Benthic Ecology Meeting

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Toxicity of nickel-chloride complexation and body burden in the estuarine grass shrimp *Palaemonetes pugio* under various salinities

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Because heavy metal ions, such as nickel, are known to complex with chloride in solution, estuarine salinity fluctuations may create complex chemical interactions (e.g. metal-anion complexation) making bioavailability and toxicity predictions problematic. To test the effect salinity and [Ni] has on mortality and tissue metal accumulation (i.e., body burden), field-collected grass shrimp *Palaemonetes pugio* were exposed to 2 salinities (5 or 20) and 7 [Ni] (0-100 µg/ml). Jars (500 mL) with 5 shrimp (5.3mm mean CL) were the experimental unit; each nickel/salinity concentration was replicated 3x on 3 dates (n=630 shrimp). Acute exposure trials were conducted in an incubator (Percival 136VL) under controlled temperature and light cycles (23˚C:21˚C; 18h:6h; L:D). After 96hr, survivorship was scored and the flexor muscle was excised from each survivor (n=386). Tissue samples were digested in nitric acid, filtered, and analyzed via ICP mass spectrophotometry. Combining all trial dates, the LC_{50} were calculated (via Probit Analysis) as 62µg/ml and 83µg/ml for 5 & 20, respectively. Body burden was analyzed as a 3-way mixed model ANOVA with salinity and nickel as fixed factors and trial date as random factor. Although nickel body burden was overall greater at 20, mortality rates, in contrast, were higher at 5.

Elevated CO_2 concentrations facilitate development in microscopic life stages of the Giant kelp, *Macrocystis pyrifera*

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Elevated atmospheric CO_2 concentrations and temperatures are leading to warmer, more acidic coastal environments. Calcareous organisms have been shown to struggle physiologically under these conditions, yet little is understood about how habitat-forming fleshy algae will respond. In this study, we cultured gametophytes of the giant kelp (*Macrocystis pyrifera*) for 15 weeks under present-day conditions (12°C, 400 ppm CO_2), elevated CO_2 alone (12°C, 1500 ppm CO_2), elevated temperature alone (15°C, 400 ppm CO_2), and future conditions (15°C, 1500 ppm CO_2). After 10 weeks, an upwelling event was simulated by adding nitrate to each treatment for the remaining five weeks. In the first 10 weeks, gametophyte survivorship was significantly higher in the elevated CO_2 treatment than in other treatments. Likewise, after the simulated upwelling event, embryonic sporophytes development increased in the elevated CO_2 treatment. This may be due to the low energetic cost associated with passive uptake of CO_2 as opposed to the active absorption of HCO_3^- and conversion into CO_2 via carbon-concentrating mechanisms. Therefore, elevated CO_2 concentrations may benefit these vulnerable life stages by expediting their growth to adulthood.

A comparison of boat wakes versus wind waves in an estuarine setting

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We conducted a 17-month survey of boats and their corresponding wakes by simultaneously videotaping boat passage and continuously recording both the boat wake signature and the ambient wind wave conditions in the Atlantic Intracoastal Waterway (AIWW). Our purpose was to: 1) quantify and characterize boat traffic wakes, and 2) determine the relative frequency and magnitude of boat wakes versus wind waves. Once boat wakes and wind wave climates were characterized, we assessed their relative energy contribution at 290 shoreline locations across a geographic gradient. Boat wakes began to exceed wind waves beginning at wave heights of 0.45m and ranged to near 0.9m high. We forecast that 61% of the locations would experience boat wakes greater than that of the background wind wave conditions. Boat wake effects were forecast to diminish rapidly with distance away from the AIWW where embayments expand and have larger fetches. In contrast, small bays that communicate exclusively with the AIWW were forecast to experience a substantial increase in wave energy from boat wakes which may drive shifts in shoreline composition and stability. Dropping vessel speeds below plowing speeds adjacent to vulnerable shorelines often adds only minutes to transit time but will prevent acute erosion.

