi Prakash[1]; J. Antonio Baeza[1]

[1]Department of Biological Sciences, Clemson University

Symbiotic associations are common yet poorly studied in marine environments. This study examined prevalence, population distribution, and reproductive performance of *Parabopyrella lata,* a parasitic isopod (family Parabopyridae) that infects the caridean shrimp *Lysmata boggessi.* Prevalence of *P. lata* on the host shrimp *L. boggessi* was greater during the warmer months compared to the colder months of the year (2012-2013) at the study site, off Homosassa Springs, Florida. *Parabopyrella lata* most often lives as male-female adult pairs in the gill chamber of their individual hosts. Within heterosexual pairs, female and male body size were highly correlated. Additionally, both male and female *P. lata* body size increased with host body size. Average fecundity in *P. lata* was 3660 eggs female^{-1} (SD=1146, range: 2181 -5998) and increased with female body size. Average egg volume was 0.0311 mm^3 (± 0.00477) and did not vary with female body size. Lastly, reproductive output increased less than proportionally with a unit increase in body size in the studied parasite. Our results suggest that *P. lata* is monogamous and females are fecund. Future studies are warranted in order to further improve our understanding of host-parasite relationships in the marine realm.

Presenter's Email: ssteedm@g.clemson.edu

Latitudinal differences in meiofaunal and algal distribution patterns on live and dead *Spartina alterniflora* stems

[1]Steelel L., [2]Guidone M., [1]Marx E., [1]Logosh A.J., [2]Ashe E.

[1]Department of Biology, Sacred Heart University; [2] Department of Biology, Armstrong State University

Spartina alterniflora marshes are critical habitats for economically and ecologically valuable species throughout the U.S. Atlantic coast. However, little is known about latitudinal variation in the distributions of organisms

residing on *S. alterniflora* stems themselves. *S. alterniflora* densities were measured monthly along replicate marsh transects at two sites in Connecticut and three sites in Georgia throughout the growing season. Live and dead stems were collected at regular intervals along each transect. Stem height and the proportion of each stem covered by algae were measured. Samples taken from patches of algae and sediment on each stem were analyzed microscopically to determine if meiofaunal abundance varied with location and stem type. Because chemical deterrents that leach away from dead stems may alter organisms' abilities to thrive on *S. alterniflora*, live and dead stems were collected from sites in Connecticut for phenolic analysis. Dead *S. alterniflora* stems and algae were both more prevalent in Georgia than in Connecticut. Meiofaunal diversity were also higher in Georgia than in Connecticut throughout the sampling period. In both states, dead stems tended to support more meiofauna and algae than live stems, possibly due to lower phenolic levels in dead stems.

Presenter's Email: steelel@sacredheart.edu

Diversity and distribution of ascidians in Gray's Reef National Marine Sanctuary

Stefaniak, Lauren M.*

Department of Biology, Georgia Southern University

Collectively, ascidians comprise 23-39% of live benthic cover on hard bottom reefs of Gray's Reef National Marine Sanctuary (GRNMS), making them an important spatial competitor on these reefs. However, determining their contribution to benthic community structure and function is difficult because the identity and, as a consequence, distribution and abundance of individual species is not well known. To address this knowledge gap, samples of apparent ascidian morpho-species were collected from several sites in GRNMS and identified to the lowest possible taxonomic resolution using morphology. Some individuals collected could only be resolved to the genus level and others were found to be so morphologically cryptic that molecular taxonomy techniques will be required for definitive differentiation. In sum, I identified an additional 11 species (including one to genus and two cryptic species) bringing the total number of ascidian species known in GRNMS to 28 (including five to genus and two cryptic species). Included in this total were two substantial range expansions, including one tropical and one temperate species. The updated ascidian species list was used in the 2016 sessile benthic invertebrate survey of GRNMS to document distribution and abundance patterns of individual species as opposed to distribution of ascidians as a group.

Presenter's Email: lstefaniak@georgiasouthern.edu

Predatory capacity of king crabs in Antarctica

Steffel, B. V.*[1]; Smith, K. E.[2]; Aronson, R. B.[1]

[1]Department of Biological Sciences, Florida Institute of Technology; [2]College of Life and Environmental Sciences, University of Exeter, UK

Near-freezing water temperatures have excluded shell-crushing predators from continental-shelf environments off the western Antarctic Peninsula for millions of years. Recently, however, lithodid king crabs, *Paralomis birsteini*, have been found in dense, reproductively viable populations on the upper continental slope, and rapid warming might enable them to invade the shelf. *P. birsteini* are crushing shelled and skeletonized invertebrates on the slope, but calcification of sturdy, shell-crushing chelae should be inhibited by the low saturation state of high-Mg calcite in the Southern Ocean. We estimated the potential force generation of the chelae and the allocation of calcium-carbonate in the exoskeletons of *P. birsteini* to better understand their predatory capacity. We then compared the results to temperate and subtropical, shallow-water species of brachyuran crabs to infer the selection pressures on polar, deep-sea crabs. *P. birsteini* can generate more than enough force to crush their invertebrate prey. They allocate more calcium-carbonate resources to their chelae than to their carapaces, in contrast to brachyurans living in shallow-water environments at lower latitudes. The difference in resource allocation is likely a consequence of the energetic cost of calcification in cold water and the limited predation pressure on the lithodids.

Presenter's Email: bsteffel2012@my.fit.edu

BEM-SEERS 2017 Oral Presentation Abstracts

With or without nutrients, sponges are boring: the effects of eutrophication on bioerosion

Stubler, A.D.[1]*; Carroll, J.M.[2]; Finelli, C.M.[1]

[1]Department of Biology and Marine Biology, University of North Carolina Wilmington; [2]Department of Biology, Georgia Southern University

Eutrophication, largely due to coastal development and human activities, is an ongoing issue for coastal ecosystems. Excess nutrients can impact ecosystem processes, promote the occurrence of algal blooms, and decrease the overall water quality. One process that may be impacted by eutrophication is the biological breakdown of carbonate material, or bioerosion. Correlative evidence suggests that bioeroding sponges increase in size and abundance along nutrient gradients, leading to increased bioerosion rates. However, there have been no experimental studies investigating the direct effects of increased nutrients on sponge bioerosion rates. To determine whether sponge bioerosion of carbonate material is enhanced under eutrophied conditions, we performed both *in situ* and laboratory studies of oyster shell bioerosion by clionaid sponges. Using Osmocote fertilizer, we artificially increased localized water column nutrients in both a mesocosm and field experiment. In each experiment, initial and final buoyant weights of oyster shells infested with *Cliona* spp. were compared to quantify sponge bioerosion rates over a 12-week period. Our results indicate that sponge bioerosion rates are not directly affected by increased inorganic nutrients. This study is the first to present experimental evidence suggesting eutrophication does not impact sponge bioerosion.

