Maternal provisioning of eggs of the starlet sea anemone, *Nematostella vectensis*: Selection pressures favoring the evolution of coloniality

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The success over evolutionary time of lineages with colonial organizations (e.g. cnidarians) is substantial. Coloniality has only evolved in a few lineages however, suggesting specific selection pressures that favor the evolution of this life history mode. To test hypotheses for why coloniality may have evolved, we are examining gene expression and physiological energetic differences between solitary and experimentally manipulated colonial morphotypes of the starlet sea anemone, *Nematostella vectensis*. Coloniality may confer specific reproductive advantages, such as increases in the quantity or quality of offspring, when compared with solitary individuals. Offspring of better quality may be produced, for example, when mothers provision eggs with biochemical constituents with greater organic content and/or per unit energy. We measured per egg levels of maternal provisioning using standard colorimetric assays of total lipid, protein, and carbohydrate content for eggs produced by solitary and two-headed (colonial) morphotypes of *N. vectensis*. Our preliminary results reveal significant differences between morphotypes in per-egg organic and energetic contents and densities. We will discuss these results in light of their effects on offspring quality, development, and growth as well as their implications for the selection pressures favoring the evolution of coloniality.
Importance of Bird Predation in reshaping the ecology of New England Salt Marshes
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Top predators can shape ecosystems via consumption of ecosystem engineers, removal of alternate prey, foraging activities, and nutrient regeneration. Teasing apart these contributions can be difficult. The range expansion of fiddler crabs (*Uca pugnax*) in New England provides an opportunity to examine the indirect effects of one of their predators, birds, on salt marsh structure and function. Fiddler crabs change marshes through burrowing, engaging in a wide variety of positive and negative ecological interactions. Consequently, bird-driven reductions in crab abundances could alter crab-related salt marsh ecosystem functions. To test this idea, we conducted a bird exclusion experiment at four different locations in New England – two with and two without large populations of fiddlers. We monitored a suite of community and ecosystem functions from plant cover to the abundance of bird prey items to benthic sediment properties such as chlorophyll a. We find that in areas where fiddler crabs occurred, caging reduced fiddler densities and had a cascading effect on chlorophyll a. In areas with few crabs, the treatment had little effect. Our results indicate that the effect of birds on salt marshes might largely be via their effect on ecosystem engineers.
Effect of sediment grain size on the distribution and density of the coquina clam, *Donax variabilis*

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*Donax variabilis* is considered an important component of healthy sandy beach ecosystems along the southeastern U.S. coast. Beach nourishment activities in this region potentially threaten *Donax* populations by altering beach sediment characteristics and habitat suitability for this burrowing bivalve. At Wrightsville Beach, North Carolina, sediment is dredged from an adjacent inlet and added to the central part of the barrier island to offset erosion. Our study examined the effect of beach nourishment projects on sediment grain size and the density of *Donax variabilis*. Intertidal sediment and invertebrate samples were collected monthly from 3 nourished and 4 control stations along Wrightsville Beach. Sediment samples were sieved using sieves ranging 2.36mm-63microns and a grain size threshold of <250μm was used as an indicator of suitable sediment for *Donax*. The Spearman rank order correlation was used to test for significant correlations between the percentage of sediment <250μm and the density of *D. variabilis*. The highest densities of *D. variabilis* were seen at northern control sites where a majority of the sediment was <250μm. In contrast, the nourished areas and southern control sites had coarser median grain sizes and lower abundances of *Donax*. 
Halophila stipulacea is a non-native seagrass, introduced into the Caribbean in 2002 from the Western Indian Ocean. Now being recorded in many Eastern Caribbean islands, including St. Thomas, USVI. One study concluded that this invading seagrass could outcompete the native seagrasses. Syringodium filiforme and Halodule wrightii are seagrasses native to the Caribbean Sea and found in the shallow waters of Brewers Bay. The purpose of this research was to determine some impacts of this invasion by examining the possible differences in the benthic fauna in the native and invading seagrasses. We suction sampled 0.1m² areas haphazardly in 10 native, invading and mixed seagrass beds. In the lab, the samples were thoroughly examined; the organisms and seagrasses were extracted. Major taxonomic group identified the organisms, the species identified the seagrasses, and were separated into detritus “brown” and live “green” and dry weights were taken. There was no significant difference in the number of organisms and the faunal diversity in the different seagrass habitats. Fauna included clams, crabs, shrimp, worms, fish, snails, and many more. Sampled fauna still need to be more precisely classified. The effects of H. stipulacea on Thalassia testudinum, bare sand patches and deeper areas need to be studied.
The Effects of Salinity on the Density and Diversity of Fish Species in Pigeon Creek Estuary in San Salvador, The Bahamas
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Estuaries are some of the most productive ecosystems in the world; the salinity gradient within estuaries often influences the distribution and abundance of species. The effects of salinity on density, species richness, and diversity of fish were observed in Pigeon Creek, a reverse estuary in San Salvador, The Bahamas. We hypothesized that an increase in salinity would decrease the density, species richness and diversity of fish, due to the energetic demands of osmoregulation in higher salinities. We counted and identified fish along 2 m x 20 m transects. A total of 16 transects were sampled at four sites; salinity varied from 36 to 43 ppt. At all sites, the fish that we observed were primarily juveniles. Several species of grunt were the most abundant fish found at all sites. At the two sites with lower salinity (36 and 38 ppt) there were 18 species, while at the two sites with higher salinity (41 and 43 ppt) there were 11 and 10 species, respectively. Fish density and diversity were also highest at the lowest salinity site. These decreases in fish density, species richness, and diversity support the hypothesis that higher salinities present physiological challenges that result in changes in community characteristics.
Invasion by the alga *Gracilaria vermiculophylla* may facilitate predation on mud snail veligers and egg capsules

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The invasive alga *Gracilaria vermiculophylla* is utilized as habitat by numerous invertebrates and a substrate for egg capsule attachment by the native mud snail *Ilyanassa obsoleta*. We examined whether invertebrates that inhabit *G. vermiculophylla* consume mud snail veligers and/or egg capsules, as this may negatively impact snail abundance in areas invaded by *G. vermiculophylla*. Egg capsule predation rates were estimated in the field by placing *G. vermiculophylla* and 16-cm² screens with a known number of attached egg capsules into a predator inhabited area for one week, after which the surviving capsules were counted. In the laboratory, we explored potential predator identity by placing a known number of veligers or capsules into one-liter mesocosms with either an amphipod (*Gammarus mucronatus*) or grass shrimp (*Palaemonetes pugio*). Predator free controls monitored natural veliger and capsule mortality. After three days, the remaining veligers or capsules were counted to determine consumption. Our field results indicate that significantly more egg capsules were consumed from *G. vermiculophylla* than the screen substrate. However, our laboratory experiments demonstrate that while both predators consumed a significant number of veligers, they did not consume egg capsules and were likely not responsible for the predation observed in the field.
No-take marine protected areas alter benthic communities with cascading positive effects on coral settlement and larval and recruit survivorship.
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Macroalgae can harm corals, and coral larvae sense and avoid chemical cues from macroalgae in settlement and flume experiments. However, coral larvae may be unable to avoid settlement near macroalgae as reefs continue to degrade on a global scale. We tested the effect of substrates from a coral-dominated no-take marine protected area (MPA) versus substrates from an adjacent fished reef dominated by macroalgae on larval settlement and recruit survivorship of the coral *Pocillopora damicornis*. We also assessed survivorship of larvae from MPA and fished reefs when maintained in water collected from each reef type. Larvae from both MPAs and fished areas initially (≤ 24 h) avoided settlement on macroalgal-fouled substrate from the fished area, but no longer avoided settlement after 48 h. When out-planted to the protected or fished areas, larvae from both areas experienced higher post-settlement survivorship at 4 and 26 days within the MPA than the fished area. Larvae from the fished area had lower survivorship than larvae from the MPA and this effect was exacerbated when larvae were maintained in water from the fished area compared to the MPA. These results indicate that no-take MPAs improve coral settlement and survivorship at multiple life stages.
The Ecological Importance of the Florida Sea Cucumber, *Holothuria floridana*, in the Florida Keys.
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Ornamental fisheries are increasing in importance due to their profitability from the aquarium trade, and in some cases, as they also become food fisheries. This has led to overexploitation and overfishing of ornamental species in many regions of the world. Sea cucumbers in particular have been overfished in many areas of the Pacific, and more recently in the Caribbean. Considering their role as deposit or suspension feeders, they are low on the trophic web and their ecological importance is too often overlooked. Here we focus on the ecology of the Florida sea cucumber, *Holothuria floridana*, which experienced a 4-fold increase in landings in Florida from 2012 to 2013. The species can be extremely abundant locally and we are determining the environmental variables that correlate with their abundance and distribution, and how their movement and foraging activities affect sediment characteristics, and in turn, seagrass growth and condition. Ongoing studies are also aimed at establishing the importance of sea cucumbers as a prey source for higher order organisms such as crustaceans, fish, and sea turtles. Ecological studies on *H. floridana* are valuable for promoting informed decisions about future exploitation such as responsibly adjusting the harvest to maximize yield and but minimize impact.
Quantification and characterization of the biological community and environment at Southern Hydrate Ridge

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Deposits of methane sequestered along continental margins and their associated seeps are found worldwide. These seeps are of increasing interest and importance because of their potential as an energy source, their contribution to greenhouse gases, and the unique community of chemosynthetic microorganisms and fauna that they host. One of the best-studied methane seep sites is Southern Hydrate Ridge, which is at a water depth of ~800 m. It is located ~90 km west of Newport, Oregon. Despite extensive geophysical and biological research completed here, no studies have quantified the relationship of seep sites and seafloor geology to the spatial distribution and abundances of microbial and macrofaunal communities. High resolution, georeferenced photomosaics of the individual seeps and the associated biological communities at this site were collected in 2011, using the remotely operated vehicle ROPOS. Detailed analyses of these images has allowed for the quantification and characterization of the diversity and structure of the faunal community. Results show that both the distribution and abundances of seep organisms are highly variable. Further examination of these photomosaics may improve understanding of the relationships between faunal distributions and seep locations, with implications for the impacts that chemical gradients have on these ecosystems.
Are introduced populations of the seaweed *Gracilaria vermiculophylla* more resistant to herbivores than native populations? A test of post-invasion adaptation

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Biological invasions are increasingly altering community structure and ecosystem function of virtually all marine habitats. *Gracilaria vermiculophylla*, a red seaweed, has been introduced in the North American and European coastlines in the last few decades. Previous investigations suggested that introduced *G*. vermiculophylla was a low preference food for herbivorous *Littorina* snails, and that introduced populations have evolved lower palatable relative to native populations. We tested these hypotheses by comparing palatability of plants from 15 native Japanese populations and 25 introduced populations from North American and European coastlines to a common generalist herbivore in estuaries of the southeastern United States, the amphipod *Ampithoe valida*. In contrast with previous studies, we found no difference in palatability between native and introduced populations using either choice or no-choice assays and suggest that regional differences in palatability must be herbivore-specific. Consumption rates increased with decreasing organic content of plant tissues, suggesting that *A*. valida can compensate for low food quality. There was also a significant latitudinal decline in palatability in the introduced range but not the native range, suggesting that plant quality may be responding to local environmental conditions in the introduced range, including salinity stress, herbivore pressure or bacterial loads.
Describing the source and biochemical composition of detritus along the coast of Maine using stable isotopes and fatty acid biomarkers

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It is well known that detrital pathways process large amounts of primary production in aquatic ecosystems; however, the quality and quantity of detritus ingested by organisms in the field is frequently poorly understood. This study will address this by characterizing the biochemical composition of detritus along the coast of Maine using stable isotope, lipid and fatty acid analysis. Stable isotopes and fatty acid biomarkers will be used to trace detrital material back to its source while nutritional quality will be determined by the percent organic content and C:N of detritus as well as its lipid and fatty acid composition. Comparison of the stable isotope and fatty acid signature of bivalves in the field with that of local detritus will inform if ingestion of the material occurs and what proportion of the diet it comprises. Areas suspected to be dominated by a single type of detritus, i.e. salt marsh, macroalgae or phytoplankton, will be selected in order to ascertain if there is any effect of detrital source on nutritional quality and contribution to bivalve diets. It is anticipated that results from this study will describe the role detritus plays in bivalve nutrition and its nutritional input into the benthos.
Has the importance of salt marshes to horseshoe crab spawning and recruitment been underestimated?

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Sandy estuarine beaches have generally been regarded as essential spawning habitat for American horseshoe crabs (*Limulus polyphemus*), while early juveniles are thought to utilize intertidal flats or shallow subtidal sediments as nursery areas. Historic aerial and satellite imagery demonstrates the rapid erosion of portions of the exposed coastline of Delaware Bay, NJ (DB); conversely, sand spits at the mouths of salt marsh creeks have been less affected. Sand deposited at Plumb Beach, Jamaica Bay, NY (PB) in a previous beach nourishment project has drifted eastward, forming a sandy bank at the mouth of a tidal creek. In DB and PB, sandy areas near salt marsh creeks attracted large densities of spawning adults and often higher densities of horseshoe crab eggs than nearby erosional beaches. At PB in 2015, we found that juvenile horseshoe crabs were significantly more abundant in the marsh creek than the intertidal sand flat. Catch-per-effort of 1-3 year old juveniles in the marsh creek was highest in mid-summer, whereas none could be found on the intertidal flat. We suggest that the importance of marsh habitats to spawning and recruitment in horseshoe crabs has been under-appreciated, and is especially relevant given the pace of sea level rise.
Genetic Evidence of a Recent Introduction of the Charru Mussel, *Mytella charruana*, to the Philippine Islands

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In February 2015, mussels were found by shellfishers in Tucok village (near Dagupan City) and other localities in the Northwest Pangasinan Territories of the Philippines that are morphologically different from the native Philippine mytilids *Perna viridis*, *Modiolus philippinarum*, and *M. moduloides*. Analysis of mitochondrial cytochrome oxidase I (mtCOI) sequences for three of these mussels indicated they have high sequence similarity with the charru mussel, *Mytella charruana*. The native range of the charru mussel extends from Guayamas, Mexico to Ecuador on the Pacific and from Colombia to Argentina on the Atlantic side of South America. Introduced populations of this species were documented on the coast of Florida in 2009. Comparing gene sequences for individuals sampled from the native and introduced populations has proven highly useful in identifying likely source populations for recent introductions. In the case of *Mytella*, we will present an analysis of expanded set of sequences for Philippine *M. charruana* and compare the patterns of haplotype introductions in the Philippines to those observed in Florida. The identification of source populations for specific invasions can provide information about the types of habitats that a given invasive species is adapted to and a species’ capacity for range expansion.
Ecosystem Resilience Following a Salinity Disturbance in a Hypersaline Estuary