Effects of Oil-Contaminated Sediments on *Ruppia maritime*

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Estuaries of the Gulf of Mexico contain a number of foundation species that provide nekton habitat, buffer coastlines from erosion, and various ecosystem services. The effects of oil inundation as a result of the 2010 Macondo spill, however, remain untested for many key species. Here, we discuss the implications of this spill for *Ruppia maritima*, one of the most common species of submerged vegetation in Louisiana and other impacted estuaries. Specifically, we present the results of greenhouse experiments where *R. maritima* was grown in a range of manipulated sediment oil concentrations: 0, 0.26, 0.53 and 1.05 mL oil /L total volume. We measured changes in growth (wet weight, stem number/length), reproductive activity (flowering/fruits), and uprooting/breaking strength of plants after a 1-month period. While no difference was detected in growth, plants exhibited significant reductions in reproduction and uprooting strength, with less flowers/fruits and force needed to uproot plants in medium and heavily oiled treatments. In addition, significant changes in root morphology were detected. Given the importance of sexual reproduction for these plants, oil contamination may have substantial population-level effects. Moreover, plants may be more susceptible to high energy storm events due to the reduction in uprooting strength and altered root morphology.

Effects of oil and ocean acidification on the survival and condition of blue crab larvae

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Blue crabs, *Callinectes sapidus*, begin their larval (zoeal) phase offshore from the adult's home estuary and circulate through the northern Gulf of Mexico for approximately 30 days before settling near shore. During that time the zoea undergo seven to eight molts before settling into a near shore adulthood. While offshore larvae may encounter undesirable circumstances. We investigated the effects of both lowered pH (ocean acidification) and oil (mimicking the Deepwater Horizon spill) on larval condition. The pH treatment was equivalent to the predicted drop in pH over the next 100 years and the oil concentration corresponded to Deepwater Horizon surface oil levels. Larvae shows resiliency under oiled conditions with no change in survival or condition. When raised in a low pH environment larvae showed delayed growth. The health and growth of the larvae has implications for the next life history stage as well as for the population at large.

An evaluation of deep-sea benthic megafaunal communities in the Northern Gulf of Mexico one year after Deepwater Horizon using ROV Imagery

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The Deepwater Horizon oil spill in 2010 created a demand for more thorough studies of deep-sea benthic biota in the Northern Gulf of Mexico (GoM). A 15°, 250 m long radial transect survey design was developed for use with industrial ROVs to evaluate benthic megafaunal communities in the vicinity of the MC252 well. Biotic and abiotic characteristics were extracted from imagery collected at seven study sites ranging from 2-39 kilometers away from MC252, and located at depths varying from 850-1500 meters. Benthic megafauna in ten taxonomic categories were evaluated in order to compare benthic community characteristics, including density and diversity. While many significant differences were observed between sites, of particular interest were the two, MC252 2000 m N and MC208, located closest to the MC252 well. Total animal abundances were significantly higher at MC252 2000 m N compared to other study sites and, particularly, MC208 where low abundances were observed. Overall, community composition was found to be primarily related to depth and, to a lesser degree, site location. Results from this study suggest that depth, location, and the abiotic seafloor environment (including anthropogenic disturbance) play important roles in the abundances and diversity of deep-sea benthic megafauna in the Northern GoM.

Survival of the fittest: performance assessment of blue crabs (*Callinectes sapidus*) under toxic stress and implications for estuarine communities

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Predators are an essential component of both terrestrial and aquatic ecosystems and can significantly affect community structure and function. The benefits to communities provided by predators can be diminished when pollution or other anthropogenic effects interfere with a predator's ability to forage or to avoid its own consumers. Insecticides are a major source of pollution in aquatic ecosystems and are known to increase mortality and change behavior of numerous, non-target species. Blue crabs, (*Callinectes sapidus*), are both ecological and economically important in estuaries, and as arthropods, are vulnerable to many insecticides that target terrestrial arthropod pests. Exposure to Malathion, a pesticide often used for mosquito abatement, increases mortality and alters behavior of adult and juvenile blue crabs. In mesocosm experiments, we found that pesticide exposure leads to an alteration in the feeding behavior of adult blue crabs. Exposed adults were less efficient at capturing prey organisms, while exposed prey organisms became easier targets for intact adults. Future studies will involve assessing how pesticides influence blue crab's ability to perceive chemical cues from potential prey.