Presenter's Email: stublera@uncw.edu

Plasticity, ecomorphs, & adaptation? *Montastraea cavernosa* has shallow & depth-generalist morphotypes across mesophotic reefs in the Gulf of Mexico

Studivan MS*[1]; O'Neal G[2]; Voss JD[1]

[1]FAU Harbor Branch Oceanographic Institute; [2]Maine Maritime Academy

To better understand coral adaptation to mesophotic (30-150m) conditions, we assessed morphological variation of the coral *Montastraea cavernosa* across the Gulf of Mexico. Corallites were smaller while corallite spacing was greater among mesophotic corals as compared to those from shallow depths. Additional corallite characteristics, including increased corallite height of mesophotic samples, is hypothesized to be a photoadaptive response to low light environments. We identified two distinct morphotypes termed shallow and depth-generalist types, based primarily on corallite size and spacing. The depth-generalist morphotype was the sole type found at mesophotic depths in the NW Gulf (Flower Garden Banks, Bright and McGrail Banks), with a combination of both types found at shallow depths. Conversely, only the shallow morphotype was observed at both shallow and mesophotic reefs (Dry Tortugas and Pulley Ridge) in the SE Gulf. The variable presence of the depth-generalist morphotype across reef habitats may indicate a genotypic influence on corallite morphology, as phenotypically-plastic responses to environmental conditions were not consistent across spatial scales. Continued examination into coral genotypic and morphological variation trends through an ongoing transplant experiment at the Flower Garden Banks will likely aid in a better understanding of shallow and mesophotic coral populations in the Gulf of Mexico.

Presenter's Email: mstudiva@fau.edu

Population genetics & gene expression reveal broad connectivity among shallow & mesophotic reefs in the Gulf of Mexico

Studivan MS*; Voss JD

FAU Harbor Branch Oceanographic Institute

Successful management of spatially isolated coral reefs is contingent on an understanding of ecological connections across populations. Microsatellite genotyping was employed to investigate genetic connectivity of depth-generalist species *Montastraea cavernosa* across shallow and mesophotic coral ecosystems (30-150m) in the Gulf of Mexico. A series of upstream and downstream reef sites were chosen across the Gulf of Mexico, including Carrie Bow Cay, Belize, the Flower Garden Banks National Marine Sanctuary (FGBNMS) and outlying Coral Habitat Areas of Particular Concern (CHAPCs), Pulley Ridge CHAPC, and the Dry Tortugas Ecological Reserve. Population-wide genetic diversity suggests relatively open coral populations and high levels of gene flow in the NW Gulf, consistent with strong current patterns and availability of reef habitats in the Gulf of Mexico. Conversely, genetic differentiation within Belize and the SE Gulf indicate relative isolation of shallow and mesophotic *M. cavernosa* populations on a sub-regional scale. Gene expression profiling to identify physiological differences across depth corroborated to trends seen in genetic connectivity. This research is designed to provide data for improved regional management of deeper coral reef ecosystems and collaborative marine research with NOAA partners through the Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT).

Presenter's Email: mstudiva@fau.edu

Effects of ocean acidification and temperature on biomineralization and adhesion in the barnacle, *Amphibalanus amphitrite*

Tedesco, D.[1]*; Nardone, J.A.[1]; Siegel, K.R.[1]; Patel, S.[1]; Orihuela, B.[2]; Rittschof, D.[2]; Dickinson, G.H.[1]

[1]Department of Biology, The College of New Jersey; [2]Duke University Marine Laboratory, Marine Science and Conservation

Increasing atmospheric CO_2 concentrations have resulted in warming of coastal waters and changes in ocean pH, trends that are predicted to continue into the future. We assessed the impact of pH and temperature on adhesion and biomineralization in the barnacle, *Amphibalanus (=Balanus) amphitrite*. Juvenile barnacles, settled on T2 silicone, were exposed to one of two levels of pH_T, 8.03 and 7.77, at one of two levels of temperature, 26° and 30°C, for five months. Panels from each pH and temperature combination were scanned biweekly, enabling quantification of base plate growth. Survival of barnacles was not significantly influenced by pH, temperature, or their interaction. A significant, interactive effect of pH and temperature was found for barnacle growth. At 26°C, barnacles grown at pH 7.77 were significantly larger than those grown at pH 8.03. At 30°C, however, barnacle growth was similar at both pH levels. Mechanical properties (microhardness and crack propagation) of the barnacle base and parietal plates, and adhesion strength in shear were not affected by pH, temperature, or their interaction. Assessments of the structure and elemental composition of barnacle base and parietal plates are ongoing. Authors acknowledge support from the Office of Naval Research.

Presenter's Email: tedescd1@tcnj.edu

An exotic species alters patterns of marine community development

Kathrynlynn W. Theuerkauf[1*], David B. Eggleston[1], Seth J. Theuerkauf[1]

[1] NC State University's Center for Marine Science and Technology, Morehead City, NC, 28557

Predictions of ecological patterns can be strengthened through replication of foundational studies under different environmental conditions to evaluate the consistency in their underlying processes. In this study, we replicated Sutherland and Karlson's 1977 classic ecology study that tested terrestrial paradigms of community development in a marine fouling community. The abundance patterns of marine fouling species were quantified on sequentially submerged settlement plates to investigate the effects of disturbance date on short- and long-term patterns of community development, and the original study's datasets were re-analyzed for comparison. In both studies, community structure was initially shaped by disturbance date due to monthly and annual variation in larval recruitment. Despite these similarities, the underlying drivers of long-term patterns of community development have shifted substantially since the 1970's. During the present study, an exotic tunicate, *Clavelina oblonga*,

dominated plates over time and its dominance was associated with significant declines in species diversity. In contrast, the 1970s long-term community was characterized by a heterogeneous mixture of species that varied interannually, yielding increased species diversity over time. These results highlight how an exotic species can alter patterns of community development and demonstrates the need to replicate foundational ecological studies in light of ongoing environmental change.

Presenter's Email: kwjenkin@ncsu.edu

Scratching the SERFIS: surveying estuarine response to freshwater inflows in the Caloosahatchee

Cassondra Thomas*; Teresa Coley

South Florida Water Management District

The majority of freshwater entering the Caloosahatchee River Estuary (CRE) comes through the Franklin Lock and Dam structure (S-79). Flow rate is controlled and varies with season, Lake Okeechobee levels, and rainfall. The quantity and duration of freshwater inflow can impact downstream water column conditions and estuarine functions such as primary and secondary production. The SERFIS project uses a shipboard flow-through data sonde system to measure surface water quality parameters including salinity, turbidity, color, and chlorophyll concentrations. Zooplankton are collected concurrently. This provides a snapshot in time and space of system-wide estuarine conditions and the location of the zones of maximum production, where turbidity, chlorophyll, and zooplankton peak concentrations can overlap. These snapshots are then compared to freshwater inflow rates of different timescales (1-day flow, 7-day average flow, 14-day average flow, etc). Assessing the existence and location of the zones of maximum primary and secondary production in relation to freshwater inflow will help water managers determine estuarine functional response to water release schedules and guide operational decision making.