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Baffin Bay, Texas, is a hypersaline estuary with salinity structure driven by evaporation rates that usually exceed freshwater delivery. El Niño conditions in spring and early summer of 2015 led to unseasonably wet conditions in the watershed, causing salinities to fluctuate a remarkable 50 psu over a 9 month period. Long residence times mean that Baffin Bay is continuing to experience an altered ecosystem state, making it an ideal time to examine benthic community dynamics, and the resultant effects on higher trophic levels. The Laguna Madre is an adjacent but more hydrologically stable system which was less affected by the 2015 salinity event. We will use infaunal community characterization and stable isotope analyses to evaluate these systems as the salinity in the Baffin Bay returns to a ‘normal’ hypersaline state. Preliminary data have shown that the two systems contain significantly different food resources and community structure despite their close proximity. Comparing these distinct systems simultaneously will allow us to better understand the direct effects of extreme salinity change on ecosystem resilience.
Density dependent and size specific cannibalism among juvenile echinoderms
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Benthic marine invertebrates recruit unevenly. During dense settlement years, cannibalism may contribute to juvenile mortality. As early as 4 days post-metamorphosis we observed frequent cannibalism among juveniles of the sea star *Asterias forbesi*. To determine if cannibalism was density dependent, we reared 2-3 week old juvenile sea stars at varying densities in 200 mL beakers. After one week, mortality rates of isolated juveniles were 10% and mortality rates at densities of 2, 10 and 20 juveniles per beaker were 10%, 73% and 90% respectively. We then conducted mesocosm trials with juvenile densities matched to field observations made during high recruitment years. Control juveniles experienced $5 \pm 3.2\%$ mortality, while juveniles allowed to cannibalize each other experienced $20 \pm 2.7\%$ mortality. We then created pairs of juveniles with differences in disk diameters ranging from 25-775 µm. We found that cannibalism was size specific, such that larger juveniles were more likely to be cannibalistic and greater size differences between juveniles increased the frequency of cannibalism. To our knowledge these are the first experiments showing that juvenile cannibalism in *A. forbesi* is density dependent, size specific and occurs at natural densities.
In this study we compare zooplankton communities attracted by UV radiation, white light and dark controls during non-moonlit nights in a tropical lagoon. Light traps with two sizes of mesh screen (500 µm; 63 µm) were used to collect meio- and macro-zooplankton in Lac Bay, Bonaire after 20 minute light trap sets. Density of macro- and meio-zooplankton was highly variable and dark controls attracted > 1 individual l⁻¹ in both size classes. Overall, the density of macro-zooplankton was higher than meio-zooplankton. The mean density of macro-zooplankton (± SD) was higher in the UV traps (6.7 ± 11.5 individuals l⁻¹) than white light traps (5.3 ± 8.5 individuals l⁻¹) whereas, the opposite relationship was found for meio-zooplankton where the density was slightly higher in white light (3.7 ± 8.9 individuals l⁻¹) than in the UV traps (2.7 ± 2.6 individuals l⁻¹). There were large differences in community composition among the three light treatments for both size classes. Meio-zooplankton attracted to white light were 75% pagurid zoea, versus 26% calanoid copepods in UV and 39% calanoids in dark treatments. For macro-zooplankton communities; dark controls were 50% cumaceans, whereas pagurid zoea composed 50% of the white and 73% of the UV community.
Ghost fishing lobster traps in the Florida lobster fishery cause the death of hundreds of thousands of lobsters, a problem exacerbated by the quantity of lost traps and the long duration the traps persist. Animals confined in ghost traps are prone to lethal and sublethal effects. We compared the nutritional condition of Caribbean spiny lobsters (Panulirus argus) found in ghost traps to the nutritional condition of lobsters found in natural shelters, and we deployed experimental lobster traps to follow the effects of confinement through time. To determine whether starved lobsters can recover if they were to escape confinement, we deprived lobsters of food for 16 weeks and then resumed feeding while tracking nutritional condition. Overall, lobsters found in ghost traps were in poorer condition than those in natural shelters. The blood serum protein of lobsters in the experimental ghost traps declined as the duration of confinement increased. Resumption of feeding resulted in recovery by half of the lobsters, though half were unable to recover and died. Lobsters that escape prolonged confinement in traps likely suffer sublethal health issues that may lead to mortality; however, the implications of sublethal effects of confinement to the fishery and the lobster population have yet to be fully explored.
Is the Way to a Lobster's Age Through it's Stomach? A Technique for Directly Ageing the Caribbean Spiny Lobster, *Panulirus argus*
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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. Yet, robust fisheries management has been hampered in part by our inability to directly age the species accurately. Like other crustaceans *P. argus* grow through a process of ecdysis, or molting, of the calcified exoskeleton. It has long been believed that molting results in the loss and replacement of all calcified structures precluding the use of conventional ageing methods. Kilada et al. 2012 demonstrated, however, that age in four temperate decapods could be accurately estimated by counting growth bands deposited in the eyestalk and ossicles of the gastric mill. The technique has since been applied to a few other crustaceans but no tropical species. Here we present the results of a preliminary study that examines whether bands are discernable in the gastric mills and eyestalks of *P. argus* of various sizes and known age. Clearly distinguishable bands were discovered and their numbers differ logically between lobsters of age 1 and 7, and among lobsters that vary in size and geographic origin.
The Kelp Ecosystem Ecology Network


The Kelp Ecosystem Ecology Network (KEEN) is a network of marine scientists around the globe interested in assessing the impacts of global change on kelp forests. Kelp forests are ubiquitous along temperate coasts, covering 25% of the world’s coastline. They are a critical foundation of many temperate and boreal coastal ecosystems. Recent studies have shown that changes in temperature and wave climate, such as those predicted by climate models, can have profound effects on kelp forests. Globally, however, there is a high degree of variability in kelp response to climate and other global change drivers. KEEN seeks to assemble a global database of standardized kelp forest metrics through coordinated monitoring of kelp forests structure and resilience to experimental kelp removals. Our group aims to understand how kelp forests might look in the future by exploring the interaction between global and local drivers of change. KEEN is organized into regional groups spread across the globe, and always looking to add new scientists to contribute to the effort.
Mating behavior of the lined shore crab, *Pachygrapsus crassipes*

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*Pachygrapsus crassipes* has the largest native range of any shore crab, though this distribution is disjunct, with one population ranging from Oregon to Baja California, and another population in Japan and Korea. Until recently, it was thought that this latter population was introduced from North America in the 1890’s, but molecular evidence suggests that these populations are separate clades that diverged 0.8-1.2 million years ago. *P. crassipes* is also notable for its complex sexual behavior, which is unparalleled among crustaceans outside the fiddler crab genus *Uca*. While these clades appear physically identical, it is possible that they are reproductively isolated by behavioral differences. We are examining mate choice as a possible mechanism of reproductive isolation in this species. First, we are measuring differences in mate choice between Southern California populations maintained in aquaria under laboratory conditions. Next, we will examine mate choice between North American and Asian crabs. If individuals preferentially choose mates from their own population, it suggests that mate choice may play a role in genetic differences observed among populations. If not, then spatial differences may play a larger role in speciation between these two clades.
Preference in prey type and size of *Crepidula fornicata* and *Mytilus edulis* by the mesopredator *Dyspanopeus sayi*.
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The limpet, *Crepidula fornicata*, is an important foundation species along Long Island’s shorelines, congregating in dense clumps that act as a habitat and a potential food resource for the mesopredator, *Dyspanopeus sayi*. To begin to understand the role *C. fornicata* has within *D. sayi*’s diet, a series of size preference experiments were conducted comparing consumption rate and size preference of *D. sayi* on *C. fornicata* to those of a well-studied prey, *Mytilus edulis*. It was hypothesized that smaller prey sizes would be preferred for *C. fornicata* based off of size preference observed in *M. edulis*. Flow-through mesocosm experiments were conducted to test prey preference of *D. sayi* in a mimicked *C. fornicata* shell hash environment. Prey treatments consisted of small, medium, and large size classes for *C. fornicata* and *M. edulis*. To examine prey preference, single size treatments were compared to a combined treatment that had all the size classes of a single prey treatment (*C. fornicata* or *M. edulis*). Results showed consumption rates to be highest in the small size class for both prey types (*C. fornicata* and *M. edulis*). Future experiments will focus on energy transfers and prey handling time to better understand size preference in *C. fornicata*. 
Integrating intertidal wild shellfish fisheries with aquaculture: Social-ecological system output capacity as an economic resource management tool

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Intertidal aquaculture of both softshell clams and other high value species such as American oysters (crassostrea virginica) and European oysters (Ostrea edulis) have potential to augment wild fisheries, provide diversification of incomes for traditional intertidal fishers, leverage the biologically productive marine intertidal zone. However, an incongruent regulatory environment, negative public perception of intertidal aquaculture, and intra-fisheries conflicts between wormers and clammers have limited development of an integrated intertidal aquaculture and fisheries resource use model. We propose a project to assess the ecological and economic production potential of an integrated wild fishery-aquaculture intertidal zone. Within our social-ecological systems “Output Capacity Zone” framework we will co-develop an intertidal resource management tool with municipal partners to inform intertidal resource use. That is, our integrated socioeconomic tool will identify an explicit and optimal configuration — a sweet spot — of wild fishery and aquaculture intertidal resource use to maximize system productivity based on the ecological, social, and economic constraints of the system. Our project will produce a bioeconomic model to assess the production potential of various configurations of an integrated wild fishery-aquaculture intertidal zone. This work will inform intertidal resource management and investigate the ecological impact of wild fishery-aquaculture intertidal use on benthic ecosystems.
Colonization of horseshoe crab nests by invertebrates on spawning beaches in Connecticut

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Abstract
An analysis of the invertebrate assemblages recently discovered to live in and around horseshoe crab (*Limulus polyphemus*) nests located on Connecticut beaches of Long Island Sound was begun in 2015. We used sand and egg clusters in pitfall traps, to test if (1) the beetle species *Hypocaccus dimidiatipennis* was seeking out *L. Polyphemus* nests, (2) the beetles were preferring nests based on their relation to the tide lines, and lab feeding trials to test if beetles were displaying predatory behavior of Dipteran larvae or horseshoe crab eggs. A total of 30 individual *H. dimidiatipennis* were collected using pitfall traps. The majority (90%) of adult beetles were collected from 6/11 to 6/22 and 57% of the total were collected in traps at 2m from the high tide line. Predatory analysis in the lab showed both *L. polyphemus* eggs and Dipteran larvae mortality with *H. dimidiatipennis* exposure. This study showed that *H. dimidiatipennis* are common seasonal colonizers in *L. polyphemus* nests on sandy beaches. *L. Polyphemus* nests act as temporary community ‘islands’ of food and/or habitat for at least 4 invertebrate species on spawning beaches in Connecticut and Rhode Island.
Blue crab predation on juvenile winter flounder in New England waters assessed through PCR-based methods

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Increasing water temperatures in the Northwestern Atlantic have resulted in blue crabs (*Callinectes sapidus*) extending their geographic range northward to Southern New England waters, including the Narragansett Bay Estuary and associated tidal rivers and coastal ponds. 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 trophic interactions. Polymerase Chain Reaction (PCR)-based methods were used to detect crab predation on juvenile flounder. DNA extractions of crab stomach contents were done using a Qiagen DNeasy Blood and Tissue Kit and then amplified using a winter flounder-specific 208 base-pair primer set. A total of 122 crab stomachs were analyzed, of which 26 tested positive for winter flounder DNA. This 21.3% positive detection exceeds predation rates estimated from traditional visual analysis of stomach contents, and suggests that crabs may be an important source of predator-induced mortality for juvenile flounder. Dynamics in this predator-prey interaction were unrelated to crab/flounder body sizes or flounder densities. Conversely, crab predation on flounder significantly decreased at low dissolved oxygen concentrations, possibly due to reduced crab foraging during hypoxic conditions (< 4 mg DO/L).
Comparing the effects of an extreme event and long-term climate change on the distribution of the barnacle *Semibalanus balanoides*

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Climate change is altering the distribution and abundance of marine organisms. Understanding the mechanisms responsible for driving these changes can be challenging due to the decade to century long time scales. The shorter time scale of range shifts due to extreme events makes them more tractable. In the 1960s the barnacle *Semibalanus balanoides* was present along the USA east coast south to Cape Hatteras, NC (35°N). Since then the southern range limit in this region has retracted poleward 350 km to Lewes, DE (38.5°N). Following the extremely cold winter of 2014/2015 recruits were present between Lewes and Cape Hatteras. We tested whether dispersal, temperature limits to reproduction, or temperature limits to survival prohibited colonization of *S. balanoides* within its historical range. Models of larval dispersal with a temperature-dependent competency window predicted dispersal was possible from currently established populations to the southern limits of recruitment observed in 2015. Successful reproduction was possible just north of Cape Hatteras in all years since the 1960s. All recruits were dead by August 2015. Winter and spring temperatures may limit the degree of dispersal and reproductive success, but low post-settlement survival most likely contributed to the retraction of *S. balanoides* since the 1960s.
Linking Heterozygosity and Morphometrics with Motility and Attachment Strength in Blue Mussels (*Mytilus edulis*)

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To test whether genetic factors or mussel size better explain motility and attachment strength of blue mussels, we determined heterozygosity of 220 wild-collected specimens from the New Hampshire coast. As a proxy for motility, mussels were buried under 5 cm of gravel and their emergence times were recorded. Attachment strength of byssal threads was measured using a Vernier dual-range force transducer. No significant correlations were found between heterozygosity and attachment strength (p = 0.0868), or between heterozygosity and emergence time (p = 0.5459). Morphometric measurements on the other hand, correlated with mussel motility and attachment strength. Specifically, mussels of longer shell length abandoned significantly fewer byssal thread bundles than shorter mussels (p = 0.00015*), and mussels of greater shell width had significantly longer emergence times than mussels with a narrower shell width (p = 0.00019*). Both findings indicate decreased motility of larger mussels. Furthermore, larger mussels had significantly stronger byssal thread attachment than smaller mussels (p = 0.00035*). We conclude that size, and hence mussel age, is a better predictor of mussel motility than genetic variation, suggesting that younger, smaller mussels move more than older, larger mussels.
Fish assemblages and trophic dynamics in eelgrass beds (*Zostera marina*) at Santa Catalina Island, California

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Seagrass beds are critical nursery habitats for many economically important juvenile fishes and invertebrates, but have declined globally, and by about 90% in southern California. The lower end of the food web of these productive ecosystems has been studied extensively, yet little is known about the effects of predators. We first evaluated whether fish assemblages or eelgrass habitat metrics differed amongst four eelgrass beds. There were significant differences among sites in the predator densities of juvenile *Paralabrax clathratus* (kelp bass) and *Halichoeres semicinctus* (rock wrasse). Eelgrass shoot density and mean blade length also differed among sites, but these differences did not correlate with differences in densities of kelp bass or rock wrasse. We also performed a 2-month-long caging experiment with two different exclusion treatments (0.6 and 2 cm mesh) to vary access of juvenile predatory fishes. There was a significant increase in eelgrass blade height in the small-mesh cages compared to the cage-control treatments, but no significance was detected in the large mesh treatment (where predators had access), highlighting the potential top-down control by predators on epiphytic algal grazers. Understanding whether predators exert trophic regulation of eelgrass is an essential next step to help resource managers protect this threatened ecosystem.
Does Lacking Induced Defensive Plasticity Contribute to the Southern Range Limit of *Chthamalus dalli*?

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The barnacles *Chthamalus dalli* and *C. fissus* overlap in distribution between Santa Cruz, CA and San Simeon, CA with *C. dalli* more common north to Alaska and *C. fissus* more common south to Baja California. *C. fissus* develops a narrow defensive morph in response to two species of predatory snails that both feed using a shell spine. Narrow morphs occur in the area of overlap of these two species but it is not known if these narrow individuals are all *C. fissus* or if, in fact, *C. dalli* also exhibits defensive plasticity. We examined morphological and molecular characteristics of barnacles sampled in the range overlap to determine if defensive plasticity is unique to *C. fissus*. Both the morphological and molecular analyses revealed that, in the overlap range, all narrow morphs sampled were *C. fissus* and all ovals were *C. dalli*. Furthermore, none of the *C. dalli* growing on shells of the predatory snail exhibited the defensive morph while all *C. fissus* growing on the predator shells were narrow. We argue that lack of defensive plasticity in *C. dalli* may impact this species' southern limit, particularly since the predatory snail, *Acanthinucella spirata* increases in abundance from Monterey, CA south to Baja.
Ecosystem response to freshwater inflow: determining a link between freshwater pumping regimes, salinity, and benthic macrofauna

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The demands of freshwater worldwide have roughly tripled since 1950 and the allocation of environmental flows for bays and estuaries has become an emerging issue for water resource management. Freshwater inflow serves a variety of important functions such as creating and preserving low-salinity nurseries; transporting sediments, nutrients, and organic matter downstream; and affecting estuarine species movements and reproductive timing. The amount of freshwater reaching Rincon Bayou, Texas, located in the Nueces Estuary of the Gulf of Mexico, has been reduced by 99% due to the construction of dams on the Nueces and Frio Rivers. This has led to reverse estuary conditions and decreased ecosystem functioning. A pumping system has been installed by the City of Corpus Christi to meet Texas Environmental Flow requirements for bays and estuaries, and is the primary freshwater source to the bayou. Analyses of benthic macrofauna and physical parameters have found a strong relationship between indicator species to salinity during pumping events. The effects of salinity changes can be related to pumping regime by modeling. Results of this study can be used in the facilitation of adaptive management for dam reoperation in providing a basis for freshwater release regimes needed to maintain optimal environmental conditions.
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A fish eyes view of the impact of non-native seaweeds on temperate reef seascapes