Wave energy and substrate stability constrain coral reef recovery after vessel groundings

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Episodic hydrodynamic disturbances can have lasting impacts on survival of benthic recruits, thereby potentially altering successional trajectories of communities. We address how hydrodynamic disturbances interact with substrate stability to constrain survivorship of coral recruits within reef sites damaged by ship groundings in Guayanilla, Puerto Rico. To better understand the different trajectories of reef recovery, we modeled a 5-year hindcast of wave energy at the sites using the numerical model SWAN to obtain wave statistics and bottom orbital velocities. We modeled rubble mobility using measurements of rubble properties and sediment transport mechanics to determine frequency of occurrence for forcing that would mobilize rubble. Coral survival from 2008-2013 was far lower within the rubble than on hardbottom injury, restoration structures, and reference reefs. Results suggest that intermittent mobilization of rubble substrate due to wave events likely limits coral survival, whereas on hardbottom substrate, the higher threshold for bottom mobility translates to higher coral survival and a recovering community.

The Impact of Anchoring on Coral Reefs in the British Virgin Islands

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Boat anchoring is one of many anthropogenic activities that contribute to the degradation of coral reefs but, surprisingly, its impacts have been little studied. Anchoring has a potentially substantial impact on reefs in regions where marine recreation and tourism are popular. We therefore conducted a spatial survey of reefs in the British Virgin Islands subject to differing frequencies of boat anchoring. We collected data on benthic community composition, and more detailed data on coral densities, size distributions, and species richness. We also quantified symptoms of anchor damage and reef rugosity. Cover of hard corals and sea fans were both reduced by 7-8% at highly anchored sites. Hard corals were ~40% smaller in size and ~50% less dense at sites experiencing high anchoring frequency. In addition, high-anchoring sites supported only 60% of the species richness of low-anchoring sites. Assessment of damage symptoms showed that overturned corals, broken corals, and broken soft corals were far more frequent at highly anchored sites. Finally, frequently anchored sites were only ~60% as structurally complex as infrequently anchored ones. Anchoring thus significantly impacts the coral reef community, but it is also a relatively tractable management issue. Therefore, it is worthy of greater study and attention.

Engineering away our first line of defense: an analysis of shoreline hardening in the United States

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Rapid coastal population growth and development are primary drivers of marine habitat degradation. Although shoreline hardening, a byproduct of development, can accelerate erosion and loss of beaches and tidal wetlands, it is a common practice globally. Here, we provide the first estimate of shoreline hardening along United States coasts and predict where existing or future hardening may result in tidal wetland loss if changes in coastal management are not made. Our analyses revealed that 22,842 km of U.S. shoreline (14% of total shoreline) has been hardened. We also considered how socioeconomic and physical factors relate to the pervasiveness of shoreline hardening and found that housing density, storm frequency, and wave height were positively correlated with hardening. Over 50% of South Atlantic and Gulf Coast shorelines are fringed with tidal wetlands and are likely threatened by hardening based on projected population growth, storm frequency, and a lack of shoreline hardening restrictions.

Shifting baselines in the distribution patterns of two submerged angiosperms in the Chesapeake Bay

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Two endemic seagrasses, eelgrass *Zostera marina L.* and widgeon grass *Ruppia maritima* co-occur in the lower Chesapeake Bay and their relative abundances vary with season, depth, and location. During the summers of 2005 and 2010, extremely high water temperatures resulted in a massive die-off of eelgrass baywide but did not appear to influence widgeongrass, which is more tolerant of warmer temperatures. Following intensive ground surveys in 2006 and 2007, we initiated a baywide program of monitoring the occurrence of these 2 species at 25 transects in the lower Chesapeake Bay in 2008, quantifying the relative cover of eelgrass and widgeon grass. In addition, we monitored temperature at each site with HOBO data loggers and analyzed water quality parameters from nearby observing systems. While we noted increased abundance of widgeongrass at some sites and at some locations along those transects where eelgrass declined, there was no consistent baywide pattern of widgeongrass replacing eelgrass. Analysis of water quality parameters suggests temperature as the most important factor correlated with the observed changes. Continued warming of Chesapeake Bay waters could lead to a regime shift from historically eelgrass dominated beds to beds dominated by widgeon grass in the future.