Presenter's Email: marshrat92@gmail.com

Examining a Temporal Shift in Regeneration Frequency and Average Arm Length for the Forbes Sea Star *Asterias forbesi* in Wassaw Inlet, GA, USA

Rebecca Noel Thublin*; Sue C. Ebanks

Savannah State University

In benthic environments, sea stars can be keystone predators. Their size is a limiting factor in prey selection, with larger sea stars having more prey options. The purpose of this study was to determine size distribution and prevalence of regeneration for Forbes sea stars *Asterias forbesi* at Wassaw Inlet, Savannah, GA, USA. Sea stars were collected via otter trawl aboard the R/V Margaret C. Robinson. Four 1 nmi trawls were conducted on 15 OCT and 9 DEC in 2015; on 2 FEB, 29 MAR, 25 MAY, 29 JUL, 19 AUG, 26 SEP, and 11 NOV in 2016; and 25 JAN in 2017. If sea stars were present, arm lengths were measured and degree of regeneration was noted. The regenerating percentage was 10.12% in October 2015 (n=70), 6.45% in December 2015 (n=115), 11.39% in February 2016 (n=69), 4.23% in March 2016 (n=71), 25% in May 2016 (n=8), and 0% in July 2016 (n=3). Average arm length by date was 3.51±0.640, 5.75±0.860, 7.07±0.813, 8.03±1.043, and 6.97±0.541 cm, respectively, and was not measured in July. Future studies should be conducted to determine the reason for low regeneration frequencies in this area and whether there is a seasonal bidirectional ontogenetic migration through the inlet.

Presenter's Email: rthublin@student.savannahstate.edu

Spatiotemporal environmental variability influences abundance and diversity of oyster reef communities in North Carolina

Maxwell L. Tice-Lewis[1], Stacy Y. Zhang[2], and S. Gray Redding[3], Quin Walker[4] and F. Joel Fodrie[1]

[1]Institute of Marine Sciences, University of North Carolina at Chapel Hill; [2]Nicholas School of the Environment, Duke University; [3]Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science; [4]NOAA Southeast Fisheries Science Center, Beaufort, NC

Understanding how oyster reef distribution, abundance, and associated biological communities vary over estuarine gradients in salinity, temperature, and depth is crucial for guiding coastal restoration. We examined the influence of natural temperature, salinity, and tidal exposure variability on oyster reef community diversity and structure in two North Carolina estuaries. Eleven oyster reefs were sampled bimonthly throughout 2013-2015, and fauna were enumerated to the lowest possible taxon. Continuous salinity and temperature data were recorded at each reef throughout the study period. Intertidal reefs tended toward high oyster abundance when compared to subtidal reefs all along the main axis of the estuary, although differences between subtidal and intertidal reefs were more pronounced at higher salinities. In contrast, the lower environmental stress in subtidal zones allowed for generally higher faunal diversity on subtidal oyster reefs. High salinity reefs displayed higher abundance and faunal diversity than low salinity reefs, but salinity appeared less important than tidal regime in determining diversity and oyster abundance. As expected, variable, low salinity reef faunal diversity fluctuated more than on reefs in saltier, stable sections. These results should be of interest to estuarine ecologists, resource managers, and restoration practitioners, and provide quantitative links between environmental drivers and oyster communities.

Presenter's Email: mwell13@ad.unc.edu

Spatial Distribution of Atlantic surfclams (*Spisula solidissima*) in the Middle Atlantic Bight and Georges Bank

Jeremy Timbs[1*]; Roger Mann[2]; Eric Powell[1]

[1]Gulf Coast Research Laboratory, University of Southern Mississippi; [2]Virginia Institute of Marine Science, College of William & Mary

The Atlantic surfclam (*Spisula solidissima*), a commercially important species, supports one of the largest fisheries on the northeast coast of the United States. Using data from ~30 years of surfclam stock surveys, variance-to-mean ratios were calculated for a range of size classes (lower boundary: 64, 80, 93, 104, 120 mm) of surfclams both temporally and spatially to measure the degree of patchiness. Analysis of the surfclam dataset showed that the variance-to-mean ratio declined over the decades from the 1980's to the present in all assessed regions (Delmarva, New Jersey, Long Island, Southern New England, Georges Bank). A possible explanation for this decline is a range shift further offshore that is occurring due to climate change. Additionally, size classes were distributed differently over each of the regions, typically with larger animals more patchy. These differences could be attributed to the fact that small animals recruit over a much broader region, some locations offering suboptimal habitat with low survival. The effect of these trends on the population dynamics of the stock require further investigation particularly regarding the stock recruit relationship of the surfclam, as some portion of the recruits appear not to support the spawning capacity of the stock.

Presenter's Email: Jeremy.Timbs@usm.edu

Matters of the mud: intra- and inter-population variation in thermal microhabitats impact blue mussel survival in the Gulf of Maine

Torossian, Jessica*[1]; Scott Morello[2]; Brian Helmuth[1]

[1] Department of Marine and Environmental Science, Northeastern University; [2] Downeast Institute for Applied Marine Research & Education

Blue mussels, *Mytilus edulis*, are found in a variety of habitats including rocky shores and intertidal mud flats. To test how substrate affects body temperature and survival of *M. edulis* in the Gulf of Maine, we measured within-site variation in thermal microenvironments in mud and rock using biomimetic sensors. Site-specific lethal exposure temperatures (LT50) were measured in the lab during winter and summer across 5 sites (2 North, 3 South). While there were no significant inter-site differences in LT50 after a single exposure to extreme temperatures, differences were apparent after multiple (2-3) repeated exposures. Overall, mussels in the mud experience a lower range of temperatures (higher minimum and lower maximum) than mussels on adjacent rock. However, the benefits of this thermal refuge vary by region and season; mud is most important during wintertime cold stress events for buffering lethal temperatures than it is during the summer when lethal temperatures rarely occur. This research highlights the importance of understanding how spatial and temporal variation in a species' thermal landscape interacts with physiological limits to drive current and future distribution patterns.