Presently, 50-80% of shallow rocky reefs in the Southwestern Gulf of Maine are covered by non-native seaweed species that are structurally different from native seaweeds. Many studies have examined the relationships between non-native species, competition, predation, diversity and food web structure. Fewer have investigated the effect of non-native species on habitat heterogeneity (ie., spatial patterns of seascapes). Number, size and diversity of patches within a seascape affect multiple ecological processes such as population numbers, diversity of species, recruitment and succession. We created 100m² mosaics of 3 habitats dominated by non-native, native and mixed seaweed species. Using landscape indices, we quantified spatial pattern metrics in these habitats. Our results indicate that habitats dominated by non-native species are more fragmented than those dominated by native species. This study serves to identify the degree to which non-native species alter the landscape of temperate reef ecosystems.
Limulus polyphemus are important members of marine and estuarine ecosystems, their eggs provide nutrition for migrating birds, and they are harvested to provide bait for other fisheries and blood for the biomedical industry. They are also an excellent model system for investigating biological rhythms, because they express both daily and tidal rhythms in the field and laboratory. In previous studies, we noted that they would occasionally stop moving for long periods of time, perhaps the inactivity was due to food digestion. In order to test this hypothesis, we monitored the horseshoe crabs activity before and after they were fed in outdoor tanks at the Jackson Estuarine Laboratory, NH. Activity was monitored using waterproof accelerometers that were attached in the center of their carapace. Their activity rhythms were recorded for one week, then they were fed blue mussels, and their activity was monitored for another week. Approximately sixty-five percent of the 77 horseshoe crabs tested decreased their activity after feeding. Another common trend was for individuals to change their original patterns of activity (either tidal, nocturnal, or diurnal), to a different pattern. Forty-five percent exhibited a change. These data support our hypothesis that horseshoe activity would change after consumption of prey.
Smithsonian’s MarineGEO: A global, collaborative network to document change in coastal marine biodiversity and its role in ecosystem resilience

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The ocean’s diverse reservoir of marine life provides food, livelihoods, protection, and inspiration. However, coastal seas are changing rapidly while the consequences affecting humans and ecosystems remain poorly understood. The Smithsonian Institution’s MarineGEO program is a growing global network of partners committed to understanding how and why coastal marine ecosystems are changing around the world through long-term research. Biological diversity is essential to ecosystem function and resilience, but is often neglected by ocean observing programs, and so is a central theme of MarineGEO research goals. Using standardized observations and coordinated experiments, MarineGEO addresses central questions facing coastal biodiversity: (1) How does marine biodiversity change geographically and over time? (2) How do human and natural forces drive changes in coastal biodiversity and ecosystems? (3) How do these changes affect coastal resilience and humans? (4) How does biodiversity influence marine ecosystem processes? (5) How can knowledge of the past help sustain resilient modern ecosystems? (6) How effective are conservation and restoration measures? Focusing on nearshore coastal ecosystems, where humans and marine biodiversity are most interconnected and concentrated, offers a complementary, unique niche among existing global ocean observing efforts. MarineGEO is building bridges with several marine biodiversity programs and seeks new partners.
Habitat heterogeneity of foundation species structures and mediates subtidal communities

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Foundation species can structure communities by modifying environmental filters that determine species persistence and mediate local species interactions. Specifically, foundation species can mediate the strength of trophic interactions, altering local community dynamics and species relative abundances. Thus, the spatial distribution of foundation species should alter community structure at the landscape scale. To examine how habitat heterogeneity of subtidal foundation species affects community composition and food web structure we compare community composition from a manipulative experiment and survey data from the Gulf of Maine. We manipulated the heterogeneity of kelp and red algae in plots on a subtidal rocky reef. In each plot we surveyed the community composition at multiple trophic levels, surveying algal, invertebrate, and fish communities. We performed similar surveys along transects at 16 sites in the Gulf of Maine. Our results show that although there were no differences in species richness, there were differences in community composition and the relative abundance distributions of species. Kelp removal plots had higher abundances of juvenile kelp and the invasive species Dasysiphonia japonica, but had lower abundances of mobile invertebrates than the other treatments. Our results suggest that heterogeneity of subtidal foundation species may affect community structure by mediating local species interactions.
Patterns of Predation by the Invasive Lionfish, *Pterois volitans*, in Bermuda

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There has been great concern about the potential impacts the invasive Indo-Pacific lionfish *Pterois* spp. may have on coral reef ecosystems. Diet analysis has mostly been limited to visual identification, however challenges arise in identifying partly digested stomach contents. In order to better evaluate the lionfish diet, we used DNA-barcoding techniques to identify the stomach contents from 44 lionfish captured on Bermudian reefs during the summer 2015. Prey fish surveys were also conducted to determine the potential prey species found on the study reef sites. We found the smallest size class of fish, 0-5 cm, made up 50.4% of all fish counted during surveying, which may reflect seasonal recruitment. The bluehead wrasse, *Thalassoma bifasciatum*, was the most abundant species encountered, making up 45% of all the prey fish surveyed. Combined with the masked goby, *Coryphopterus personatus*, and the yellowhead wrasse, *Halichoeres garnoti*, these three species accounted for almost 75% of all the fish tallied during the surveys. However, these three species were not found in any of the lionfish stomachs during this study. Results found species not previously identified by visual assessment. Further identification of gut contents with DNA-barcoding will help determine the relative importance of less common species, giving clearer insight to the feeding ecology of lionfish in Bermuda.
Habitat complexity modifies mud crab predation on oysters

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A prominent predator of juvenile (spat) Eastern Oysters (\textit{Crassostrea virginica}) is the Atlantic Mud Crab (\textit{Panopeus herbstii}). This common crab can substantially reduce spat survival and may act as a bottleneck to adult oyster populations. The objectives of this study were to describe the feeding rate and size preference of mud crabs, as well as examine how habitat complexity may affect foraging of mud crabs. We conducted two lab experiments using multiple size classes of oysters and mud crabs ranging in size from 20-30mm. We used t-tests to compare feeding rates between (1) each habitat treatment and (2) male and female crabs. A Chi-Squared analysis was used to test for oyster size preference, and a linear regression described the feeding rate of crabs as a function of crab size. There was a 55.02\% reduction in the feeding rate of mud crabs in complex habitats compared to non-complex habitats. We did not detect a relationship between size and feeding rate, and mud crabs showed no preference for spat from 8-20mm. These results suggest a positive relationship between habitat complexity and foraging time of mud crabs. As oyster reefs decline and lose complexity, mortality may increase due to mud crab predation.
Foraging ecology of blue crabs (Callinectes sapidus) and their potential impact on winter flounder (Pseudopleuronectes americanus)

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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 examines the potential impact of blue crabs on local fauna by analyzing their abundance, size-structure, and diet. Potential crab predation on winter flounder, Pseudopleuronectes americanus, was of particular interest due to locally declining populations. Crabs were collected from the Seekonk River (RI) and Taunton River (MA) from May to August 2012-2015, and preserved for measurements and visual stomach content analysis. Crab abundance exhibited spatial and temporal variations in the rivers, but overall estimates were consistent with Mid-Atlantic populations. Decomposition of crab 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.
Spatial and temporal patterns of barnacle settlement within the Southern California rocky intertidal

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Barnacles are model systems for understanding how larval transport processes influence settlement and population dynamics. Settlement of barnacle larvae was quantified in the Southern California intertidal from April 2014 through January 2015 and from April through December 2015. Settlement plates (settlement area, ~1.9 cm²) were deployed daily at 12-14 locations within our study site in the Bird Rock, La Jolla, California. Time series of temperature and pressure (significant wave height) were also collected within the study site to better understand how settlement varies with changes in environmental conditions. Settlement was higher in spring-summer months when compared to fall-winter periods during both years, but greater overall settlement occurred in 2014 despite similar annual trends in temperature. Spatially, at 10-100 m scales, settlement was variable across plates deployed within our site. We will discuss how some site-specific locations may enhance settlement.
Hit the road: assisted migration as population enhancement?

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Assisted migration applies human intervention to allow fish to bypass migration barriers through volitional passage (e.g. fishways) or translocation. There is increasing interest in using assisted migration to enhance Atlantic salmon populations, under the hypothesis that colonization of previously inaccessible habitat by reproductive adults will increase available habitat, thereby reducing density-dependent effects on juvenile growth and survival. We are evaluating a translocation program on population productivity of the Sainte-Marguerite River (Québec). For three years, returning adults are being captured, transported by truck, and released upstream of a pair of impassable waterfalls. We will examine habitat use by adults following transport and assess spawning habitat choice on juvenile growth and development. We transported 12 adults in 2014 (2F, 10M) and 25 adults in 2015 (12F and 13M), which we tagged with acoustic transmitters. A high percentage of fish strayed downstream over the falls (42% in 2014; and 28% in 2015). Males moved greater distances, whereas females had a greater propensity to stray. Evidence of reproductive activity was obtained from fish telemetry, visual inspection, and electro-fishing. Passive acoustic monitoring has proven ideal for tracking fish movements in a remote, gravel-bed river. Our study will inform future translocation programs throughout Québec rivers.
A fishery in flux: Claw removal and its impacts on survivorship and physiological stress in the Jonah crab (*Cancer borealis*)

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Found in coastal and shelf waters along the Atlantic coast of North America, from Newfoundland to Florida, Jonah crab (*Cancer borealis*) have been captured as incidental bycatch in the New England lobster industry for over 80 years. In the last 20 years however, Jonah crabs have become an alternative fishery target and landings have more than quadrupled. This has necessitated evaluation of the current status and prospective long-term health of the fishery. The biological implications of harvesting Jonah crab through the live removal of claws remain mostly unknown. The goal of this ongoing research is to evaluate current harvest practices (claw removal) and the implications on the health and behavior of Jonah crabs. Preliminary results from laboratory trials (\(n = 232\) total crabs) suggest that double-claw removal incurs markedly more mortality (~74 %) compared with single-claw removal (~56 %) and control animals (~19 %). Physiological stress, assessed through concurrent haemolymph analyses suggest elevated levels of glucose and lactate in de-clawed crabs. Continued studies on behavior (feeding) and growth are ongoing in an effort to better understand Jonah crabs and manage this rapidly developing fishery in New England waters.
Recent years has been a huge push to amass and distribute biological collection information online. Such databases provide a wealth of easily accessible historical data for ecologists. While not necessarily suitable for robust statistical analysis, these data can provide useful insights about species interactions over long periods of time. *Codium fragile* is an invasive seaweed that has been introduced all over the world, becoming the competitive dominant in some areas. In addition to directly competing with native species, it has the potential to compete indirectly via shared predators. Several species of sacoglossan sea slugs have adapted to feed on *C. fragile* in addition to their native diets. I have examined the apparent competition between *C. fragile* and native sacoglossan prey species using online herbarium data and GIS tools. I will present my methods as well as a discussion of some potential pitfalls of using such a data set.
Assessing the effects of the mud snail, *Ilyanassa obsoleta*, on the benthic microalgal community in a pristine saltmarsh
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Saltmarshes are among the most productive ecosystems globally; at North Inlet, South Carolina, about one third of the primary production comes from benthic microalgae. During the tidal cycle, the mobile microalgae vertically migrate through the upper 3mm of sediment. At low tide the algae are vulnerable to a variety of grazers, including the mud snail, *Ilyanassa obsoleta*, which is abundant in the tidal creeks. Many species of intertidal snails have been shown to significantly affect the community structure and density of microalgae within the sediment. This study found that *I. obsoleta* could cause a significant decrease in the concentration of total chlorophyll *a* when grazing an area with low snail density, but not in areas with high snail density. In the laboratory, snails were introduced to Petri dishes with both grazed and ungrazed sediments. The *I. obsoleta* spent more time on sediment that had been previously grazed by its conspecifics. When snail cues were introduced to both sides of the dish, snails showed no clear preference for location, indicating that *I. obsoleta* likely uses chemical cues to locate conspecifics and congregate towards them, despite the competition for food.
Moving Anoxic Porewater: The Dark Side of Bioirrigation
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Enhanced supply of oxygen to reduced sediments by pumping activities of benthic organisms is a critical component of benthic ecosystem functioning, but current knowledge of species-specific patterns of pumping activity and related geochemical dynamics is limited. We used time-lapse photography, planar optode imaging, and pore water pressure sensing to link the activities of three types of bioirrigators (the tube-building, head-down deposit-feeding polychaete Clymenella torquata, the mobile surface-feeding polychaete Nereis succinea, and the suspension feeding bivalve Ensis directus) with oxygen dynamics and pore water bioadvection in permeable sediments. Although sediment organic carbon content was similar in all trials, temporal patterns in oxygen dynamics significantly differed among bioirrigators, suggesting species-specific impacts on biogeochemical processes. Both polychaetes induced rapid switches between oxic/anoxic conditions in the sediment surrounding their burrows on time scales of minutes to hours. With razor clams, oxygen supply to subsurface sediments was detected only occasionally but changes in the position of the oxic-anoxic boundary in surficial sediment, upward movement of injected fluorescein, and pore water pressure data all suggest bioadvection of anoxic pore water. These data suggest that bioirrigation through the creation of pore water pressure gradients alone can have significant effects on sediment biogeochemistry through removal of metabolic products.
Reproductive investment in the Caribbean king crab *Damithrax spinosissimus*: exploring egg production costs in brooding phyletic giants

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The Caribbean King crab *Damithrax spinosissimus*, a phyletic giant, was used to explore the costs of brooding, in terms of reproductive investment, in invertebrates. Considering the expected allometry of egg production with increasing body size, we predicted that larger broods from larger crabs should suffer higher mortality and brood loss than smaller broods from smaller crabs. Fecundity in females carrying early and late embryos varied, respectively, between 5,170 and 26,024 eggs crab⁻¹ (mean ± SD = 16,569 ± 4,899) and between 1,966 and 26,906 eggs crab⁻¹ (15,147 ± 7,003). In disagreement with expectation, females did not experience brood loss during embryo development. Egg mortality in females carrying early and late eggs varied, respectively, between 0% and 69% and between 2% and 100%. Also in disagreement with expectations, egg mortality did not increase disproportionately with female body size.

Reproductive output varied between 10.45% and 43.79% of crab body dry weight. The slope (b=0.54) of the relationship between brood and parental female dry weight was significantly less than unity. Overall, the results disagree with the notion that the allometry of gamete production and increased physiological costs with increased brood size explain the association between brooding and small body size in marine invertebrates.
Tell it from the heart: Cardiac responses of *Argopecten irradians* to diel-cycling hypoxia

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In coastal environments bottom water oxygen concentrations can oscillate between fully oxygenated conditions during the day and hypoxic conditions during nighttime. How benthic organisms deal with such drastic changes in oxygen availability is not well understood. Specifically, we do not know at which magnitude, duration and frequency of diel-cycling hypoxia conditions become stressful. We have used non-invasive infrared sensors to measure the cardiac activity of the Atlantic bay scallops, *Argopecten irradians*, in response to diel-cycling hypoxia *in-situ* over one month periods as well as in the laboratory in controlled short-term incubations. In the field, heart beat frequencies varied between 13 and 46 beats per minute with highest values during early mornings once oxygen concentrations fell below 5.0 mg L⁻¹, while further decline in oxygen concentrations resulted in reduced cardiac activity. In laboratory incubations heart beat frequency was a good proxy for respiration under normoxia but scallops were unable to compensate for reduced oxygen availability by increasing heart rate at oxygen concentrations below ~3.0 mg L⁻¹ consistent with the *in-situ* data. Scallops were able to survive anoxia for >12 hours but we speculate that repetitive exposure to oxygen concentrations below this threshold will significantly affect their fitness, growth and reproductive success.
Comparing recruitment, survival, and performance between two competing invasive 
deissenid mussels

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Much of the research on invasive species examines the interactions between native and non-native species. However, the most interesting relationships are often those between two different invaders, such as between zebra (Dreissena polymorpha) and quagga mussels (D. bugensis). Introduced to North America in the early 1990’s, these dreissenid mussels often co-occur and likely compete for space and/or resources while concurrently causing problems for native species. However, important differences in growth, resource allocation, and dispersal have resulted in two closely related species that have followed very different invasion pathways. While zebra mussels have spread more quickly, quagga mussels are slowly displacing D. polymorpha in many North American waterways, especially the Great Lakes and the St. Lawrence River (SLR). The goal of this study is to examine recruitment and survival of both species within the SLR, and determine what abiotic and biotic factors affect performance and dispersal of each species, and thus contribute to the shifting dominance between them.
The Relationship between larval supply, settlement, and adult populations of barnacles within the La Jolla, California, Rocky Intertidal

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A diversity of organisms including benthic, sessile invertebrates such as barnacles inhabit rocky intertidal ecosystems. Barnacles serve as ideal models for understanding the influence of pre- and post-settlement processes on population dynamics. The purpose of this research was to examine the relationships between larval supply, settlement, and adult population densities of *Chthamalus* sp. and *Balanus glandula* within the La Jolla, California rocky intertidal. We deployed 6 larval traps to quantify daily larval supply, 12 settlement plates to quantify daily larval settlement, and conducted monthly adult surveys to examine the relationship between habitat availability and adult population densities, from November 2014 to December 2015. Habitat availability decreased across from fall-winter months, through summer months. Settlement was variable, but was relatively high during spring-summer. We will discuss how larval supply is related to settlement, habitat availability, and adult densities.
Plasticity in egg placement in response to predator cues in the mud snail, *Ilyanassa obsoleta*