Kelp in hot water: Warming seawater temperature induces weakening and loss of kelp tissue

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Recent declines and losses of highly productive kelp beds worldwide have been linked to increases in ocean temperature. We investigated the impacts of 4 temperature treatments (11, 14, 18 and 21 ˚C) on growth, tissue loss and mortality of the dominant kelp species in Nova Scotia, *Saccharina latissima*, *Laminaria digitata* and *Agarum clathratum*. Growth rate of *A. clathratum* was reduced at 18˚ C over 3 wk of exposure, and all species experienced negative net changes in length at this temperature. Exposure to 21 ˚C led to severe tissue loss and mortality within 2 wk of exposure. 1-wk exposure to 21 ˚C reduced tissue strength (breaking stress) and extensibility (breaking strain) by 40 – 70% in *S. latissima* and *L. digitata*, and all 3 species exhibited reduced strength after 3-wk exposure to 18 ˚C. Histology of the blade tissue showed temperature-induced damage to the cellular structure that could weaken tissue. Breaking stress and strain of *S. latissima* collected biweekly in summer 2013 and 2014 indicated an increase in strength over summer, suggesting that acclimation of material properties to changing temperatures is possible. Our findings provide a mechanism by which rising temperatures could contribute to observed population declines of kelp species.

Synergistic effects of hydrologic changes and biological feedback processes on SAV in a Southwest Florida Estuary

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Examining historical changes in submerged aquatic vegetation (SAV) in Southwest Florida reveals the primacy of hydrologic alteration (e.g., causeway construction, dredging of urban and agricultural canals, manipulation of freshwater inputs through dam and weir structures, etc.) as a cause of habitat degradation and loss. However, detailed ecosystems monitoring over the last 15 years suggests that biological feedback processes (such as overgrazing of remnant SAV habitats) increasingly exacerbate and perpetuate degraded habitat states. Effective SAV restoration in the area will therefore require both hydrologic reengineering and attention to consumer-mediated effects.

Disturbance mediated shift in nutrient limitation in a seagrass ecosystem

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Disturbances can impact ecosystem processes by altering nutrient supply to primary producers and organism distribution. Understanding the role of disturbance in ecosystems is important in predicting ecosystem responses in an increasingly altered world. This is particularly true for seagrass meadows, an ecosystem threatened by both physical disturbance and nutrient alteration. In this study, seagrass beds in Abaco, Bahamas, were used to test the impacts of habitat fragmentation on nutrient dynamics. Propeller scars were simulated in circular configurations within continuous seagrass beds and maintained scars for 6 weeks. In scarred plots, elemental content (C, N, and P) of seagrass leaves was determined at edges (the seagrass-scar interface) and interiors (center). Seagrasses were abundant (median = 82.5% cover), and had N:P ratios indicative of light rather than nutrient limitation (N:P = 28.36) in undisturbed conditions. Seagrass disturbance by simulated propeller scars significantly decreased phosphorus supply relative to seagrass growth ($p = 0.002$) at edges. Decreases in relative phosphorus in seagrasses in disturbed landscapes could have potential effects on higher trophic levels, potentially reducing the palatability of seagrasses near scars. These results have broader implications for higher trophic levels as grazers generally prefer to consume macrophytes with lower C:N and C:P values.

The effects of warming ocean temperatures on the growth of *Ulva* spp. in Narragansett Bay, RI, USA

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Narragansett Bay has been plagued with frequent 'green tides' comprised of blade-forming *Ulva* spp. The mean annual water temperature of Narragansett Bay has increased by 1°C since 1960 and is predicted to warm another 1-4°C by 2100. We aimed to determine the effect of warming ocean temperatures on the survival and growth of bloom-forming *Ulva compressa* and *Ulva rigida* and the abundant but not bloom-forming *Ulva lactuca. Ulva compressa, U. lactuca,* and *U. rigida* were grown for 3 weeks under temperatures that represented current monthly averages prior (10°C) and during the summer bloom-forming season (15°, 18°, and 24°C), as well as a projected increase of 3°C (27°C) and 9°C (33°C) above the maximum monthly average. Percent survival of all species was >70% when grown between 10° and 24°C. Above 24°C, survival of *U. lactuca* and *U. rigida* declined rapidly, while *U. compressa* maintained 100% survival up to 27°C. All species had significantly lower growth rates above 24°C. *U. compressa* and *U. rigida* grew 27-78% faster than *U. lactuca* at 15°C and above. The projected warming of Narragansett Bay is likely to negatively affect *U. lactuca* and *U. rigida* survival and growth and *U. compressa* growth.

Ecosystem response to nutrient loadings following Hurricane Sandy in the Long Island South Shore Estuary: increased nitrogen removal or availability?