Presenter's Email: torossian.j@husky.neu.edu

Monitoring Marine Fouling Assemblages Using Comparative Techniques: Assessing Resolution and Accuracy of Photograph-based Taxonomy of Invertebrates

Brianna Tracy[1] and Katy Newcomer[1]

Smithsonian Environmental Research Center, 647 Contees Wharf Road, Edgewater, MD 21037, USA

Marine invasions must be efficiently and effectively monitored in order to detect changes in community composition, population dynamics, and regime shifts over time. In San Francisco Bay, the marine invertebrate fouling community is a well-studied and vital ecosystem in the search to stem the tide of invasions, but long-term ecological monitoring is expensive and time consuming. With the rise of citizen science and available technology, photographs and their associated use for species identifications are becoming increasingly popular and useful data collection tools. In this study, we used settlement panels to directly compare two standardized measures of fouling community assessment: examination of live organisms in the field and analysis of organisms via photographs. Species lists and abundance data produced from these assessments allowed researchers to compare the quality of data that photographs could provide to scientists hoping to employ volunteers to collect information on marine invertebrate invaders. Comparisons of data derived from photographic analysis to live microscopic analyses suggest that while photographs are an extremely useful tool, some caution is warranted in interpreting the resulting data. Our results suggest that diversity and richness measurements obtained from photographs can approximate live measurements, but with significant variation. Relative abundances of species and morphotype groups are captured fairly well by photographs. Photographs also perform markedly better for some groups of taxa. In the face of volatile environmental shifts, long-term monitoring is important to detect, understand, and predict future phase shifts in biological communities and help managers and researchers allocate resources efficiently – but data derived from photographs of sessile invertebrate communities should be interpreted carefully.

Presenter's Email: tracyb@si.edu and newcomerk@si.edu

Exposure to elevated pCO_2 does not alter reproductive suppression of *Aurelia aurita* jellyfish polyps in low oxygen environments

Laura M. Treible[1,2]*; Kylie A. Pitt[2]; Shannon G. Klein[2]; Robert H. Condon[1]

[1]Center for Marine Science, University of North Carolina Wilmington; [2]Australian Rivers Institute – Coasts and Estuaries, Griffith School of Environment, Gold Coast Campus, Griffith University

Eutrophication-induced hypoxia is a major threat to coastal ecosystems and appears to be expanding globally. In hypoxic waters, the pH is lowered because enhanced respiration elevates *p*CO2, yet hypoxia-low pH interactions are rarely considered. Jellyfish tolerance to hypoxia is considered to be a competitive advantage in coastal systems that experience seasonal hypoxia, and has been speculated to stimulate localized jellyfish blooms. Previous studies on gelatinous organisms conclude that they are fairly robust to both low oxygen and low pH conditions. This study sought to determine individual and interactive effects of hypoxia and elevated pCO_2 on the asexual reproduction and respiration rates of *Aurelia aurita* scypho-polyps. Hypoxia significantly affected asexual reproduction, whereby low DO reduced propagation by ~50% relative to controls. In contrast, hypoxic treatments experienced elevated respiration during an initial acclimation period, but did not differ between DO levels under prolonged exposure. Interestingly, there was no significant effect of increased pCO_2 on either asexual reproduction or aerobic respiration, opposing the need to consider elevated pCO_2 in conjunction with hypoxia for *A. aurita* polyps. While studies on other taxa highlight the importance of these multiple stressor interactions, responses may differ in gelatinous organisms that are more robust to environmental changes.

Presenter's Email: laura.treible@gmail.com

The spotfin killifish *Fundulus luciae* (Baird, 1855) in salt marshes of coastal South Carolina: population characteristics and parasite fauna

Kristen M. Trevey*[1]; Erin J. Burge[2]

[1]School of Coastal and Marine Systems Science, Coastal Carolina University; [2]Department of Marine Science, Coastal Carolina University

The spotfin killifish is unusual as a permanent resident of intertidal salt marsh habitat. *Fundulus luciae* was historically reported as rare or infrequently encountered, but recent collections in appropriate habitat continue to document new populations within the established range. Prior to this study, *F. luciae* had only been officially reported from South Carolina once, in 2014, when two individuals were captured in Beaufort County. Three locations were selected for this project, spanning 84 km along the coast of northeastern South Carolina. Pit traps were installed in the intertidal salt marsh and dip-netted monthly for a year. Eight fish species were captured from pit traps. *F. luciae* comprised nearly half (49%; n = 1,072) of fishes from all sites, and was present on 98% of sampling trips (43/44). The consistent presence of *F. luciae* in the intertidal salt marsh means it could function as an intermediate parasite host for subtidal, marine and terrestrial predators. Parasite examinations of *F. luciae* have been relatively limited. A subset of *F. luciae* was inspected for ecto- and endoparasites, yielding 24 taxa, including several new parasite records and a potentially undescribed monogenean flatworm.

Presenter's Email: kmtrevey@g.coastal.edu

Rarity and Functional Diversity in Rocky Shore Species Assemblages

Trott, T. J.*[1]

[1]Department of Biology, Suffolk University

Rare species can significantly contribute to ecosystem stability and resiliency. Furthermore, wider taxonomic trees can support a wider range of functional diversity. These ideas with the notion that functional diversity leads to ecosystem resiliency suggest rare species can disproportionately increase taxonomic and functional diversity. To test this hypothesis, functional distinctness was used to estimate functional diversity, and average taxonomic distinctness to evaluate taxonomic diversity. Analyses used intertidal survey data from twelve exposed headlands spanning the Gulf of Maine sampled with directed searches aimed to maximize estimates of macroinvertebrate species richness. Species were ranked from abundant to rare using incidence among $0.1m^2$ quadrats. Forty-three

life-history and ecological traits were assigned to the total 95 species observed. Influence of rarity on functional and taxonomic diversity was appraised by comparing intact assemblages to ones where uniques (species observed once per location) were removed imitating rare species loss. For intact assemblages, functional diversity was correlated with taxonomic diversity. Removal of uniques significantly decreased functional and taxonomic diversity though concordance among the affected assemblages was partial. Removal of abundant species produced no significant effects. Results demonstrate rarity can shape functional and taxonomic diversity in ways abundant species do not, but the effects appear assemblage specific.

Presenter's Email: ttrott@suffolk.edu

Effects of proximity to source population and substratum type on recruitment in the kelp *Alaria esculenta* and *Laminaria digitata*

Trueman, S*; Gagnon, P

Department of Ocean Sciences, Memorial University of Newfoundland

Wild kelp harvesting has increased over the last few decades to help meet the growing world demand for kelp and kelp products. Knowledge about the timing and intensity of kelp recruitment is required to inform productive and sustainable wild kelp harvesting practices. To help evaluate the potential for a wild kelp harvesting industry, we carried out a 17-month experiment at a wave-exposed site in southeastern Newfoundland to characterize recruitment patterns in the dominant kelp *Alaria esculenta* and *Laminaria digitata*. Recruitment on polyvinyl chloride (PVC), wood, and ceramic panels deployed at monthly intervals above the seabed at 5, 15, and 35 m from an extensive kelp bed was quantified from August 2015 to December 2016 using digital photographs of the plates. The abundance of kelp recruits on all substrata was generally lowest from January to September 2016 and peaked from October to December of both years. However, recruitment during peak periods was influenced by substratum type and proximity to source population, being highest on wood at 5 and 15 m from the bed and lowest on PVC and ceramic at all distances. Light and wave action were generally lowest at 35 m, suggesting the physical environment influenced recruitment patterns.