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Most marine invertebrates develop in the plankton, where microscopic offspring are safe from abundant benthic predators until settlement. However, at least four phyla of marine invertebrates (Annelida, Mollusca, Nemertea and Platyhelminthes) deposit benthic egg capsules or masses. These animals possess other means to protect their young, which may include chemical or morphological defenses or nonrandom selection of deposition sites. Among gastropod molluscs, egg capsule deposition is the dominant reproductive strategy, including in the abundant mud snail, *Ilyanassa obsoleta*. In intertidal and shallow subtidal habitats in Maine, the mud snail preferentially lays egg capsules on blades of eelgrass (*Zostera marina*) that stand upright in the water column. We found that mud snails lay their egg capsules on eelgrass starting 6-8 cm off the benthos. When exposed to egg capsule predators such as hermit crabs and periwinkles, mud snails increase the average lowest height of laying by 1-3 cm. In the presence of hermit crabs, capsules placed just 5 cm up a blade have survivorship up to 4 times higher than capsules placed directly on the benthos. Placement of egg capsules off of the benthos may be an adaptive plastic response allowing mud snails to protect their embryos from benthic predators.
Impacts of abrupt climate change on the American lobster: exploring local adaptations in physiology across the Gulf of Maine

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The American lobster sustains the most economically valuable fishery in the Gulf of Maine and Atlantic Canada. Lobster biology and distribution are influenced by ocean temperature, which has increased rapidly and exhibited more frequent abrupt climate change (ACC) events in recent decades. ACC events are linked to mass mortality and disease in southern New England and enhanced growth and reproduction in historically colder northern waters, causing a net northward shift in the population. Modeling efforts suggest this shift will continue, but generally assume individual responses to ACC are uniform across the species’ range. Warm-acclimated lobsters tolerate heat spikes better than cold-acclimated lobsters, but it is unclear whether individuals from warmer regions have a greater acclimatory capacity than those from cooler regions due to local adaptation to changing conditions over time. We predict lobsters from southern New England will have a greater capacity to acclimate to warming temperatures than those from northern regions because they experience greater seasonal thermal extremes. We will use impedance pneumography to measure physiological responses (gill ventilation and heart rates) in lobsters originating from regionally-isolated subpopulations during temperature-ramping experiments. Exploring thermal tolerance plasticity across the species’ range will provide a better understanding of future impacts of ACC.
Title: Mercury concentrations in rocky shore island and mainland populations

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Abstract: Methylmercury is a neurotoxin that bioaccumulates in marine organisms, therefore posing a threat to human health via seafood consumption. It has been linked to cardiovascular disease as well as birth defects. Concentrations of methylmercury have previously been studied in organisms that inhabit sedimentary environments, which are known sites of methylmercury transformation and accumulation. This study focused on mercury and methylmercury accumulation in organisms collected from areas of different seabird concentrations and on island and mainland coastal sites. All samples were collected from rocky intertidal environments where the sediment stores of methylmercury cannot have a direct influence on tissue concentrations. The snail *Littorina littorea*, the blue mussel *Mytilus edulis* and the fish *Fundulus heteroclitus*, were collected from the island of Appledore in Maine, and coastal sites of Fort Stark, Rye and Odiorne Point in New Hampshire. Once collected, samples were then analyzed for concentrations of methylmercury and stable isotopes. Overall, concentrations of methylmercury were higher in organisms collected in high bird concentrations, with mercury concentrations greatest at sites with high numbers of seabirds and at coastal mainland sites.
Community turnover and the influence of habitat on the composition of mesofaunal communities associated with sponges

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Sponges can be thought of as microhabitats because they provide shelter, food, and a haven for reproductive mesofauna. Often described as ‘living hotels,’ sponges can host incredibly diverse and abundant assemblages of tiny organisms such as crustaceans and polychaetes. Lack of knowledge about the specific host associations of many of these inquilines has limited our understanding of sponges as microhabitats. To investigate the influence of habitat type on the composition of symbiont communities, I have sampled mesofauna associated with the ubiquitous Caribbean fire sponge, *Tedania ignis*, that occurs in seagrass and mangrove habitats in the Florida Keys and Panama. Reciprocal transplants of sponge hosts between habitats have revealed that partial community turnover can be induced by a change in habitat, and that symbiont community diversity and abundance are influenced by both the native source and the transplant site. By using the sponge as a model system, we are able to control for host genotype as we examine patterns of symbiont community assembly and assess the invasibility of established inquiline communities.
ECOLOGICAL EFFECTS OF DETRITAL ALGAE ON INTERTIDAL COBBLE HABITAT COMMUNITIES IN MAINE
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On the rocky shore when marine herbivores are rare and algal canopies dense, the supply of detrital algae can be a persistent feature. We suspected the presence of detrital seaweed mounds could play an important role in structuring intertidal faunal assemblage because of the food and cover they provide, but that it may impose stress if the detrital load becomes hypoxic. This study examines how detrital macroalgae influences the distribution and abundance of intertidal faunal assemblages and grazing rates on cobble beaches in midcoast Maine. During the summer of 2015 we designed a factorial field experiment using wire-mesh trays filled with cobble testing the joint effects of (1) algae treatment (with and without unattached rockweed, *Ascophyllum nodosum*), and (2) degree of exposure (outer and inner coast) as factors. Results suggest that the presence of rockweed detritus had a significant positive effect on abundance and richness of the mobile fauna in cobble beds, including green crabs, littorines, and amphipods. Degree of exposure played a significant role in grazing rates, as stations with higher wave exposure exhibited increased grazing by *Littorina littorea*. Further research should be conducted to determine how the presence of detrital algae influences the structure and trophic dynamics of intertidal communities.
Survey of Native and Non-native Mussel Species in the
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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. John’s 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 1989 with reported die-offs during colder months. Since then, green and charru mussels throughout the St. John’s River are sparsely documented in the literature, therefore, this study provides baseline data regarding the presence of non-native and native mussel species for this estuary.
Movement patterns and estimation of home range size for adult horseshoe crabs in Long Island Sound: results from a 15 year mark recapture study.

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Understanding resource use and movement patterns is key to development of sustainable management plans for any commercially important species. Horseshoe crabs in DE Bay migrate to the continental shelf post spawning while in New England States there is evidence that crabs residing within local embayments tend to remain there. Horseshoe crabs in DE bay can be managed as one large intermixing population; management plans in New England are localized as a result of embayment-specific population assessments. We analyzed 15 years of mark-recapture data to determine if movement patterns and home range sizes of crabs in Long Island Sound are indicative of embayment specific populations like New England States or one large intermixing population as observed in DE Bay. Within a spawning season, horseshoe crabs generally remain at the initial spawning beach where they were tagged over the course of successive tides. After one season, adults disperse more widely and are frequently recaptured on beaches other than the one they were originally tagged on. Long distance dispersal occurs but is not common. Only 2.2% of crabs cross LIS and even fewer leave the Sound. The data support development of an intermediate management strategy that includes both localized and regional approaches.
Many questions and a few answers about why herbivorous coral reef fish avoid foraging on algae where it is dense
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Reef building corals are threatened by local and global scale stressors that kill live coral and open space for macroalgal settlement. When herbivore communities are intact, algae is removed, preventing space preemption by algae and promoting a return to coral dominance. Unfortunately, Hoey and Bellwood (2011) demonstrated that herbivorous fish forage less intensely on macroalgae where it is dense, potentially leading to a positive feedback loop toward algal dominance. In a series of experiments we have tested the underlying mechanisms for this behavior. Video observations of foraging during daylight hours have proven ineffective at recording herbivore activity. However, in consumption experiments, we have found that fish do not forage effectively against algae-like backgrounds. Also, when algae from sparse locations are presented alongside algae from dense plots, herbivores selectively forage on sparse-sourced algae. Preliminary experiments demonstrate that there does not appear to be an associational defense effect when palatable algae are presented in mix plots with less palatable species. In future work, we will look for differences in the presence of unpalatable chemicals and epiphytes on algae growing in sparse and dense plots. This work may help explain why dense algal stands remain (or even expand) in the presence of herbivorous fish.
Members of family Caprellidae include predators, scavengers, and filter-feeders and are often incredibly abundant in marine fouling communities. Recent studies have suggested that cryptic speciation and broad intraspecific morphological variation are well represented in the Caprellidae. Because of these two factors, questions remain about the taxonomic status of some species of Caprellidae. We conducted a survey of Caprellids inhabiting the fouling community along the coast of Outer Island in Long Island Sound, Branford, CT, USA. We examined DNA sequences from a mitochondrial (CO1) marker along with morphological characteristics. Based on these data, we confidently identify one species (n=4) as *Caprella penantis*. The other species (n=4) morphologically matches *Caprella equilibra* but the molecular results from GenBank do not confirm this identification with a best match of only 83% similarity with whale lice, *Cyamus ovalis*. We plan to evaluate morphological characters using type specimens from Yale University collected from the same island in the mid-1900’s to determine if this unknown species was present then or is a recent addition to the fouling community.
Potential bioturbator bottleneck to *Posidonia australis* seedling establishment

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Seeds navigate a number of abiotic and biotic bottlenecks in order to successfully establish. A large scale seed based restoration project off Perth, Western Australia of the seagrass *Posidonia australis* reported low seedling establishment at all sites. Sea star and sand dollar bioturbators were abundant at several sites suggesting their behavior may have contributed to seedling losses. The goal of this preliminary study was to ask two basic questions: 1. Can these two bioturbators influence survivorship of recently settled seeds and loosely anchored seedlings? and 2. Are older, more established seedlings able to persist in the presence of these bioturbators? Results demonstrate sand dollars and sea stars dragged, pushed, and carried recently settled (days) seedlings along the sediment surface >50cm and are capable of uprooting young seedlings (weeks) recently buried within the sediment. In contrast, neither sand dollars nor starfish significantly impacted one-year-old seedlings. A survey of fauna and seedlings indicate that both sand dollars and sea stars may interact frequently with seedlings at this location. Repeated pushing and upheaval of seeds and young seedlings could prevent survival of seedlings beyond these early life stages. Thus, faunal disturbance could be an additional bottleneck to *P. australis* establishment, restoration, and recovery.
Localized and systemic palatability changes in the seaweed *Silvetia compressa* vary with herbivore species

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Herbivores can induce both localized and systemic responses in terrestrial plants, but due to poorly developed internal transport systems, seaweed research has primarily focused on localized grazing and waterborne cue effects. To further investigate previous findings that snails elicit stronger *Silvetia compressa* defenses than isopods, we examined whether these herbivores have different effects on local and systemic palatability. Divided containers split *Silvetia*, exposing half of each thallus to direct snail or isopod grazing, while the other half was exposed to systemic grazing effects. Identical containers without herbivores served as the non-grazed treatment. We then used choice feeding assays to compare 1) locally grazed and non-grazed tissues and 2) systemically grazed and non-grazed tissues. We found that isopods preferred non-grazed to both locally and systemically grazed tissues, suggesting that isopods elicit both localized and systemic defenses. In contrast, snails preferred non-grazed to locally grazed tissues, but preferred systemically grazed to non-grazed tissues. Thus, local snail grazing decreases palatability, while increasing palatability of adjacent tissues. As a consequence, although locally, snail grazed tissues are less palatable than isopod grazed ones, herbivores may avoid entire *Silvetia* thalli with isopod grazing damage, but increase consumption of individuals that have been partially grazed by snails.
Specificity of Sponge Defenses against Congeneric Sea Star Species
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We examined the specificity of prey defenses against two congeneric predatory sea stars, Echinaster spinulosus and Echinaster sentus. While previous studies have looked at sponge palatability to sea stars, few have looked at the differences in preference between closely related predators. To make feeding trials as natural as possible, we recorded sea star feeding behavior with intact live sponges of 25 species representing 13 orders of Demospongiae. For both Echinaster species there were consistent patterns of acceptance or rejection for each sponge species. The proportion of trials in which a given sponge species was consumed ranged from 0% to 100%. Sponges that were determined to be highly palatable, and nevertheless coexist with sea stars, employ other strategies to avoid predation, underscoring the complex nature of sponge defense strategies.
Population Connectivity of Slender *Sargassum* Shrimp Populations in the Northwest Atlantic and the Gulf of Mexico
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Pelagic *Sargassum* provides a unique drifting macroalgal substrate in the Northwest Atlantic and Gulf of Mexico that supports a variety of important species. Past studies have noted differences in community level biodiversity and species composition between *Sargassum* associated faunal communities in the Gulf of Mexico and communities in the Sargasso Sea and Caribbean. These observations suggest the potential for population genetic structure differences that have not been explored. This study examines population connectivity of the slender *Sargassum* shrimp (*Latreutilus fucorum*), a species endemic to pelagic *Sargassum*. Using 300 individuals from three regions that encompass the entire range, the Caribbean, the Gulf of Mexico, and the Sargasso Sea we characterized genetic diversity and population structure using mitochondrial 16S gene sequences. The results of this analysis will be outlined in the poster and will provide insight into the structure of *Sargassum* associated fauna and has important implications for the management of these regions and this unique ecosystem.
Regional Migration Patterns of Female Blue Crabs in the Gulf of Mexico: Where did all the ladies go?
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Female blue crabs undertake a spawning migration seaward. While the estuarine portion of the migration has been subject of much research, little is known about movement once crabs leave the estuaries. Beginning in March, 2016, we will undertake a Gulf-wide mark-recapture study to examine regional scale migratory patterns of the Gulf of Mexico blue crab spawning stock. In collaboration with fisherman and state agencies, 25,000 female blue crabs will be tagged as they migrate towards high-salinity waters to spawn. Tags will be attached externally using copper wire looped around their lateral spines. Each tag possesses a unique identification number, an offer of a monetary reward, and instructions for reporting recaptured crabs and claiming the reward. A dedicated phone line, web page, and voice mailbox will be available 24/7 for reporting of captured crabs. We are requesting recapture information including the identification number, location and date of recapture, and status of any present egg mass. With this information we hope to elucidate where these females are traveling once out of their estuaries. This information 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.
The Role of Heat Tolerance in the Invasive Success of the Red Seaweed *Gracilaria vermiculophylla*

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The red macroalga *Gracilaria vermiculophylla* is native to the Northwest Pacific and has invaded North American and European coastlines in recent decades. We tested whether the success of this invasion was likely aided by genetic adaptation of thermal tolerance after introduction. We sampled 15 native populations in Japan and 25 introduced populations along the United States and European shorelines. Within a week of field collection, we subjected thalli to 34, 39, 44 or 49°C for 15 minutes and followed their rates of bleaching and survivorship for 8 days at 16°C. All thalli died when exposed to 49°C regardless of population or regional source. At 34° - 44°C, native populations bleached and died significantly more often than did introduced populations. We are now repeating this experiment with thalli kept in a common garden for approximately 3 months. Preliminary assays suggest that the greater thermal tolerance among introduced populations has a genetic basis. Given the invasive history of this species, we propose that adaptation to greater heat tolerance occurred post-introduction, and that evolution in this and other plant traits facilitated invasion success. The role of evolution in biological invasions is an understudied but integral component to our understanding of invasion success.
Commercial shellfish beds in Galicia, NW Spain are often near river mouths in estuaries, and are prone to mortality events due to temporary drops in salinity caused by rainfall. In the laboratory, we developed relationships between the duration and intensity of salinity stress and the resulting mortality rate for three commercially important venerid bivalves, *Ruditapes philippinarum*, *Ruditapes decussatus*, and *Venerupis corrugata*. Using these relationships, it was possible to forecast upcoming mortality events, and provide an early warning to prompt emergency harvests. In order to estimate the short-term mortality in the shellfish beds, ocean forecasts from the regional weather service, MeteoGalicia, were used to obtain hourly surface salinity values on a 250m grid. A surface salinity time series, from June 2010 to December 2015, was established at each point on the grid, and daily mortality was recorded using the derived relationship. Significant mortality events discovered in these hindcasts were often replicated in reports from the regions. Modeled cumulative mortality reached 100% in January 2014 in locations of shellfish beds in the upper Ría de Arousa, coincident with reports of total loss of the *V. corrugata* population in the same area.
Saxy Science: hands-on genomics and bioinformatics in the undergraduate classroom using genetic and phenotypic variation in *Littorina saxatilis* and *L. obtusata*