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Hurricane Sandy damaged a waste water treatment plant (WWTP) in New York causing 28.3 billion liters of partially treated sewage to be released in the Western Long Island South Shore estuary. Our objective was to determine if the estuary responded to elevated nutrient loads by serving as a nutrient sink, or becoming a nutrient source. We measured nitrogen (N) cycling with 15N tracers seasonally for 1 year following Hurricane Sandy using flow-through cores. Sediments from saltmarsh, mudflats, and channels were collected from a eutrophic site influenced by the WWTP inputs and a reference site. Measurements of water quality indicators (dissolved oxygen, chlorophyll *a*, reactive nitrogen) show only short-term impacts (i.e. days) of the sewage release. We found no long term impact on sediment characteristics or N cycling dynamics. Enrichments with 15N showed the potential for season specific shifts in the fluxes of reactive nitrogen and phosphorous but these would likely be mitigated by a concurrent increase in denitrification. Autumn and winter were most sensitive to 15N enrichments. The major controls on N removal and fluxes of reactive nitrogen appear to be sediment oxygen demand, nitrification, and the quality of sediment organic matter (C:N).

Effects of development and shoreline armoring on the high marsh ecosystem

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Humans have been living near the ocean, and subsequently protecting themselves from the ocean for centuries, however relatively little work has been conducted to evaluate the effects of armoring on marsh shorelines. To evaluate the effects of development and shoreline armoring on the high marsh ecosystems we surveyed 20 sites in each of three land use types; 1) marshes where the upland is developed and the upland/marsh interface was modified by bulkheads, 2) marshes where the upland is developed but not armored, and 3) marshes where the upland/marsh interface is adjacent to undeveloped forested borders. We used GIS data to select locations of armored shoreline and upland type. At each site, we ran 2 transects, with plots located at 2, 4, and 8 m along each transect. We characterized the high marsh geomorphology and sedimentology at each site, and the soil characteristics, pore water, flora and fauna in each plot. The high marsh was located lower in the intertidal at sites with bulkheads, and the soils had a lower percentage of sand. We do not know whether this is a consequence of the bulkhead altering geomorphological processes or whether when installed the bulkhead "captured" some of the high marsh. Regardless of the cause, this difference in elevation and soil composition led to differences in the biological community among upland types. Our results, though subtle, add to the growing literature showing that upland land use can affect adjacent salt marshes, even in areas with low population densities.

Deep history of American Clawed Lobster exploitation in the Canadian Maritimes and Northeastern United States

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The North American northeastern coast is a rich fishing ground as it is supplied by the northward flowing, warm, and nutrient-rich Gulf Stream and the south flowing, cold, oxygen-rich Labrador Current. The American clawed lobster occupies a range from Labrador and Newfoundland to the shelf waters of North Carolina. Because the peopling of the Americas is relatively recent compared to Europe and Asia, there are few written records of ancient use of lobsters. Most written records come from European visitors and/or colonialists from the late 1500's onward. Nevertheless, archaeological records demonstrate that lobsters may have been used very early by native peoples that occupied coastlines or nearshore islands. For example, lobster remains in middens on Block Island off the coast of Rhode Island show that local people were feeding on clawed lobsters nearly 2,500 years before present. This presentation will explore the deep history of lobster exploitation in this region.

Direct and indirect effects of a human triggered trophic cascade on basal trophic levels

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Understanding direct and indirect human impacts on ecosystems is necessary to elucidate and potentially mitigate anthropogenic environmental change. In New England, salt marsh die-off has been triggered by marine predator depletion releasing herbivorous crabs from predator control leading to regional salt marsh loss. How this has impacted lower trophic levels, however, is unknown. Using mensurative and experimental data we examined the hypotheses that: 1) by releasing common deposit feeding fiddler crabs from consumer control, predator depletion decreases meiofaunal abundance via a trophic cascade, and/or 2) by releasing blue carbon via the erosion of centuries of accreted marsh peat, marsh die-off increases meiofaunal abundance. Experimental deposit feeder removal led to 20% higher meiofaunal density at die-off than healthy sites. Reciprocally transplanting carbon rich and carbon poor sediment from die-off and healthy sites, respectively, revealed that indirect substrate effects of predator deletion on increased meiofaunal density by over 75%. This suggests that the ecosystem consequences of the trophic downgrading of coastal habitats can be more strongly driven by the indirect effects of ecosystem engineering than direct trophic effects and thus difficult to predict or generalize among ecosystems.