Presenter's Email: samantha.trueman@mun.ca

Impacts of multiple predator effects on prey assemblages in the northern Gulf of Mexico: a mesocosm test using additive and substitutive designs

Valentine, J. F.[*,1]; Martin, C. W.[2]; Alford, S. B.[1]

[1]Dauphin Island Sea Lab; [2]UF/IFAS Nature Coast Biological Station, University of Florida

Consumer biodiversity is perceived to have a significant impact on marine ecosystem functioning. The generality of this perception may be questioned, however, based on recent reviews. The reason for variability in the results of biodiversity experiments may be a consequence of the simplicity of the study designs. Specifically, few of these studies have considered how variance in consumer density affects biodiversity's effects on ecosystem processes. Here we report the findings of a mesocosm experiment that manipulated the density and species diversity of invertebrate and vertebrate predators and measured their effects on three species of prey common in the northern Gulf of Mexico. Predator density strongly modified multiple predator effects on prey density. We found no evidence of either interspecific competition for prey or intraguild predation among consumers in any of our trials. We also found no evidence that the polyculture performed better than the best vertebrate monoculture. The invertebrate predator we used had limited effects on prey density. Overall, our results indicate that vertebrate predator identity, not species richness, was a key determinant of the transfer of energy across adjacent trophic levels.

Presenter's Email: jvalentine@disl.org

Resource Competition Among Sponges in Shallow Tropical Ecosystems

Valentine, M.M.*; Butler, M.J.

Department of Biological Sciences, Old Dominion University

Competition for resources can be intense in many diverse, densely packed benthic communities, but there is debate whether food availability limits the growth and distribution of sponges on coral reefs. These conclusions cannot be generalized to sponge communities in the shallow, wind-driven waters of Florida Bay, FL. In that system, water residence times are generally high and filtration by dense communities of sponges deplete the water column of picoplankton, setting the stage for intense competition for planktonic food resources. To test this hypothesis, we transplanted three sponge species to nine locations in Florida Bay and the Gulf-side of the Florida Keys that differed in sponge community biomass: areas with high biomass, low biomass, and areas devoid of sponges following mass sponge die-offs in 2007 and 2013. We then measured sponge growth and mortality for two years. Growth of transplants in areas devoid of sponges was 40 times greater than in areas with dense sponge communities, and three times greater than areas where biomass was low. This is striking evidence that sponges in this environment experience competitive release when transplanted from densely populated areas and that competition for food is a critical determinant of sponge fitness and distribution in Florida Bay.

Presenter's Email: mvale017@odu.edu

The effect of temperature on growth, mortality, and settlement of larval ribbed mussels (*Geukensia demissa*)

Virgin, S.D.S.*[,1]; Sorochan, K.A.[2]; Metaxas, A.[2]; and Barbeau, M.A.[1]

[1] Department of Biology, University of New Brunswick; [2] Department of Oceanography, Dalhousie University

Geukensia demissa contribute to the high productivity of salt marshes along the Atlantic coast of North America, from Florida to the Gulf of St. Lawrence. However, nothing is known about the larval ecology of this species. As a step in determining the effect of a changing climate on *G. demissa* at their northern range limit (i.e., Maritime Canada), we determined the effect of temperature on larval growth, survival and metamorphosis for *G. demissa*. We reared larvae at 4 temperatures (15, 19, 23, and 28˚C) for 28 days. In daily subsamples, we enumerated live and dead larvae and measured shell length (in μm) of 20 individuals. When larvae began settling, we measured the proportion of settlers in cohorts of larvae at 19, 23, and 28˚C; there was no settlement at 15˚C. Larvae grew fastest at 28˚C, followed by those in 23, 19, and 15˚C. Mortality was low and similar at the high temperature treatment levels (≥19˚C), but was higher in 15˚C. The proportion of total larvae that settled was similar among temperatures, but the time to settlement was delayed at temperatures <28˚C. This suggests that relatively cold water temperatures could be a major limiting factor for the dynamics of northern *G. demissa* populations.

Presenter's Email: svirgin@unb.ca

Population Density, Distribution & Health of Shallow Water Caribbean Porifera from an UNESCO Biosphere Reserve, St. John, USVI

Vojnyk, P.*; Bologna, P.

Marine Biology and Coastal Sciences Program, Montclair State University

Porifera are a crucial phyla of organisms in benthic ecosystems that filter water, act as biogenic habitat, and provide 3-dimentional structure. Sponge diversity and abundance are often used as bio-indicators for good or improving water quality in a system. Transects were performed during July 2015, January 2016, and July 2016 to determine species richness, diversity, and asses necrotic pinacoderm tissue decay of Porifera species in St. John, USVI. 6,800 individuals and over 17 different species were recorded during observation periods in Great and

Little Lameshur Bays. Results indicate that *Amphimedon compressa* and *Aplysina fulva* had the highest population densities showing differences in depth distributions between bays. Great Lameshur Bay showed higher species richness and population density by a small margin over Little Lameshur Bay, possibly due to benthic topography and substrate composition. In the summer of 2016, disease prevalence for *A. compressa* and *A. fulva* increased from previous surveys performed in January 2016, but the mechanisms of this increase is still uncertain. This research represents the first evaluation of shallow sponge communities in this area and provides baseline data for future evaluations of system health.

Presenter's Email: Vojnykp1@montclair.edu

Connectivity and Symbiont Adaptation among Mesophotic Corals in the Northwest Gulf of Mexico

Voss, Joshua[1]*; Polinski, Jennifer[1,2]; Studivan, Michael[1]

[1]Harbor Branch Oceanographic Institute, Florida Atlantic University; [2]Josephine Bay Paul Center, Marine Biological Laboratory

Despite the importance of coral-algal symbioses in corals' ability to thrive in multiple dynamic environments, few studies have investigated symbionts associated with corals on mesophotic reefs (30-150m). This study evaluated symbiont assemblages in *Montastraea cavernosa* on both shallow and mesophotic reefs in the Flower Garden Banks National Marine Sanctuary. While chlorophyll concentrations per unit area of coral tissue varied among banks, the concentrations were significantly higher in mesophotic corals due to an increased abundance of symbiont cells and increased concentration of chl *a* per cell. This strategy may represent a novel adaptation to light limitation among corals living at mesophotic depths. Illumina MiSeq sequencing of ITS2 regions revealed strong similarities among *Symbiodinium* assemblages across banks and between depths. All coral colonies were dominated by sequences most closely related to *Symbiodinium* type C1. These results, coupled with population genetic analyses of the same coral colonies in the Northwest Gulf of Mexico, suggest that these shallow and mesophotic *M. cavernosa* populations demonstrate strong connectivity and similarities among an interdependent series of banks. Through ongoing collaborative partnerships between NOAA and the Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT), this research was conceived and designed to provide data for improved management of coral reef ecosystems.