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The revolution in next generation sequencing techniques over the last decade has brought about a “crush” of new molecular data and accompanying complex analytical problems. In molecular ecology and evolution we have transitioned from data-limitation to analysis-limitation, so students are counseled to strengthen computational skills and learn computer languages through applied projects. We are faced with the challenge of combining big-data scale computational and coding-oriented course content with traditional field ecology and evolution, all in a time-limited framework. Here, we present phenotypic and genomic analyses driven by two undergraduate biology classes at Bowdoin College (Marine Molecular Ecology and Evolution). Students completed field collection of snails in the Gulf of Maine (n=146 for each species, 5 localities), DNA extraction and next generation library preparation, phenotyping, single nucleotide polymorphism (SNP) genotype catalog construction, population genomic analyses and scientific writing. Students utilized ~20,000 loci across the genome to test a variety of hypotheses of their choosing, ranging from dispersal limitation of gene flow to linking genotype and phenotype.
Environmental conditions can influence growth rates and size at maturity in commercially harvested species. Understanding the importance of these conditions is necessary for proper management and maintaining sustainable populations. 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. Crabs were collected as megalopae and held in temperature-controlled incubators at 25°C and 30°C. Crabs were fed daily, checked daily for molting, and measured following each molt. Temperature significantly affected both IMP and GPM. Crabs reared at the warmer temperature molted more frequently but grew less per molt. Furthermore, crabs reared at the cooler temperature molted less frequently but grew more per molt. These results suggest that temperature has a significant role in determining the growth rate and size at maturity in blue crabs. We will extend this study until crabs reach maturity to determine how temperature influences growth rates and size at maturity on a long-term scale.
Variable population responses of *Macrocystis pyrifera* to warming temperatures

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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 along the West Coast of North America, supporting a diverse ecosystem that contributes to recreational fisheries, tourism, and industry. *M. pyrifera* shows decreased abundance in years of warm water temperature (Grove et al. 2002), but no study has examined genetic variation in the response of *M. pyrifera* to warming. I compared the settlement of *M. pyrifera* zoospores from three distinct populations at three different temperatures (14 °C, 16 °C, and 18 °C) to study the effect of warming on this early-life-history stage. Successful settlement varied amongst populations, and on average was highest at the ambient temperature. These results may indicate that some populations of *M. pyrifera* are more resilient to the effects of warming temperatures than others.
Low salinity compromises larval metamorphosis and growth in the colonial ascidian

*Botryllus violaceus*

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Abiotic factors influence the success and distribution of many invasive marine invertebrates. The invasive colonial ascidian *Botryllus violaceus* is a common inhabitant in fouling and shallow benthic communities in the Gulf of Maine. Although capable of tolerating a range of salinities, low salinities (<10 ppt) seem to be physiologically limiting. We exposed tadpole larvae to salinities (0-30 ppt). Tadpoles metamorphose in salinities ≥16 ppt; percent metamorphosis of larvae was not significantly different at salinities ≥20 ppt. We then tested whether larval exposure to low salinity impacts the growth of the resulting colonies when allowed to grow in full strength seawater. Larvae were metamorphosed larvae in four salinities (18 ppt, 20 ppt, 25 ppt, and 30 ppt). Colonies were transferred to 30 ppt seawater and colony growth was monitored for 9 weeks post-metamorphosis by counting the number of zooids per colony and measuring the area occupied by the colonies. Colonies that resulted from larvae that metamorphosed in lower salinities (18 ppt, 20 ppt and 25 ppt) had fewer zooids and covered less area than colonies metamorphosed at 30 ppt. A brief period of salinity stress during the larval stage has compromised growth of the adult colony.
The Slipper Lobster, *Scyllarides latus*, Uses Apatite and Fluorapatite to Protect its Sensory Organules

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The cuticle of arthropods has been intensely studied not only to better understand the properties of a natural composite material, but also to understand how structural properties and mineral contributions to this composite offer a durable protective covering from predator and microbial attack. Thus far, most marine cuticular studies have focused on the American lobster, *Homarus americanus*, or several crab species, but have largely ignored other types of lobsters, such as spiny or slipper lobsters that have exoskeletons differing in both structural properties (i.e., amount of trabeculae present in pits and spines) and resistance to structural failure. Using an electron microprobe, we analyzed various segments of the exoskeleton of the Mediterranean slipper lobster, *Scyllarides latus*, to determine the mineral content in discrete domains of cuticle. EMP analysis determined that the cuticle of *S. latus* is similar to that of *H. americanus* in that it contains carbonate apatite in canal linings and in the areas surrounding sensory organules (setae). The slipper lobster also uses a fluorapatite mineral that further adds strength to the shell. Results will be discussed in the context of what this means for defense against attack and differences in environmental water chemistry and resilience to climate change.
The long-spined sea urchin, *Diadema antillarum*, is a particularly important herbivore on coral reef and shallow benthic communities throughout the Caribbean. By grazing on algae, they clear substrates and allow for the settlement of other species, especially corals. *Diadema antillarum* abundance is often associated with decreased algal cover, increased coral recruitment, and higher biodiversity. To further understand urchin dynamics and their recovery following the 1983 mortality event, transect surveys were conducted at 1m and 3m depths in St. John, USVI, focusing on *D. antillarum* population densities, test size distribution, and biomass. Results revealed higher urchin densities at shallower depths for surveys conducted in Little and Great Lameshur Bays. Both bays displayed similar overall densities, but Little Lameshur Bay contained larger urchins than those found in Great Lameshur Bay leading to a greater calculated biomass. In addition to population metrics, *D. antillarum* was also surveyed for the presence of commensal species. Several species, including *Percnon gibbesi*, *Stenorhynchus seticornis*, *Panulirus argus*, *Stenopus hispidus*, and *Malacocentrus macropus*, were identified from visual surveys as using the spines as biogenic habitat.
Meiofaunal and algal distribution patterns in *Spartina alterniflora* marshes along the U.S. Atlantic coast

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*Spartina alterniflora* marshes are critical habitats throughout the U.S. Atlantic coast, supporting a variety of organisms, including both algae and animals. However, little is known about how distributions of algae and meiofauna residing on the *S. alterniflora* stems themselves differ across regions. *S. alterniflora* densities were measured monthly along transects in both the low marsh and high marsh at two sites in Connecticut and two sites in Georgia throughout the growing season. Live and dead stems were collected at regular intervals along each transect, and samples taken from patches of algae and sediment on those stems were analyzed microscopically to determine how stem height and position in salt marsh affected algal presence and meiofaunal abundance. Dead *S. alterniflora* stems and algae were both more prevalent in Georgia than in Connecticut. Meiofaunal diversity also appeared to be higher in Georgia than in Connecticut throughout the sampling period. In Connecticut, stems located in the low marsh tended to support more meiofauna than stems from the high marsh, and dead stems tended to support more meiofauna and algae than live stems in both the low and high marsh. In general, dead stems seemed to support more algae and meiofauna than live stems.
Comparison of nutrient inputs from two diverse watersheds and implications for benthic communities
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Coastal zones are among the world’s most diverse and productive environments, encompassing a broad range of habitat types and harboring a rich and diverse array of organisms that provide ecosystem services that are critical to the livelihoods of people living in coastal zones. Adjacent watersheds help define coastal systems by controlling inputs of chemical constituents, both natural and anthropogenically-derived, into the system. Surface discharge is often the major pathway for chemical constituents to enter the coastal zone. However, submarine groundwater discharge (SGD) into the coastal zone can also be an important source of chemical inputs into coastal systems. Here we estimated groundwater and surface water nutrient inputs into two diverse watersheds (Dingle Harbor and Ballyferriter) on Dingle peninsula in Ireland. Radon levels were measured to estimate SGD and stream flow was measured for all streams within each watershed over two seasons. Preliminary analysis indicates that total nitrate and phosphate fluxes (kg/day) were lower in summer than in winter across both watersheds. Nutrient concentrations in general were higher in Dingle than in Ballyferriter. Nutrient fluxes appear to be correlated with land use patterns and have the potential to influence benthic community structure.
Assessing the efficacy of reef restoration efforts by comparing nekton abundance in Corpus Christi Bay, Texas
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Habitat degradation by natural and anthropogenic influences has lead to a rapid decline in near-shore ecosystems across the globe. Estuarine ecosystems often struggle to recover naturally from anthropogenic stressors, necessitating the development and incorporation of effective restoration strategies. In Nueces Bay, TX, a local nonprofit restored over 40 acres of salt marsh, and we investigated community assemblages between restored marsh areas and adjacent natural marsh sites. Nekton data collected using a combination of throw trap and suction sampling was compared between natural and restored marsh sites. Preliminary analysis found no significant differences in shrimp abundance, fish abundance, or total abundance of species present between the natural and restored sites, suggesting the restoration is suitable habitat for these organisms. A significant difference (p<0.05) was shown in total crab abundance with natural sites (mean=9.5) having more than twice the crab abundance when compared to restored sites (mean=3.8). Initial results on the efficacy of the restoration are promising, however, additional monitoring and data analysis is required.
Ectoprocts (or bryozoans) are a diverse group of colonial invertebrate animals that are of interest to biologists and ecologists as their collective suspension-feeding activities are significant to the functioning of aquatic ecosystems. The marine ectoproct, *Membranipora membranacea*, is an introduced species along the northeast coast of the USA and has been noted for its negative impacts on the growth and reproduction of some commercially important species of kelp. Limited embryological and colonial growth data are available for this species from some European and Pacific populations. Our study focused on the effects of energy reduction on embryogenesis, larval development in culture, and post-metamorphic growth of *M. membranacea* from southern Maine. Previous studies on echinoids show that smaller egg sizes are correlated with an exponential increase in developmental time. Based on our laser ablation experiments, *M. membranacea* eggs may be at the boundary for minimal energy provisioning. Under our culture conditions, *Membranipora* larvae reached metamorphic competence in approximately four weeks, and more readily metamorphosed in the presence of local species of brown kelp. Unfed (twinned) ancestrulae did not grow, but fed ancestrulae added approximately five new zooids in the first week.
Examining the Relationship Between Environmental Parameters and Bivalve Abundance in the Gulf of Maine

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Bivalves are integral members of the benthic community in both estuarine and oceanic environments. Changes in water quality can impact population health, in particular, because they are marine calcifiers. In the Gulf of Maine, bivalves are a major source of income to many fishermen and assessing the impacts of water quality on abundance 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. We analyzed correlations between environmental variables (salinity, pH, temperature, and dissolved oxygen) and bivalve abundance. In addition, we isolated a single genus, Astarte, for finer analysis. There was a weak correlation between bivalve abundance and sediment type and a weak correlation between Astarte abundance and salinity.
Open wave height logger: a low-cost, open source, long-duration ocean wave sensor

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Wave disturbance plays a major role in structuring coastal ecosystems and its effects on foundation species can have community-wide consequences. Commercial products to measure waves have long been expensive to purchase, deploy, and maintain. These tend to be cost prohibitive for budget-restricted applications or for use conditions prone to loss or failure.

We have created an inexpensive open source wave logger, the OWHL (Open Wave Height Logger). It uses an energy efficient, Arduino-based microcontroller and a small pressure transducer housed in PVC pipe, to collect wave data via user definable parameters for over a year.

The OWHL uses readily sourced parts, making it easy to build and use by anyone with access to basic tools and a minimal budget. It is durable, foul-resistant, and easily calibrated; allowing for sampling on parts of the coast that aren't well represented by existing buoy data, especially at smaller spatial scales.

The OWHL is inexpensive enough to be deployed individually in risk adverse settings or even in larger clusters to characterize wave direction. It can be used as a teaching tool for high school or university students and is a great option for those wishing to better understand how waves can influence marine environments.
Anthropogenic burning of fossil fuels over the last 200 years has nearly doubled atmospheric carbon dioxide (CO$_2$) levels. This CO$_2$ dissolves into the ocean, decreasing pH and calcium carbonate (CaCO$_3$) saturation state (Ω). This effect is called ocean acidification (OA). Coastal eutrophication and increasing freshwater inputs exacerbate OA impacts. Shell forming organisms, like the Eastern Oyster (*Crassotrea virginica*), build shells out of calcite, a mineral form of CaCO$_3$. Decreased Ω$_{ca}$ increases dissolution of calcitic material, and requires more energy for shell building. This study, based in mid-cast Maine, investigates the response of juvenile *C. virginica* shell mineralogy to calcite saturation state (Ω$_{ca}$). Two sets of juvenile *C. virginica*, reared in Casco Bay, Maine, were exposed to manipulated Ω$_{ca}$. One set was exposed to high Ω$_{ca}$ conditions, and the other to lower Ω$_{ca}$. Shell trace element composition will be analyzed with the ICP-OES, and shell growth with Image J analysis; both will be related to water chemistry throughout the experimental period. The data are currently being analyzed, but it is hypothesized that *C. virginica* will respond chemically to decreased Ω$_{ca}$ by incorporating less magnesium into their shells, resulting in a lower Mg:Ca ratio and less soluble new shell growth.
Experimental Assessment of Floating Seagrass Wrack as Potential Habitat for Benthic Organisms
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During the summer, seagrass blades are frequently released into the water column as a method to reduce respiration demands of the plant and physical disruption of the bed (e.g., crab foraging, boat propellers). This wrack has the potential to serve as both food and habitat for organisms dislodged or actively moving within the system. The purpose of this research was to determine how benthic organisms may use floating wrack as a food resource or shelter. Four series of experimental floating wrack bags were assembled containing using artificial *Zostera marina* (i.e., poly-ribbon), *Z. marina* blades, *Ruppia maritima* blades, or a wrack bag control. Wrack bags were placed in Barnegat Bay, NJ for four months, during which collection and replacement occurred bi-weekly. The results demonstrate a clear preference of *Z. marina* over the *R. maritima*, followed by the artificial *Z. marina* by amphipods and isopods. Because there was a lack of response to the artificial *Z. marina*, we conclude that the benthic organisms not only use wrack as refuge, but also obtain trophic resources from them.
Coarse and Fine Scale Patterns of Community Structure of Benthic Habitats along the US Atlantic Continental Margin.

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The US Atlantic continental margin is characterized by multiple topographically complex features that house a variety of benthic assemblages. The variety of these features provide an ideal setting to examine coarse and fine scale differences and similarities in benthic assemblage structure. Assemblage of species were characterized at 4 stations that ranged in depth from 643 to 2026 meters. Observations and analysis of benthic fauna was carried-out using a Remotely Operated Vehicle (ROV) equipped with several high definition video cameras, LED lights and two laser pointers. Preliminary findings suggest both a coarse and fine-scale difference in assemblage composition along a latitudinal gradient. At a fine-scale, differences in assemblage composition is attributed to the variety of sediment types along a single ROV transect. While our preliminary results indicate a high degree of heterogeneity between stations and within ROV transects, further analysis of the mechanisms that drive the distribution of benthic assemblages is needed.
Comparative survival of color morphs of the bay scallop *Argopecten irradians irradians*

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Restoration of the bay scallop *Argopecten irradians irradians* in the Peconic Bays of Long Island, New York began in 2006 after the decimation of the population by brown tide algal blooms between 1985 and 1995. The uncommon “skunk” color morph (one or more white rays on a dark shell background) was planted to help track the contribution of restoration efforts to population rebuilding. Preliminary studies on survivability suggested that skunks may have a lower survival rate than “normal” color morphs (dark shell without white rays). To examine this hypothesis, four types of analyses were done: tensile strength of shells and growth rates of different color morphs were determined, relative proportions of the color morphs within natural populations were quantified at different life stages (post-set, large juvenile, adult) and rates of predation by mud crabs, *Dyspanopeus sayi*, on different color morphs were compared. Preliminary studies of tensile strength have shown skunks to be the weakest color morph. Results of the other analyses will be presented.
Impacts of water chemistry and sediment qualities on clams on the Kennebec Estuary


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The largest estuary north of the Chesapeake, the Kennebec Estuary is an important region for the soft shell clam *Mya arenaria*. Sensitive to changes in land use and climate, some clam flats within the Kennebec have recently shown a decline in population size and clam health. The Maine Commission on Ocean Acidification has highlighted these economically and ecologically significant habitats as particularly vulnerable to ocean acidification resulting from unprecedented atmospheric CO$_2$ levels. Students at Bowdoin College conducted this study of the Kennebec during semester-long projects in 2014 and 2015. Water and sediment characteristics were assessed along the estuary to determine the primary controls on clam size and shell integrity (pitting and thickness), and identified areas most conducive to clam productivity. Overlying water, pore water, and sediment characteristics were compared to the health of clams along the estuary. Clam size and integrity were found to increase down the estuary indicating greater productivity near the mouth of the Kennebec. Sediment grain size and porewater saturation state were found to be the primary controls on clam size and shell integrity. Overlying water saturation state was found to decrease with lower salinity along the estuary.
Peconic bay scallop, *Argopecten irradians irradians*, populations have increased greatly since 2006 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 taking advantage of some other suitable habitat in place of eelgrass. Extensive field observations have been made of small (seed) scallops attaching within *Crepidula* shell beds, suggesting that these may offer some form of spatial refuge for seed scallops. In preliminary field trials, some of the seed scallops planted on *Crepidula* beds remained after 2 months - also suggesting the potential value of this habitat. Observations were also made in the lab by mimicking *Crepidula* shell clumps on sand. Seed scallops were observed attaching to the shells when these were placed facing upside down as well as in their normal orientation. Further research will be conducted in the field and in the laboratory to determine the extent of *Crepidula* shells as a spatial refuge.
*Lobophora variegata* has photosynthetic competitive advantage over crustose coralline algae on coral reefs and walls of Little Cayman

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*Lobophora variegata*, a species of brown fleshy algae, and *Peyssonnelia spp.*, a type of crustose coralline algae, are two lobed algae found in abundance on the reefs and walls of Little Cayman, Cayman Islands. This study examines the photophysiology and irradiance preferences for both species. HOBO light monitors were used to measure irradiance levels within algal patches at six sites (15-20m depth) around the island. *In situ* irradiance levels indicate that *Peyssonnelia spp.* grows almost exclusively in shaded areas with irradiance levels less than 70 lum ft⁻², whereas *L. variegata* does not have a preference for irradiance levels between 10 and 700 lum ft⁻². Photosynthesis-irradiance curves constructed for both species suggest that although *L. variegata* is similar to *Peyssonnelia spp.* in efficiency, the *pₘₐₓ* for the former is nearly double that of the latter algae indicating a higher capacity for photosynthetic production. The cumulative results indicate that *L. variegata* has a competitive advantage on the reef. Potential phase shifts toward *Lobophora* dominated reefs should be monitored in the future, especially as the resilience of reef calcifiers, such as *Peyssonnelia spp.*, is lowered with the progression of ocean acidification.
Measuring Water Quality Improvements in Narragansett Bay – What Can We Learn Through Benthic Video Monitoring?