Presenter's Email: jvoss2@fau.edu

A tool to maximize shoreline protection by shellfish reefs

Walles, B.*[1]; van Prooijen, B. C.[2]; Ysebaert, T.[1,3]

[1] NIOZ Yerseke, Royal Netherlands Institute for Sea Research and Utrecht University, The Netherlands; [2] Faculty of Civil Engineering and Geosciences, Delft University of Technology, The Netherlands; [3]Wageningen Marine Research, The Netherlands

Shellfish reefs have been recognized to play a potential role in shoreline protection and erosion control. Although restoration of shellfish reefs is a widely-applied technique, not all projects succeed in delivering shoreline protection. The ability of reefs to attenuate waves and to affect sediment patterns in its lee-side (long-distance engineering effect) can be used to optimize restoration projects. To estimate wave attenuation by oyster reefs, design rules from breakwaters are applied and validated. To estimate the area of influence, a model was set up with input parameters: reef height, bed slope, water depth and wave height. Based on different environmental conditions, the length of influence ranges from meters up to several hundreds of meters. The length of influence increased for higher reefs, higher waves and milder slopes, indicating that application of reefs for shoreline protection is site specific. Effectiveness of reefs on shoreline protection furthermore depends on the niche oysters occupy. Reefs are therefore more effective in microtidal systems than in macrotidal systems. Model outcomes were verified using

published and unpublished data. Our design rules determine where and how reefs will be effective to reduce erosion and provide shoreline protection, even if a limited amount of system knowledge is available.

Presenter's Email: Brenda.walles@nioz.nl

What doesn't kill them makes them stronger: disease and genetic tolerance in the keystone predator *Pisaster ochraceus*

John Wares*[1], Lauren Schiebelhut[2]

[1]University of Georgia; [2]University of California, Merced

In recent years, a massive mortality event has killed millions of sea stars, of many different species, along the Pacific coast of North America. This disease event, known as 'sea star wasting disease' (SSWD), is linked to viral infection. In one affected sea star (*Pisaster ochraceus*), previous work had identified that the elongation factor 1-*α* locus (EF1A) harbored an intronic insertion allele that is lethal when homozygous yet appears to be maintained at moderate frequency in populations through increased fitness for heterozygotes. The environmental conditions supporting this increased fitness are unknown, but overdominance is often associated with disease. Here, we evaluate populations of *P. ochraceus* to identify the relationship between SSWD and EF1A genotype. Our data suggest that there may be significantly decreased occurrence of SSWD in individuals that are heterozygous at this locus. These results suggest further studies are warranted to understand the functional relationship between diversity at EF1A and survival in *P. ochraceus*.

Presenter's Email: jpwares@uga.edu

Cracking the code: the molecular nature of diet dependent aversive cues mediating trophic cascades

Weissburg, M.*[1], Poulin, R.X[2], Kubanek, J. [1,2]

[1]School of Biological Sciences, Georgia Institute of Technology; [2]School of Chemistry, Georgia Institute of Technology

Water born chemical deterrents are ubiquitous in aquatic and marine systems, where they exert important direct effects on prey species, as well as cascading effects when changes to the focal prey affect other organisms. In particular, behaviorally mediated trophic cascades are as, or perhaps more important than those produced by direct consumption. Unfortunately, we have little understanding of how prey encode the risk associated with a particular predator, and of the chemical nature of such water born deterrents. Our work on predator detection in mud crab prey has revealed that mud crabs encode the riskiness of predators fed different diets by recognizing a blend of common, primary metabolites released in predator urine. These metabolites differ in amount when predators feed on different types of prey, but the blends are qualitatively similar; that is, no unique molecule reveals what the predator has consumed. We have identified several of the molecules that underlie blend recognition by prey, which comprise primary metabolites produced by protein catabolism. Bioassays with these identified compound show that they account for much of the activity of the natural water born signal. We believe this is the first time such water born deterrents have been fully identified.

Presenter's Email: marc.weissburg@biology.gatech.edu

Reef building in the U.S. Virgin Islands threatened by ecosystem decline

E.M. Whitcher*[1], R. B. Aronson[1], I.B. Kuffner[2], C.D. Storlazzi[3], C.G. Pollock[4], Z. Hillis-Starr[4].

[1]Department of Biological Sciences, Florida Institute of Technology; [2]U.S. Geological Survey, St. Petersburg Coastal and Marine Science Center; [3]U.S. Geological Survey, Pacific Coastal and Marine Science Center; [4]National Park Service, Buck Island Reef National Monument

Coral reefs are critical barriers to coastal erosion and flooding throughout tropical regions, but their role in coastal protection is threatened by declining coral populations and sea-level rise. Climate change is causing widespread losses of live-coral cover on Caribbean reefs, and reducing the capacity of reef building to keep pace with sea-level rise. We used a census-based carbonate budget model to investigate contemporary reef building processes on a bank-barrier reef in Buck Island Reef National Monument, a marine protected area in the U.S. Virgin Islands. The model reveals that the mean rate of framework production by living coral falls short of biological erosion rates in 8 of the 9 shallow-water reef habitats studied. Reef habitats that grew at a mean rate of 2.4 mm yr^{-1} in the late Holocene are now in a state of net erosion, with reef surfaces poised to lose 8–25 cm of elevation by the year 2100. Erosion of reef framework will amplify the rate of relative sea-level rise over shallow reef crests surrounding Buck Island, with consequences for the long-term viability of the ecologic and coastal protection services that the reefs provide.

Presenter's Email: ewhitcher2015@my.fit.edu

A multibiomarker analysis of pollutant effects on Atlantic stingray populations in Florida's St. Johns River

John C. Whalen*; James Gelsleichter

Department of Biology, University of North Florida

The goal of this study was to examine the potential health effects of organochlorine (OC) and polycyclic aromatic hydrocarbon (PAH) exposure on Atlantic stingray (*Dasyatis sabina*) populations in Florida's St. Johns River (SJR). Special emphasis was placed on identifying OC- and/or PAH-related effects in stingrays from areas of the lower (LSJR) and middle (MSJR) basins that have been shown to possess elevated levels of these compounds. To accomplish this, we measured OC and PAH biomarker levels in stingrays collected from contaminated sites and reference locations. We specifically examined the biomarkers cytochrome P4501a1 (CYP1a1), a phase I detoxification enzyme; glutathione-S-transferase (GST), a phase II detoxification enzyme; uridine diphosphate glucuronosyltransferase (UGT), a phase II detoxifiocation enzyme; fluorescent aromatic compounds (FACs), PAH bile metabolites; and lipid peroxidation (LPO), cell membrane damage. The data suggest that biomarkers in stingrays from a reference site near Brunswick, Georgia, and the MSJR were significantly higher than those from Florida estuaries, including the LSJR. This indicates that residing in the MSJR is detrimental to stingray health, but residing in the LSJR is not. This study has developed a baseline for biomarker levels in the LSJR, allowing for the identification of possible dredging-induced changes to the system.

Presenter's Email: john.whalen@unf.edu

Water management, not overharvest, contributed to the 2012-2013 Apalachicola Bay oyster fishery collapse

J. Wilson White[1]*; Timothy J. Pusack, Christopher D. Stallings, David L. Kimbro

[1]UNC Wilmington

When managing estuarine resources, it can be difficult to resolve the relative influence of distant, upstream activities from local, within-estuary stressors. For example, Apalachicola Bay, FL, had supported a productive oyster (*Crassostrea virginica*) fishery for decades until it experienced high, unexplained mortality and rapidly

collapsed in 2012-2013. Competing explanations were a) overharvesting and b) higher salinities due to regional drought and upstream freshwater withdrawals from the Apalachicola watershed stressed oysters and promoted an outbreak of predatory southern oyster drills (*Stramonita haemostoma*) in the bay. To resolve this question, we used a state-space oyster population model, parameterized with field and lab experiments. We fit the model to 30-year fishery-independent time series of oyster abundance to estimate historical harvest rates, and then made runs with alternative flow and salinity conditions to assess the effect of upstream withdrawals. We found that harvest rates leading up to the 2012-2013 collapse were consistent with historically sustainable levels. High salinities in the summer and fall of 2012 led to low recruitment and higher incidence of disease and predation in the model, and these effects were mitigated when we simulated higher river flow (and thus lower salinities). Thus upstream factors – not overharvest –contributed to the collapse.

Presenter's Email: whitejw@uncw.edu

Consumer control of salt marsh geomorphic processes

Bethany Williams*[1]; David S. Johnson[1]; Kassandra Baron[2]

[1]Virginia Institute of Marine Science; [2]Washington & Jefferson College

Salt marsh persistence in the face of accelerated sea-level rise relies on landward migration and vertical accretion. Vertical accretion occurs through the contribution of belowground organic matter and the facilitation of sediment deposition aboveground by plants. Animals can regulate the abundance of plant biomass through ecological interactions such as herbivory and facilitation, but their indirect effects on sediment deposition through such interactions have not been explored. We examined the potential for a detritivore, Melampus bidentatus, to indirectly influence vertical accretion, using sediment deposition as a proxy, through its density dependent effects on Spartina patens litter decomposition, using field and lab manipulations. We found that as M. bidentatus density increases, S. patens litter decomposition also increases. Additionally, we found that with higher S. patens biomass, more sediment deposition occurred. These relationships demonstrate that a consumer can have an indirect effect on a geomorphic process, through ecological interactions and that changes in consumer population could influence salt marsh responses to sea-level rise.

Presenter's Email: bwilliams@vims.edu

Interested in behavioral/physical interactions in larval transport? Can't track larvae? How about robotic larvae you <u>can</u> track?

Wolcott, T. G. *; Wolcott, D. L.

Dept. of Marine, Earth & Atmospheric Sciences, NC State Univ.

A tool for examining how transport of weakly-swimming larvae is affected by the interactions between vertical migration behaviors and local current regimes has been lacking—until now. The "Larval Mimic," developed over the past 35 years, has metamorphosed into its adult instar, the "Autonomous Behaving Lagrangian Explorer." ABLE is a 3 kg neutrally-buoyant drifter that every 10s observes its microenvironment (time, depth, temperature, light, salinity, speed through water, contact with the bottom) and logs those measurements in 16 MB of non-volatile memory. Based on those data and its behavioral program (modeled on observed or theoretical larval behaviors, e.g., diel vertical migrations, ontogenetic changes in behavior) it recalculates its "target depth" and swims toward it at a biologically realistic rate. It can be tracked underwater with a pinger that telemeters depth, and periodically pops to the surface to get a GPS fix and transmit it by other locating beacons (LED, VHF radio, Globalstar satellite modem.) At the end of a deployment it surfaces, on schedule or on ultrasonic command, for recovery and data uploading. ABLE is ready to be built commercially and made available. Who needs it? What other capabilities are needed? What company might build them?

Presenter's Email: tom_wolcott@ncsu.edu

Tracking larval transport in upwelling using ABLEs (biomimetic "robot larvae.")

Wolcott, T. G.[1]*; Wolcott, D. L.[1]; Morgan, S. G.[2]; Largier, J. L.[2]; Susner, M. G.[2]

[1]Dept. of Marine, Earth & Atmospheric Sciences, NC State Univ.; [2]Dept. of Environmental Science & Policy, Bodega Marine Laboratory, UC Davis

How transport of weakly-swimming larvae of benthic species is affected by interactions between vertical swimming and local currents is poorly understood, especially in spatially and temporally complex settings (coastal waters, estuaries) that are not conducive to numerical modeling. Individual larvae cannot be tracked through development, yet we need to know how they move. Transport is critical for sustainability of populations and a major determinant of genetic connectivity between metapopulations. Field experiments with our biomimetic "robotic larva" are helping close this knowledge gap for an upwelling system on the California coast. The ABLE (Autonomous Behaving Lagrangian Explorer) has matured into a practical field instrument with pinger, LED, radio and satellite beacons for tracking; 16 MB datalogging memory; and Bluetooth connectivity. ABLE trajectories revealed that different vertical swimming behaviors have profound effects on transport during both upwelling and relaxation. Larvae that remain deep (16m) are unlikely to be transported far. Those that remain shallow (2m) will be transported rapidly downwind and, during upwelling conditions, offshore. Larvae undertaking diel vertical migration, swimming up at dusk to 2m and down at dawn to 16m, will show differing patterns depending on diel cycles of wind. (NSF OCE-1334553 [Wolcotts] and OCE-1334448 [Morgan & Largier.])

Presenter's Email: tom_wolcott@ncsu.edu

Estimating heritability in thermal tolerance and identifying stress markers that correlate to survival at higher temperatures in *Acropora cervicornis*

Yetsko, K.*; Gilg, M.

University of North Florida

Human activities are increasing atmospheric concentrations of greenhouse gases, leading to an enhanced greenhouse effect that has resulted in warming air and ocean temperatures. Corals have shown recent reductions globally and are susceptible to changes in temperature. Understanding the degree to which species vary in their tolerance to elevated temperatures and whether this variation is heritable is important in determining their ability to adapt to climate change. *Acropora cervicornis* fragments from 20 genetically distinct colonies were kept at ambient and elevated temperatures, and mortality was monitored for 26 days. Time of death was determined by loss of photosynthetic efficiency (Fv/Fm < 200) measured by PAM fluorometry and visually by total loss of coral tissue. Heritability of thermal tolerance was estimated using a clonal method comparing the difference in lifespan within and among clones in a one-way ANOVA, as well as a marker based method using the program MARK (Ritland, 1996) to estimate relatedness between colonies. To understand the physiological basis of thermal tolerance, tissue samples from both treatments were taken after 12 hours to measure several cellular biomarkers associated with sub-lethal temperature stress. Variation in mortality following lethal temperature exposure, heritability estimates, and stress biomarker data will be discussed.