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Narragansett Bay Commission

In 2014, the Narragansett Bay Commission (NBC) began conducting benthic video transect surveys in the Providence River in upper Narragansett Bay, Rhode Island, as part of an already extensive water quality monitoring program. Through these videos, NBC scientists make qualitative observations about the organisms and habitats present in the region, as well as quantitative time-series comparisons. These surveys supplement less-frequent or more spatially limited benthic surveys conducted by other agencies that utilize more expensive and time-consuming methods, though with finer-scale resolution, including traditional grab sampling. As the owners and operators of the two largest wastewater treatment facilities discharging to Narragansett Bay, the NBC strives to be a leader in protecting and enhancing Bay water quality while providing reliable wastewater treatment at a reasonable cost to residents. It is the goal of the monitoring program to provide accurate and comprehensive data to guide stakeholders as major infrastructure improvement projects go online at regional wastewater treatment facilities including recent substantial reductions in wastewater nitrogen loading. Data collected through the NBC monitoring program are available for public download on the web; the NBC hopes they may be used to continue to improve the joint stewardship of this important embayment.

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The effects of natural biofilms on the settlement and metamorphosis of *Hemigrapsus sanguineus* and *Dyspanopeus sayi* megalopae

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Understanding variation in settlement cues is important for determining what locations invasive invertebrates may come to inhabit. While the larvae of many crab species settle and metamorphose (molt) in response to chemical cues, only *Hemigrapsus sanguineus* was shown to respond to physical cues in prior studies. This study focused on the response of megalopae of two crab species, non-native *H. sanguineus* and native *Dyspanopeus sayi*, to biofilms accumulated onto plastic mesh netting in the field. Biofilms were created by placing black polyethylene mesh netting (size of openings 64 mm) in two muddy and two rocky locations for one week. In the laboratory, individual megalopae were placed in containers with artificial seawater and pieces of clean netting or netting with biofilms, and the time until molting was recorded at 12h and 24h intervals. Although both species molted in response to mesh netting with biofilms, *D. sayi* tended to molt half a day sooner in response to biofilms from muddy rather than rocky sites, whereas *H. sanguineus* responded similarly to all biofilms. The lower selectivity for habitat-specific cues of *H. sanguineus* could help explain its successful colonization of new coastal habitats.
Using Mooring Buoys to Suspend Mid-Water Coral Nurseries

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In response to the global decline of coral reefs, reef restoration is a rapidly growing conservation practice. Temporary nurseries to propagate broken coral fragments are a promising method for restoration, but in some Caribbean locations it is difficult to obtain legal permission to use the seabed for this purpose. To circumvent this problem, we are testing whether yacht moorings that are already permitted can be used as coral nurseries. Four prototype designs were deployed in the British Virgin Islands, using the underwater lines of mooring buoys to suspend them in the water column. Broken fragments of staghorn coral, Acropora cervicornis, were collected from a local site and attached to the nurseries, while other fragments were secured to degraded reefs nearby as a control. Pictures and measurements were taken of both sets of corals to track their growth and survival. After four months, the corals on the nurseries were transplanted to degraded reefs nearby, alongside the controls. So far, the survival of corals on mooring nurseries is similar to controls, but we will compare the long-term success of corals produced from each of the four nursery prototypes for another year to judge their long-term success relative to the controls.
Non-native crab larvae are more responsive than native crab larvae to physical cues during settlement and metamorphosis

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Chemical cues are often more important than physical cues for stimulating settlement and metamorphosis of planktonic larvae. The non-native crab *Hemigrapsus sanguineus* is an exception; its larvae respond to both chemical and physical cues, including rocks and plastic mesh netting. The responses of late-stage crab larvae (megalopae) of both *H. sanguineus* and a native species of crab, *Dyspanopeus sayi*, to different types of mesh netting used in bivalve aquaculture were tested (spat bags, transparent and black predator exclusion netting). Laboratory-reared megalopae were placed in containers with different mesh types or control seawater, and metamorphosis (molting to the benthic crab stage) was monitored every 24 h. Megalopae of *D. sayi* did not respond to any mesh type. *H. sanguineus* megalopae molted ~1d sooner when presented with the spat bag material or black netting. Transparent mesh netting did not enhance the molting response, suggesting that opacity enhances the effect of physical structure. Results confirm that megalopae of the non-native *H. sanguineus* are more responsive to physical cues than are megalopae of a native crab species.
Blue crabs, *Callinectes sapidus*, support Louisiana’s third largest commercial fishery; 2013 landings totaled 38.8 million pounds for a dockside value of $51 million. Although not currently overfished, estimates of abundance have declined in recent years and are below long-term averages. Current fishery management plans are based on incomplete knowledge of the migration patterns and fishing mortality of blue crabs. In March 2016, we will initiate a mark-recapture study to examine these processes. Additionally, we will analyze sperm stores of recently-molted females to assess the potential for sperm. In collaboration with local fishermen, we will tag 6,000 female blue crabs from multiple salinity zones. Tags will be attached by copper wire wrapped around the lateral spines. Each tag is printed with a unique ID number, offer of monetary reward, and instructions for reporting. A designated website and phone line will be available 24/7. We will request tag number, location caught, date caught, presence and stage of egg mass. This information, combined with lab results from the examination of sperm stores, will be directly applicable to Louisiana blue crab management plans and stock assessments and will ensure the continued sustainability of the Louisiana blue crab fishery.
The European green crab, *Carcinus maenas*, is variable in ventral sternite coloration, green after molting, turning red after prolonged intermolt. Previous studies reported that red morphs are less stress tolerant than green morphs. No information is available on stress tolerance during the transition from green to red during the molt cycle. Therefore, we used freshly molted juvenile green crabs and assessed coloration and respective stress tolerance to severe hypoxia weekly using righting response and treadmill endurance. Unexpectedly, the animals did not change color significantly despite going through the full molt cycle. Stress tolerance measured by righting response remained constant at 1.5±0.9s, while the effect of hypoxia on treadmill endurance became more pronounced further through the molt cycle, increasing from 10±50 to 190±70s. Lactate accumulation also increased through the molt cycle from 0.2±0.1mM to 2.5±1.0mM. After molting, lactate levels immediately dropped towards baseline levels. The change in stress tolerance was correlated only to time in the molt cycle, but not to ventral sternite coloration. Our data show gradual change in stress tolerance through a full molt cycle and indicate that ventral sternite coloration is most likely not mechanistically linked to the respective stress tolerance.
The Effect of Recreational SCUBA Diving over a Gradient of Diving Traffic on the Coral Reefs of Bonaire (Dutch Caribbean)

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It is well-known that recreational SCUBA divers have a direct effect on coral reef ecosystems: they can break, abrade, and eventually cause disease in the stony corals that form the structural basis of these ecosystems. Our study, which was conducted on Bonaire, a top diving destination in the Caribbean, followed up on the findings of Lyons et al. (2015), namely, that the benthic community assemblages near dive site entrances is different than at points 200 m away. Here, we used video belt transects at three different depths to examine how the abundances of different categories of benthic substrate change as distance from the entrance increases; by sampling at 0, 20, 40, 60, and 80 m from the entrance, we analyzed how these abundances changed over a gradient of diving traffic. We were unable to find a clear trend in our data that showed how the effects of SCUBA diving change with increased distance from site entrances. Our results raise questions about the proper scale at which one can observe changes in diver impacts and whether it is even possible to resolve these changes given the high levels of variation in coral reef ecosystems.
Habitat partitioning in free-living zooxanthellae
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Zooxanthellae preferentially occupy the sediment while not associated with a coral host; however, not all individuals migrate into the sediment. A small number of zooxanthellae favor the water column. These zooxanthellae have a high risk of fatality due to irradiance exposure and thermal stress, but do not compete with the zooxanthellae residing in the sediment. Competition and habitat partitioning is analogous to partition coefficients in biochemistry, which refer to the equilibrium of a solute between two layers. This principle may apply to zooxanthellae as the solute for a habitat partition coefficient (HPC), where the sediment and water column are the layers. Counts of zooxanthellae may determine the factor by which the equilibrium of zooxanthellae prefers the sediment. HPC may be influenced by varying different sedimentary characteristics, such as sediment depth, grain size, nutritional content, or irradiance. By shifting the HPC, an optimal combination of habitat characteristics could be described. This combination may lead to a predictive model developed using this data in order to predict favorable habitats for zooxanthellae across coral reefs. If the optimal environment on a reef for zooxanthellae is identified, it will be established as an area where conservation efforts such as reef transplantation should be focused.
Do fiddler crab larvae settle differently on horizontal and cylindrical hog’s hair collectors?
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Passive larval collectors have been extensively used to estimate larval availability, particularly in crabs. Recent evidence suggests that standard cylindrical hogs hair collectors are not unbiased when sampling fiddler crab megalopae, collecting proportionally more *U. pugnax* and fewer *U. pugilator* than are present in the plankton. We tested the hypothesis that collectors with a horizontal surface rather than the vertical surface of the cylindrical collectors would be more attractive to *U. pugilator*, which often settles in sandy areas with little vertical structure. We deployed two rectangular horizontal collectors adjacent to traditional cylindrical collectors from the Duke Marine Laboratory dock and harvested them daily in September and October 2015. Patterns of abundance on the two types of collector over time were similar. Horizontal collectors sampled fewer total larvae than the cylinders, but were not different when normalized for surface area. Species composition on the two collector types was significantly different on some collection days but not on others. Comparisons with plankton samples taken on the same days, along with future deployment during the peak larval transport season will provide additional insight into the value of using flat collectors to assess fiddler crab larval transport patterns.
The marine polychaete worm, *Hediste diversicolor* (Annelida; Polychaeta), was used to detect possible genetic differences among populations obtained from heavy metal-contaminated sediments and from non-contaminated sediments. Worms were collected from sediments known to contain high levels of copper (following the Callahan Mine operations in Goose Pond, Brooksville, Maine) and from relatively clean sediments of nearby estuaries (Horseshoe Cove, Brooksville and Bagaduce River [North Bay], Penobscot, Maine). Sequences from selected genes (Cytochrome Oxidase subunit I [COI], 16S, 18S and 28S) were compared to determine whether different haplotypes existed. RNA will also be extracted from individuals and expression levels of metal-trafficking proteins (e.g. metallothionein) will be assessed using quantitative PCR to determine if polychaetes from the heavy-metal contaminated sediments express significantly more metal-trafficking proteins.
Seagrass beds are considered essential habitat and provide numerous ecosystem services such as sediment stabilization and carbon sequestration. Additionally, grazing on seagrass provides a fundamental trophic link in these communities, with the bucktooth parrotfish (*Sparisoma radians*) being a dominant herbivore in shallow tropical seagrass systems. In St. John, USVI, field and laboratory experiments were conducted to assess the herbivory potential of *S. radians* on the dominant seagrass species present. Grazing on native turtle grass, *Thalassia testudinum*, and the invasive seagrass, *Halophila stipulacea*, was observed and quantified through a series of tethered seagrass experiments and in situ field observations. Field experimental results indicate that *S. radians* actively grazes on *T. testudinum* and *H. stipulacea*. Laboratory choice feeding experiments also confirmed that *S. radians* will feed on both *T. testudinum* and *H. stipulacea*. As such, the expansion of *H. stipulacea* may have significant impacts to seagrass communities, however it is apparent that it is providing trophic resources for herbivores.
The milk conch *Strombus costatus* is a mobile oasis of diversity

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The milk conch *Strombus costatus* is a fairly large Caribbean gastropod found in seagrass meadows, sand beds, and algal flats at a depth up to 20 meters. A snorkel survey of Brewers Bay, St Thomas, VI, revealed that approximately 50% of the milk conch were heavily fouled. 23 fouled conch were collected haphazardly from Brewers Bay, then brought to the lab where the fouling algae and fauna were removed and identified. 15 species of algae, tunicates, several sponges, and 2 coral species fouled these conch. The most common fouling algal species were *Laurencia, Acanthophora spicifera, Hypnea spp, Dictyosphaeria cavernosa* and *Spyridea* sp. A variety of fauna reside within the heavy fouling algae, sponges and tunicates. We identified fish, crabs, amphipods, anemones, snails, annelids and bivalves. The community residing on the shells of these milk conch is quite different than the sandy seagrass community and more like that in the shallow rocky habitat over 100m away. Why some conch are fouled and others are not is not understood.
As bleaching and coral reef decline become more prevalent, understanding the patterns and effects of both natural and anthropogenic climate change is necessary. One way to better understand the temperature changes influencing coral reefs is to analyze annual growth bands present in modern and fossil coral, which are often related to sea surface temperature (SST) at the time of growth, providing a window to climate characteristics of past environments. This study examined fossil and modern Diploria and Orbicella corals of Little Cayman, attempting to use growth bands to begin to reconstruct SSTs of Little Cayman for past time periods. Fossil coral growth rates were examined with image analysis, and modern growth rates were determined from coral cores extracted by hydraulic underwater drilling, followed by x-ray image analysis. Fossil coral is believed to be from the late Pleistocene, a time that experienced temperatures a bit warmer than today, which could make a useful source to help predict effects of a current warming environment. Results of this study include graphical comparisons of fossil and modern extension rates of both Diploria and Orbicella, illustrated relationship between Little Cayman SST and coral extension rate, and attempted SST estimates of fossil coral environments.
Genetic Diversity of Red Mangroves (*Rhizophora mangle*) In an UNESCO Biosphere Reserve, St. John, USVI

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*Rhizophora mangle* (Red mangrove) is an important coastal species throughout the Caribbean owing to the large number of ecosystem services which it provides. Despite its importance, little work has been done to assess the genetic diversity of red mangrove populations within the Caribbean. The red mangrove population in Great Lameshur Bay, St. John, USVI was decimated by Hurricane Hugo in 1989 and subsequent recovery of trees in this system has been slow despite the bays inclusion in an UNESCO Biosphere Reserve. In order to determine the genetic diversity of the Great Lameshur Bay red mangrove population, leaf samples were collected from 25 individuals and DNA from these samples was extracted and analyzed at 7 microsatellite loci for homo/heterozygosity. This population was then compared to three other red mangrove populations on the eastern side of St. John: New Found Bay, Hurricane Hole (Otter Creek), and Coral Bay, as well as an outgroup from New Port Richey, Florida using the same molecular techniques. These data are important, as it will increase the understanding of genetic diversity in Caribbean red mangrove populations and help to determine the rate and likelihood of recovery in damaged systems.
Multi-scale spatial genetic structure of the eastern oyster, *Crassostrea virginica*, along the coast of North Carolina

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The eastern oyster (*Crassostrea virginica*) is a keystone species that provides important benefits to estuarine coastal areas. Unfortunately population numbers have been declining for almost a century due to factors such as disease and habitat destruction. Understanding how larval dispersal influences population connectivity at multiple spatial scales is crucial in order to manage this species successfully and sustainably. We genotyped 1,384 adult individuals (> 40 mm) at 22 microsatellite loci from twenty-four oyster reefs located along 300 km of the North Carolina coast. These reefs were sampled from 4 different regions: Pamlico Sound, Hewlett’s Creek, Masonboro sound and Lockwood’s Folly. We found very weak population differentiation across the range, potentially a result of this species’ 3-week pelagic larval duration. However, we also found considerable population differentiation within regions, indicating fine-scale genetic structure. Population differentiation did not correlate with distance among sites and some sites in close proximity were more differentiated than sites at opposite ends of the range. Defining the extent of oyster population structure and connectivity in these areas will potentially aid in spatial fisheries management.
The effect of environmental change on the chemosensory abilities of the Caribbean spiny lobster *Panulirus argus*

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The Caribbean spiny lobster, *Panulirus argus*, supports the single most valuable fishery in the greater Caribbean. The IPCC 2013 identified the coastal marine ecosystems that these lobsters inhabit as high-risk areas for climate change. Anthropogenic induced climate change has strong consequences for marine ecosystems, including sea surface temperature rise, altered freshwater inputs, and ocean acidification. One potential consequence of these changes is alteration in the chemosensory abilities of marine animals such as the spiny lobster. Lobsters rely heavily on chemical cues for many biological and ecological activities. The objective of this study is to determine the effect of these environmental changes (temperature, salinity, and acidification) on the chemosensory abilities of *P. argus*. Lobsters will be placed in the center of the mesocosms, exposed to a chemical cue from one end of the mesocosm and seawater only from the other, and left to move about in the mesocosm. Experiments will be video recorded and responses measured by the time spent in each half of the mesocosm and time spent within a shelter placed at each end. Understanding the interactions between climate change and chemical communication will fundamentally effect the ecology of many marine organisms, and especially those that support valuable fisheries.
Comparing historical and recent benthic data should allow us to detect decadal changes in estuarine habitat quality providing differences in sampling approaches and analysis methodology can be addressed. Here, we analyze two surveys from the Delaware Estuary, the Mauer et al. study (1972-73 sampling) and the Delaware Estuary Benthic Inventory (DEBI, 2008). To accommodate differences in sampling area, grab and sieve size, we (1) analyzed only mid-bay stations, (2) examined all taxa as well as only large polychaete species separately, and (3) used a consistent set of predictor variables from the sediment and water column. These data were analyzed using PRIMER 7 and PERMANOVA+ methods, including MDS, ANOSIM, and SIMPER. dbRDA analysis revealed sediment class as the most important predictor in the Maurer study, in contrast to salinity for the DEBI survey. Species contributing to similarities differed as well. This result suggests assemblage differences may reliably indicate identifiable changes between surveys, although overall lower abundances and diversity in the Maurer data cannot be explained by our analysis. We suggest such analyses of historical benthic surveys with federally sponsored surveys from the 1990’s-present may resolve how and why the benthos of the Delaware Estuary has changed over time.
A Freshwater Inflow Model for the Conservation of Texas Oyster Reefs
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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 volume, frequency, and timing of freshwater needed to regulate Dermo disease on a local and regional scale. On a local scale, seven stations along a salinity gradient in the Mission-Aransas Estuary are sampled quarterly for oyster characteristics and water quality to better understand current disease levels throughout the system. 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. The model being developed in this investigation will provide a more comprehensive understanding of freshwater inflow needs to Texas bays for supporting oyster populations. This study will benefit ongoing management and research efforts regarding hydrologic influences on oyster health.
Biodiversity can positively influence ecosystem services, and these effects may be strongest in the presence of disturbance. We predicted that the positive effects of increased wetland plant diversity on ecosystem processes would be more prominent in oiled than unoiled areas, and tested this in 3,785 L mesocosms, where we examined the interactive effects of oil exposure, and plant genetic and species diversity on key ecosystem processes. Experimental tubs within mesocosms were assigned to a no plant control or one of five plant diversity treatments: *Spartina alterniflora* genotypic monoculture, *S. alterniflora* genotypic polyculture, *S. alterniflora* genotypic monoculture + *Avicennia germinans*, *S. alterniflora* genotypic polyculture + *A. germinans*, or *A. germinans* only. In two oil-exposed mesocosms, we used a 5-day repetitive dosage procedure, with each tub receiving 1 L m⁻² of a 1:1 oil-water mixture. In two non-oiled mesocosms, seawater was added using the same procedure. Eight weeks later we quantified plant growth, morphology, and productivity 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. In addition, the magnitude of oiling effects on *Spartina* was reduced in mixed species and polyculture treatments.
Two coral reef calcifiers show contrasting calcification responses under increased pCO₂ and temperature

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Previous studies have demonstrated that coral reef calcifiers are affected negatively by climate change and ocean acidification. The aim of this investigation was to determine whether the calcification rates of two calcifiers are impacted separately and/or synergistically by CO₂ and temperature. The net calcification rates of a calcified alga, Lithophyllum insipidum, and a coral Montipora aequituberculata, were quantified under two levels of pCO₂, 400 and 1000 μatm, and two temperatures, 27 and 30°C. Organisms were acclimated for 1 week under ambient conditions and incubated in 8 mesocosms for 2 weeks in a fully crossed experiment. Montipora aequituberculata and Lithophyllum insipidum displayed contrasting calcification responses to the treatments. The calcification rate of Montipora aequituberculata was depressed by the increase of pCO₂ and temperature while Lithophyllum insipidum remained unaffected. These results suggest that expected environmental changes will affect organisms differentially. Further, these results highlight the variability in organism responses to ocean acidification and climate change, suggesting that the community composition of future reefs likely will reflect varying organismal sensitivities to environmental change.
Linkages between marsh fragmentation and blue crab (*Callinectes sapidus*) abundance, growth, and mortality

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Louisiana is losing coastal marsh at an unprecedented rate due to subsidence and climate change. In addition to loss of marsh area, fragmentation of the marsh is also 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 juvenile blue crab, *Callinectes sapidus*. Blue crab comprises one of the largest commercial fisheries in Louisiana, worth over $50 million in 2013. We will be studying the linkages between marsh fragmentation, SAV cover, and blue crab abundance, growth and mortality due to predation. We will quantify marsh fragmentation and SAV cover, conduct monthly crab surveys in different habitats and fragmentation levels, and conduct in-field experiments on juvenile blue crab looking at growth and predation rates in different habitats and fragmentation level. This data will ultimately be used to update the blue crab habitat sustainability index model that informs conservation and management policy surrounding coastal marshes and the blue crab fishery.
Evaluating the role of the predatory snail *Thais deltoidea* on reducing predation on staghorn coral, *Acropora cervicornis*, as part of a comprehensive coral reef restoration strategy

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Coral reefs in the Florida Keys have become highly degraded, prompting considerable effort to re-establish populations of the vital reef-accreting coral *Acropora cervicornis* to restore reef structure and ecological function. However, predation on *A. cervicornis* by the gastropod *Coralliophila abbreviata* has been a substantial impediment to restoration efforts. We conducted laboratory experiments to determine whether *Thais deltoidea*, a carnivorous gastropod, can reduce predation rates on *A. cervicornis* by *C. abbreviata*. We demonstrated that *A. cervicornis* consistently exhibited a higher percentage of living tissue when in the presence of *C. abbreviata* and *T. deltoidea* than when in the presence of only *C. abbreviata*. This was due to both predation by *T. deltoidea* on *C. abbreviata* and because *T. deltoidea* elicited a considerable anti-predator behavior on *C. abbreviata*. Presenting *T. deltoidea* with *C. abbreviata* and two alternate potential prey species (*Lithopoma americanum* and *Cerithium* spp.) revealed that *T. deltoidea* preferentially preyed upon those two species, but the presence of *T. deltoidea* still reduced predation on *A. cervicornis* by *C. abbreviata*. If this relationship can be demonstrated through further *in situ* experimentation, this predator-prey dynamic could aid coral reef restoration practitioners to enhance coral outplant survival in Florida.
Effects of ocean acidification and nitrate enrichment on crustose coralline algae

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Due to human impacts on the environment, problems such as ocean acidification (OA) and nutrient enrichment are becoming more pressing issues for the survival of coral reef ecosystems. Crustose coralline algae (CCA), an important group of reef organisms that reinforces the reef structure and induces coral larval settlement, is being affected by both of these water chemistry changes. OA has been shown to have a negative effect on the calcification rates of CCA while nutrient enrichment has a positive effect on algal growth rates. Because of the increase of pCO\textsubscript{2} concentrations and nutrient flux in many tropical coastal waters where coral reefs are found and their potentially interactive effects, an experiment was conducted to measure the effects of increased pCO\textsubscript{2} and increased nitrate concentrations on Porolithon onkodes, a common species of CCA. Calcification, photosynthesis, respiration, and photosynthetic pigment concentrations were measured after a week in one of four treatments of low or high pCO\textsubscript{2} concentrations crossed with low or high nitrate concentrations. Future studies will expand on these results by studying more species and adding phosphate enrichment as a factor. These results can then help predict how CCA will be affected by OA and nutrient enrichment in the future.
The Gulf of Maine is a large, dynamic coastal shelf ecosystem that experiences constant environmental and ecological change. Many of the recent changes (< 60 years) are well-documented by ongoing fisheries/oceanographic surveys for the offshore Gulf of Maine. However, our ability to detect, describe, predict and communicate changes in the nearshore region (coast to ~3m) is limited. Recently (last few decades), this region has experienced profound changes, including declines in groundfish, an explosion of lobsters, declines in critical habitat such as eelgrass and key species such as alewives, and the appearance of southerly species such as black sea bass. We have undertaken a comprehensive survey of the nearshore environment in and around Casco Bay, a bay at the transition between the warmer western Gulf of Maine and the colder mid-coast and eastern Maine regions. This long-term survey (10+ years), utilizing a range of survey techniques, will give us an unprecedented view of how this bay ecosystem is structured and functions and how it is changing in response to climate change and changing land use practices—essential information for fisheries and coastal resource management.
Barnacles play dominant ecological roles in intertidal communities, and are major contributors to marine biofouling. They adhere tenaciously using a secreted proteinaceous glue. Here, we assessed the impact of salinity on the adhesion strength and biomineralization in the barnacle *Amphibalanus (=Balanus) amphitrite*. Larvae cultured from adults (salinity ~36 psu) were settled onto T2 silicone coated glass panels. Animals were acclimated to eight levels of salinity (10-45) and exposed for 16 weeks. Base plate area, adhesion strength (in shear), shell mass, shell microhardness, shell plate thickness, capillary glue duct density, and glue concentration and composition were quantified at the conclusion of the experiment. The effect of salinity on base plate area, shell microhardness, shell mass, and capillary glue duct density was not significant. Adhesion strength significantly differed between treatments, with a maximum strength at 15 and minimum at 35. Concentration and composition of glue proteins was similar among salinities for most proteins, with the exception of ~130 kD protein that was expressed at 35 but not at lower salinities. Salinity significantly affected shell thickness of parietal plates, but not the base plate, with parietal plate thickness highest at 15 and lowest at 45. Authors acknowledge support from Office of Naval Research.
Using allometry to test the Metabolic Theory of Ecology for effects of ocean acidification and temperature on crustose coralline algae
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The effects of ocean acidification and rising temperature on coral reef metabolism and calcification have been primarily explored empirically, using individual study species. However, it would be useful to understand these effects at more complex ecological levels. Using the Metabolic Theory of Ecology (MTE), the response to climate change drivers on individuals varying in size can be evaluated and then theoretically scaled. Crustose coralline algae (CCA) are reef-building organisms that contribute to reef calcification, framework stabilization, biodiversity, and primary production. In this study Porolithon onkodes, a dominant species of CCA in Moorea, French Polynesia, represents a flattened morphology. Different size classes of P. onkodes were collected to achieve a range of organism biomass over two orders of magnitude. Samples were placed in fully-crossed treatments with ambient (27 ºC) and high temperature (30 ºC), and ambient (400 µatm) and high pCO2 (1000 µatm) conditions. Photosynthetic, respiratory, and calcification rates were measured for each individual. Individual metabolic rates then were compared with predictions of MTE to test for congruence with theory for this CCA species. In the future, studies will address the MTE using different species and morphologies of CCA individually and as a community to predict allometric trends under climate change.
Temperature can affect hard clam (*Mercenaria mercenaria*) growth and survival directly and indirectly through its influences on metabolism, dissolved oxygen concentration, and activity costs and energy gains of suspension feeding. Warming seawater raises the standard metabolic rate and would raise the active metabolic rate if filtration rates increased to offset the associated reduction in dissolved oxygen. Warming seawater may also affect active metabolism through temperature-induced changes in viscous drag forces on beating cilia. It is unknown if temperature-induced increases in filtration rates, and therefore food intake, can offset the higher metabolic costs experienced at warmer temperatures. To understand how temperature affects suspension feeding, we did laboratory experiments to quantify the effects of temperature and viscosity on *M. mercenaria* filtration and ciliary beat rate. Filtration rate varied with temperature but not with viscosity, a result confirmed by separate ciliary beat measurements. These results contradict previous findings for the mussel *Mytilus edulis*, indicating that suspension-feeding dynamics are species-specific. These initial results are an important step towards identifying the impacts of temperature on hard clam energetics. Future metabolic experiments will describe the complete energetic balance as it varies with temperature, improving our ability to predict shellfish survival in a warming ocean.
Histological Comparison of Rapid Post-Spawning Oocyte Resorption in Three Caribbean Coral Species

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Understanding the process of oocyte resorption is integral to understanding the effect of environmental change on coral gametogenesis, spawning, and population maintenance. Despite reference in reproductive literature, a detailed histological account of resorption across multiple hermatypic Caribbean species has not been provided. Here, tissue samples from three common Caribbean coral species, Siderastrea siderea, Solenastrea bournoni, and Stephanocoenia intersepta, were collected from the northern Florida coral reef tract 2-3 times weekly during gametogenesis and analyzed via histology. Rapid resorption of un-spawned oocytes was observed across multiple years following histologically inferred spawning in all three species. Three “phases” of resorption, consistent across all species in both histological presentation and timing within the reproductive cycle, were identified and described. Results reveal massive and rapid assimilation of gametogenic material into the gastrodermis for use in somatic growth and maintenance.
Growth and survival of juvenile oysters (*Crassostrea virginica*) among adult conspecifics

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American Oyster (*Crassostrea virginica*) larvae can use conspecific chemical cues during settlement, which results in the development of complex habitats. Complex habitats may facilitate growth and survival of juveniles by acting as a refuge from predators. To test how increased complexity affects juvenile growth and survival, we conducted a manipulative field experiment wherein we monitored juvenile oysters grown on tiles with and without adults. We monitored three treatments (cage, cage-control, and control), at four sites in Saint Augustine, FL from June 2015 to January 2016. Using a two-way ANOVA, we described growth rates (mm/day) and survival as a function of sites and presence/absence of adults. Though growth varied among sites, 0.056mm/day to 0.149mm/day, within each site we did not detect a difference in growth between adult oyster treatments. However, when available to predators, juvenile oysters grown in the presence of adults were 130% more likely to survive than conspecifics grown in the absence of adults. This large difference is most likely driven by the different predators present at the sites. These results indicate that though juvenile oyster growth is predominantly based on larger-scale physical properties, micro-scale habitat choice has a large affect on juvenile oyster survival.
Ocean acidification affects shell formation but not adhesion in the barnacle *Amphibalanus amphitrite*

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Ocean acidification is a decrease in seawater pH, resulting from an increase in atmospheric CO₂ concentration. In this study, we assessed the impact of pH on adhesion and biomineralization in the barnacle, *Amphibalanus (=Balanus) amphitrite*. Juvenile barnacles, settled on T2 silicone, were exposed to three levels of pHₗ, 8.01, 7.78, and 7.50 at constant temperature and salinity. These pH levels correspond to pCO₂ of ~400, 800, and 1750 μatm. Panels from each pH level were scanned biweekly, enabling quantification of base plate growth. Growth was significantly influenced by pH; barnacles at pH 7.78 and 7.50 were significantly larger than those at 8.01. This trend emerged starting at 8 weeks exposure. Total alkalinity of exposure seawater was significantly higher at pH 7.5, suggesting that despite increased base plate area in barnacles held at 7.5, dissolution of shell plates occurred. Shell height, tissue mass, adhesion strength (measured in shear following ASTM standards), morphology of the adhesive layer, and sexual maturity (proportion ovigerous) did not differ significantly among treatments. We will report on ongoing assessments of the structure, elemental composition and micromechanical properties of shell plates. Authors gratefully acknowledge support from the Office of Naval Research.
Zoogonus rubellus is a trematode parasite that infects multiple polychaet worms as its intermediate host. Z. rubellus is able to vary in size in its intermediate host, and the reason for that remains unknown. This experiment looked at if the size of Z. rubellus was correlated with the amount of food their host receives. For this experiment the intermediate host that was observed was Hediste diversicolor. The infected worms were put into two groups, a fed group and an unfed group. The average rate of parasite growth in the fed group was 9.38 µm/week while the unfed group growth rate was 7.81 µm/week. There was no significant difference between the two groups, suggesting that the size of Z. rubellus is not determined solely by the nutrient intake of their hosts.
Coral and Algal Coverage in Relation to *Diadema antillarum* Density

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Abstract

The long spined sea urchin, *Diadema antillarum*, is a key grazer of reef algae, and indirectly supports the settlement and survivorship of reef forming corals. A mass die-off in 1983 has seen a slow recovery of urchins, and the presumed negative impact on reef health. This study sought to quantify the relationship between *Diadema antillarum* and coral/algal coverage on Little Cayman Island, BWI. Patch reefs were surveyed for coral/algal cover, and density of *Diadema*. Regression analysis revealed a positive relationship between *Diadema* density and coral cover (R²= 0.326, p-value= 0.0001), and a negative relationship between *Diadema* density and algal cover (R²=0.217, p-value=0.003). The role of *Diadema antillarum* as a prominent reef grazer is a key factor in controlling coral reef health. However, *Diadema antillarum* abundance and density on Little Cayman is low, an important consideration for future management and conservation efforts.