Presenter's Email: kelsey.yetsko@unf.edu

Will restored salt marshes in urban eutrophic estuaries provide ecosystem services?

Zarnoch, C.*[1]; Alldred, M.[1]; Hoellein, T.[2]; Bruesewitz, D.[3]

[1]Department of Natural Science, Baruch College, City University of New York; [2]Department of Biology, Loyola University Chicago; [3]Environmental Studies Program, Colby College

Salt marshes are important areas of nutrient cycling, flood mitigation, and biodiversity on coastal landscapes but have experienced considerable degradation worldwide. Salt marsh restoration efforts are now common and are often motivated towards regaining lost ecosystem services including nitrogen (N) removal and carbon (C) sequestration. There have been multiple large-scale restoration projects in New York City, however, it is not clear if restored marshes have the capacity for N removal and C retention in urban eutrophic environments. In summer 2015 we began a 2-year study examining the interactions among plant growth, sediment conditions, and C and N dynamics across a chronosequence of restored marshes in Jamaica Bay, NY. We measured N fluxes seasonally at 4 restored marshes and 2 natural marshes using continuous-flow sediment core incubations. We found highest rates of denitrification (i.e. N removal) in a natural stable marsh. Denitrification rates in young restored marshes were lower than older restored sites likely due to limitation of nitrate and/or organic carbon. We measured sediment C and belowground plant biomass at each site and found that these increased with marsh age. Our preliminary results suggest that restored salt marshes may be important sites for N removal in eutrophic estuaries.

Presenter's Email: Chester.Zarnoch@baruch.cuny.edu

Effects of *Spartina* genotypic diversity, nutrient availability and environmental stress on plant and community-level responses in a Florida marsh

Zerebecki, R.A.*; Hughes, A.R.

Northeastern University Marine Science Center

Plant genetic diversity, like species diversity, can influence a variety of community and ecosystem processes. However, little is known regarding the importance of these diversity effects relative to other key environmental factors. We conducted a 2-year field experiment manipulating *Spartina alterniflora* genotypic diversity and nutrient availability across a natural stress gradient (i.e. tidal elevation) within a *Spartina* – dominated Florida marsh to examine the effect of *Spartina* diversity relative to the abiotic environment on plant and community-level responses. We found that the effects of *Spartina* diversity on primary production (stem density) varied by tidal height and nutrient availability: production was generally higher in polycultures, except in the low intertidal in the absence of nutrients and in the high intertidal in the presence of nutrients. The effects of *Spartina* diversity on invertebrate abundance also varied by tidal height, but was not modified by nutrient availability. Together, our results demonstrate that *Spartina* diversity can enhance both plant production and associated community abundance/diversity, but the magnitude of these effects depends on the abiotic environment.

Presenter's Email: zerebecki.r@husky.neu.edu

Coastal habitat restoration: Priorities, methodologies, and distribution

Zhang, Y.S.*[,1]; Silliman, B. R.[1]

[1]Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University

Globally, coastal ecosystems and the valuable services they provide are being degraded by human-induced stressors at an alarming rate. Conservation alone may not suffice such that restoration is becoming increasingly necessary to maintain coastal and estuarine ecosystems. We synthesized the literature to determine what abiotic and biotic factors were prioritized for restoration of oyster reef and salt marsh habitats and further compared where studies were conducted relative to estimates of regional habitat loss in the United States. Despite the fact that multiple studies have shown that trophic and non-trophic biotic interactions play a critical role in structuring ecosystems, they were consistently overlooked as important factors for successful habitat restoration. The greatest estimated amounts of marsh loss occur along the Pacific coast, and oysters across the United States are in poor condition with the exception of the Gulf coast. In comparison, restoration studies were most often conducted in the northeast, followed by the gulf coast. Our findings highlight a need for emphasis on restoring biotic interactions that can easily be included in methodology at little to no additional cost or effort. Additionally, further studies should be conducted in regions of high habitat loss, namely, the Pacific and southeastern coasts.

Presenter's Email: stacy.zhang@duke.edu

Snailed It: the effects of tidal inundation and structural complexity on predator-prey dynamics in salt marshes

Ziegler, S. L.*[1]; Fodrie, F. J.[1]

[1]Institute of Marine Sciences, University of North Carolina at Chapel Hill

The relationships between predators and prey across landscapes can have significant influence on ecosystem dynamics and functions. Abiotic forces (i.e., tide) and habitat structure (i.e., canopy density) can drive or limit the ability of predators to access their prey items within these landscapes, especially along the land-water interface. To quantify how tidal flooding, and distance from the edge influenced predator-prey dynamics in salt marsh habitats, we conducted prey tethering assays across three distinct tidal regimes. Marsh periwinkles *Littoraria irrorata* were tethered, placed at three distances (within 1m, 5m and 10m) from the marsh edge, and monitored for predation. Predation rates were positively correlated with tidal amplitude. Predation decreased with increasing distance from the edge except for at the marsh with the highest tidal amplitude. Our data also indicated *Spartina alterniflora* shoot density significantly decreased as tidal amplitude increased across sites. To separate the effects of shoot density from tidal forcing, we manipulated shoot density within a marsh at the median tidal amplitude. Shoot density did not significantly affect predation rates. Our study indicates that tidal forcing, more so than local (m^2) habitat structure, can greatly affect the ability of predators to access their prey items across the land-water interface.

Presenter's Email: sziegler@live.unc.edu

Mesopredator release: Moray eels inconspicuously predominate heavily fished reefs

Julie Zill*; Clara Schlieman; Megan Donahue

University of Hawai'i at Mānoa, Hawai'i Institute of Marine Biology

Populations of apex predators have declined globally due to human activities. Without sufficient top-down control, mid-level predators can increase drastically in number, termed "mesopredator release". On densely populated coastlines of the Main Hawaiian Islands, few large piscivorous fish remain, and fishermen act as the top predators in the system. However, prey selectivities of humans differ from that of the natural predator assemblage, resulting in high levels of top-down control on targeted fishes and, we hypothesize, mesopredator release of non-target species, such as moray eels. Because eels are greatly underestimated in visual fish surveys, almost no accurate data on eel abundances are available over space or time. Here, we developed a novel eel-specific survey that involves baited camera deployment to more accurately estimate eel densities. We conducted these surveys on shallow reef habitats in the pristine Northwestern Hawaiian Islands and the human-influenced Main Hawaiian Islands. First, we show that moray eels are a large component of the reef fish biomass in the Main Hawaiian Islands, and comprise almost all of the (otherwise low) piscivore biomass. Second, we evaluate whether the reduction of natural apex predators has led to an asymmetrical release of moray eels from top-down control in heavily fished areas.

Presenter's Email: jzill@hawaii.edu