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Analysis of Long-term Datasets Indicates Heterogeneous Impacts Resulting from the DwH Accident on Nekton in the Northcentral Gulf of Mexico

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Among the greatest of the challenges scientists face is determining the relative effects of natural and anthropogenic disturbances on ecosystem structure even more so because of the paucity of long-term monitoring efforts that span the occurrences of both forms of disturbance. Here, we report on the results of such an effort to separate the relative impacts of the Deepwater Horizon (DwH) accident, and earlier natural disturbances, on nekton in the northcentral Gulf of Mexico. Specifically, we used two state and federal databases (1999-2014), and our intensive sampling efforts (2010-2012), to assess the impacts of the DwH accident on these consumers in the region’s inshore and offshore waters. Results from these analyses detected significant changes in the relative abundances and biomasses of most of these organisms beginning in 2010 offshore, where oiling was heaviest, which persisted through 2014. The exception to these results was offshore sharks whose abundance receded to background levels quickly. Importantly, no such shifts were detected in the region’s inshore waters where oiling was intermittent. We found no evidence of lasting impacts from natural disturbances (i.e., freshets or hurricanes) in the region. These results provide evidence that longer-term impacts of the DwH accident on higher order consumers were limited to offshore waters of the northcentral Gulf of Mexico.
Geographic and Interspecific differences in sponge microbiomes on the Oregon coast

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As filter feeders with high pumping rates, sponges interact with tens of thousands of liters of water every day, making them excellent at integrating their environment. Additionally, sponges host vast bacterial communities, which respond to even small environmental changes. Some of these bacteria are capable of numerous nitrogen transformations. We compared bacterial communities (the microbiome) and the presence of bacterial genes involved in nitrogen transformations among four different species of marine sponges at two different sites on the Oregon Coast. DNA was extracted from sponge tissue samples and analyzed via next generation sequencing to determine the microbiomes of each individual. Microbial DNA was also extracted from sponge tissue and amplified via PCR using several different primer sets to determine the presence of nitrogen transforming genes. The microbiome results indicate that there are differences in host bacterial communities in relation to sponge species but not in relation to study site. The PCR data indicates that there is no relationship between the presence nitrogen transforming genes to sponge species or study site. These results suggest that the microbiome is not as sensitive to environmental change as previously hypothesized.
The predation impact of *Hemigrapsus sanguineus* and *Carcinus maenas* on three littorinid species in the Gulf of Maine

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The Gulf of Maine has been host to copious numbers of invasive species that have altered the community structure through increased competition and predation upon native species. These strong influences have led to discrete niche partitioning in three New England littorinid snails – *Littorina littorea*, *L. obtusata*, and *L. saxatilis*– resulting in a well-defined community structure. Prior to the invasion of the decapods *Carcinus maenas* and *Hemigrapsus sanguineus*, there were no true shore crabs present, and littorinid species had a refuge from crab predation in the mid and high intertidal zones. However, *C. maenas* is found in the mid intertidal and *H. sanguineus* is found in the mid and high intertidal zones. With this recent introduction, this refuge was eliminated and the vertical distribution of the snail species changed. The increased predation pressure and shifted vertical distribution of decapods predators in this habitat has the potential to alter the demographics of the littorinds. Previous studies have determined the demographics of three populations of littorinids and two introduced crab species on the exposed rocky coast of the Gulf of Maine. In the current study, we report any species or size preferences of *H. sanguineus* and *C. maenas* for the three littorinid species.
Comparing the survivorship of *Dyspanopeus sayi* in slipper snail and seagrass beds in Shinnecock Bay, New York

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Habitat structure type can influence the degree to which a habitat can serve as a refuge from predation. In Shinnecock Bay, New York, the Sayi mud crab (*Dyspanopeus sayi*) inhabits seagrass (*Zostera marina*) and slipper snail (*Crepidula fornicata*) beds. Slipper snail beds provide more interstitial space that could provide greater refuge from predation than seagrass beds. However, slipper snail beds have been shown to have higher background densities of potential mud crab predators. Tether experiments were conducted in both habitat types, alongside field surveys to quantify potential predators, to examine the survivorship of *D. sayi*. To separate the effect of the habitat refuge from the background abundance of predators, *D. sayi* were either tethered to a disk or stake. We expected to see greater survival of *D. sayi* in *C. fornicata* beds when tethered to disks than all other treatments, based off of its structure type allowing greater refuge from predators. Results showed higher survivorship of *D. sayi* in *C. fornicata* habitat, even when *D. sayi* was exposed to predators in *C. fornicata* habitat. Further follow-up experiments are needed to determine what factors could be causing higher survival in *C. fornicata* beds.
Porifera are a crucial class of organisms in benthic ecosystems filtering water at high rates depending on species, body mass and geographic location. With few natural predators and accelerated rates of reproduction, sponges can be found in high abundance from tropical to arctic systems from depths of 1m to 8,000m. Forty eight, 20m² transect surveys were conducted in Great and Little Lameshur Bay, USVI at 1m and 3m depths. A variety of cryptic and non-cryptic sponge species were observed during transects and data were used to determine abundance, richness, diversity, spatial relations with other benthic organisms, and assess necrotic tissue bleaching. Results show that *Aplysina fulva* (yellow rope sponge) was found to be the most abundant sponge species in Great Lameshur Bay, while *Amphimedon compressa* (red rope sponge) was the most abundant in Little Lameshur Bay. Overall, 2300 individuals of sponge were identified and Porifera density was greater at Great Lamedhur Bay at 3m depths. However 3m depths in Little Lameshur Bay had a higher Porifera population density. During surveys, disease based mortality of species, both red and yellow rope type was observed indicating the presence of disease in the populations. This quantitative data may lead to more questions on benthic reef health.
Chemical cues from adult fiddler crabs stimulate molting of conspecific megalopae: Evidence from field-caught megalopae
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In mid-Atlantic estuaries, \textit{Uca pugilator}, \textit{Uca pugnax} and \textit{Uca minax} co-occur; adults occupy different habitat types separated by salinity and sediment size. Selective settlement may be responsible for this separation but the mechanism is unknown. We examined the effect of chemical cues from adult fiddler crabs on the metamorphosis of field-caught fiddler crab megalopae. Adult conspecific odors have been shown to accelerate metamorphosis of lab-reared megalopae. We hypothesized that chemical cues from conspecifics would also stimulate molting in field-caught fiddler crab megalopae. Individual megalopae were held for 10 days in estuarine water or water in which adult crabs had been incubated. Only \textit{U. pugilator} accelerated molting, but did so in water that contained any adult cue, indicating that acceleration of molting is not the primary mechanism for settlement site selection by this species. However, a significantly higher proportion of megalopae of all 3 species molted in conspecific water than in estuarine water or water containing odors of other species. Chemical cues from conspecific adults may be important in stimulating molting to occur, rather than to accelerate the timing. This stimulation, in conjunction with a behavioral change to terminate flood-tide transport, is likely important in selective settlement of fiddler crab megalopae.
Evidence of gene flow in adjacent oyster populations around a commercial aquaculture lease

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Commercial aquaculture leases typically support dense aggregations of shellfish that may contribute to wild populations through their reproductive efforts. Aggregations are thought to facilitate successful spawning and fertilization, potentially producing large numbers of larvae that may recruit to wild populations. We investigated the reproductive contribution of cultured oysters (*Crassostrea virginica*) to wild populations around a commercial aquaculture lease in Stump Sound, North Carolina. Through the late 1990s, the lease was stocked with oysters that originated from remotely set larvae that were produced in a hatchery in Louisiana using oysters from the Gulf of Mexico, which are genetically distinguishable from North Carolina oysters. An initial evaluation in 2001 using mitochondrial 16S ribosomal gene sequence data from oysters collected from seven natural beds in and around the lease site showed a significantly elevated frequency of oysters exhibiting the Gulf Coast haplotype. The same sites around the lease were revisited in 2015 to evaluate subsequent changes in the frequencies of Gulf Coast haplotypes in Stump Sound. Preliminary analysis indicates an overall increase in the frequencies of Gulf Coast haplotypes, however site-specific frequencies are variable.
Tidal and diel vertical migration of *Mytilus edulis* larvae in the eastern Gulf of Maine

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Many invertebrate larvae cannot swim fast enough to overcome horizontal advection, but vertical migration can significantly alter dispersal trajectories. Vertical migration as a function of tidal phase is expected to have a large effect on dispersal, while diel vertical migration (DVM) has been linked to nocturnal feeding. We evaluated the behavioral response of *Mytilus edulis* larvae in the Gulf of Maine to tidal phase and assessed the relative importance of DVM and degree of water column stratification in modifying that response. Pump-based larval sampling occurred either (1) during daytime ebb and flood tide pairs or (2) over trios of daytime ebb and flood and nighttime ebb tides, and we quantified the vertical structure of the water column before and after each sample. Mussel larvae were identified by scanning electron microscopy. We then calculated the percentage of larvae at different depths in the water column. Results confirmed that *M. edulis* larvae migrate vertically in response to tidal phase, though the magnitude of this response varied among sample dates and was sometimes modulated by DVM. This behavioral complexity is likely to have a considerable impact on dispersal patterns, with tidal phase migration acting to increase local retention.
The ability to recognize individuals and track growth over time is crucial to population dynamics research and to parameterizing bioenergetics models. Soft-bodied invertebrates are particularly difficult as they often molt, have regenerative capabilities, or lack hard parts to attach markers. We experimentally tested, in laboratory and field studies, a new way of marking sea anemones (Actiniaria) through injection of three vital stains (i.e., neutral red, methylene blue, and fluorescein) in situ. Neutral red and methylene blue do not affect growth or survival, but fluorescein is lethal at high concentrations. Marked individuals can be identified seven months after injection with neutral red, six weeks with methylene blue, and three days with low concentrations of fluorescein. Neutral red could be used for long-term monitoring of growth and survival in the field, and in combination with methylene blue could be used to mark individuals in distinguishable patterns for short-term studies.
Comparing planulation patterns and the reproductive fitness of the brooding coral, *Porites astreoides*, at different depths in Bermuda.

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Mesophotic coral reef ecosystems (MCEs), which extend from 30-150m, are sheltered from anthropogenic and natural disturbances resulting in low reef degradation compared to shallow reef counterparts. MCEs are hypothesized to serve as a refuge for shallow reefs, where larvae may aid the re-population of disturbed shallow habitats. This study examines the reproductive patterns of upper mesophotic and shallow corals to determine variations in planulation, planula size and settlement rates. *Porites astreoides* adult colonies were collected from shallow (10 m) and upper mesophotic (30 m) reefs in Bermuda during July and August 2015 and monitored for planulation timing, fecundity, planula size and, settlement success. Planulation patterns and mean number of planulae released differed significantly by depth and month. Shallow colonies released more planulae on average than upper mesophotic colonies in July, however this pattern was reversed in August. Planulae settlement rates in August did not differ with parental depth, indicating that upper mesophotic *P. astreoides* produce viable planulae that are able to colonize available substrates at similar rates to shallow planulae. These results, in conjunction with vertical connectivity studies, suggest that upper mesophotic *P. astreoides* may be able to serve as a reproductive refuge for shallow water environments.
Is thermal tolerance heritable in *Acropora cervicornis*, and what is the physiological basis of adaptation that correlates to survival?

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Human activities are substantially increasing the atmospheric concentrations of greenhouse gases, and this has led to an enhanced greenhouse effect that has resulted in warming air and ocean temperatures which are predicted to continue to rise. Corals have shown recent reductions globally and are highly susceptible to changes in temperature. Understanding the degree to which species vary in their tolerance to elevated sea surface 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 (~27°C) and elevated temperatures (31-32°C), and mortality was monitored for 21 days. Time of death was determined by a loss of photosynthetic efficiency (Fv/Fm < 200) measured by PAM fluorometry and visually by total amount of bleaching. Heritability of thermal tolerance was estimated using the phenotypic data plus 4 microsatellite loci input into the program MARK (Ritland, 1996). To understand the physiological basis of thermal tolerance, tissue samples were taken after 48 hours to measure several cellular biomarkers associated with sub-lethal temperature stress. Variation in mortality following lethal temperature exposure, heritability estimates, and oxidative stress biomarker data will be discussed.
Differential growth and survival of juvenile *Porites astreoides* based on parental depth
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Coral reefs, one of the most productive ecosystems in the world, are currently threatened by natural, anthropogenic, and climate change mediated stressors. Many factors that disturb shallow reefs are not as influential in the deeper waters of Mesophotic Coral Ecosystems (MCEs), which have not experienced trends of loss like shallow reefs. The apparent stability of MCEs has led to the Deep Reef Refugia (DRR) hypothesis, which posits that MCEs could serve as a refuge for corals, providing a potential source of larvae that could assist in shallow reef recovery. This study aims to determine the ability of corals from MCEs to contribute to larval recruitment on shallow reefs. Rates of growth and mortality of juvenile *Porites astreoides* spat produced by shallow and mesophotic parental colonies were assessed for 10 weeks post-settlement to test the ability of offspring to survive under shallow water conditions. Despite initially smaller spat and slower growth rates, overall growth and mortality of spat produced by mesophotic and shallow corals were similar, supporting the DRR hypothesis. The depth of parental colonies was not found to affect post-settlement growth and mortality, thereby indicating that mesophotic coral larvae may be able to recruit to and repopulate disturbed shallow reefs.
Nursery Habitats for Early-Life Stages of American Horseshoe Crabs
in Great Bay-Little Egg Harbor, NJ
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Little is known about the preferred nursery habitats of the declining American horseshoe crab, *Limulus polyphemus*. We combined lab experiments with a novel field sampling technique to examine the relatively understudied early stages of horseshoe crab life history in Great Bay-Little Egg Harbor, NJ, a small estuary. Exposing larvae simultaneously to two sediment types in a series of experiments indicated that larvae prefer to settle in large grain sediment, whereas juveniles showed no preference. Larval preference for large grain sediment was also supported by field collections in 10-60 cm deep waters. While larvae appear to stay close to shore (< 22.9m), juveniles could be migrating to subtidal waters.
Mussel Settlement and Post-Settlement Dynamics

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Successful recruitment often depends upon early survival and rapid growth in the first few weeks following settlement when new recruits are vulnerable to variation in the physical environment and the availability of food in the near-shore plankton. The dynamics of early recruitment have been poorly studied because newly settled juveniles are typically cryptic and the availability of food in the plankton of the near-shore environment has rarely been studied. We made high resolution sampling of newly settled juvenile mussels over the duration of settlement season to estimate temporal variation in growth and survival. Growth rates were assessed in relation to near-shore abundance of phytoplankton. Plankton samples were analyzed by flow cytometry to separate putative food sources from those that cannot be fed upon by newly settled mussels. We observed several episodes of settlement followed by growth. Growth rates were generally positive but substantially less than that observed in aquaculture. Putative food sources for newly settled mussels were usually above the concentration threshold for starvation but significantly lower than that required to support maximal growth rates. These results are discussed in relation to the high variation in recruitment into the adult populations observed in most marine species.