The responses of tropical seagrass epiphytes to alterations in nutrient supply and grazer abundance

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Epiphytes comprise an important component of seagrass meadows around the world, contributing to both productivity and sediment production. While epiphytes play a critical role in the functioning of seagrass meadows, anthropogenic increases in nutrient supply may accelerate the growth of both macro- and microalgae, which can shade seagrasses and result in seagrass decline. While multiple factors have been demonstrated to regulate epiphyte loading (e.g. nutrient supply and grazer abundance), we are currently in need of studies that examine the interaction of these factors across a variety of locations. Using a network of standardized experiments, we tested the relative influence of nutrient supply, mesograzer and macrograzer abundance on *Thalassia testudinum* epiphyte structure at several sites in the Caribbean. Epiphyte load, chlorophyll *a* load, and epiphyte autotrophic index were all assessed at the end of the 100 day experiment. Our results demonstrate site-specific responses. While certain locations displayed increases in seagrass epiphyte loading under nutrient enrichment, other sites displayed minimal responses. Furthermore, mesograzers played a relatively minor role towards regulating seagrass epiphyte abundance. Our work suggests that factors controlling epiphyte loading within tropical environments are likely complex, and may not be broadly controlled by mesograzer abundance.

Responses of tropical seagrass meadows (*Thalassia testudinum*) to experimental manipulations of nutrient supply and consumer abundance

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Seagrass meadows are productive marine habitats that provide key ecosystem services. Seagrasses are declining globally, with a reported 30% loss in areal coverage since the late 1800s. While we have a basic understanding of some of the mechanisms driving seagrass degradation (eutrophication, physical disturbance, and overfishing), we have a poor understanding of how these pressures interact to influence seagrass meadows across regionally distinct locations. We conducted a factorial experiment that manipulated nutrient supply, mesograzer, and macrograzer abundance at a variety of tropical seagrass meadows (Central Florida, Florida Keys, Belize, and Panama). Our results demonstrate that at certain locations (Belize and Panama), macrograzers play a strong role towards regulating seagrass responses to nutrient enrichment. At these locations, nutrient addition increased the consumption of seagrass biomass, which reduced average leaf length (up to 20%) and average standing crop (up to 47%). Conversely, seagrasses at the Florida Keys site displayed distinct responses to nutrient enrichment, consistent with the common paradigm of seagrass eutrophication (increases in epiphytes and declines in shoot density). Furthermore at this site, top-down forces were negligible. Our results demonstrate site-specific responses within tropical environments, and suggest that macrograzer abundance can strongly regulate the effects of nutrient enrichment at certain locations.

Microplastic distribution within a mussel bed at Sandy Hook, NJ

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Waste plastic constitutes the majority of marine debris with some estimates greater than 58% of total debris in the world's oceans (STAP, 2011). Recent attention has concentrated on fragmented and cosmetic plastics less than 5 mm in size called microplastics that can be ingested by lower trophic organisms. To date, no research has specifically focused on microplastic distribution in mussel beds, locations where suspended particles occur in greater quantities due to wind and water movements. Mussel beds are critical to marsh growth, as well as energy and nutrient cycling in estuarine communities. In this study, the abundance and distribution of microplastics is examined in a ribbed mussel (*Geukensia demissa*) bed in central coastal New Jersey. Preliminary results show that microplastics occur in high quantities down to a maximum sampling depth of 10 cm. These data suggest that sampling depth may need to increase below the superficial layers sampled in most studies in the past to help identify possible plastic sinks.

Antibiotic resistance among bacteria near sewage outfalls in Bermuda

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Antibiotic resistance among bacteria is a portentous global concern, which threatens the ability of medical professionals to successfully treat bacterial infections. In Bermuda, there is no wastewater treatment plant; therefore, about 4.3×10^6 L per day of untreated sewage is released into the ocean through two marine outfalls. High bacterial loads from anthropogenic sources are known to result in greater instances of antibiotic resistant genes, which may consequently put marine bathers at risk for severe infections. Water samples were collected from 12 sample sites (two outfalls, offshore sites, and onshore beach sites near the outfalls) over 4 sampling events between August and October, 2013. Water samples were analyzed for the presence of *Escherichia coli*, *Enterococcus* sp., and *Staphylococcus aureus*. Antibiotic susceptibility of each purified isolate was tested and classified using Clinical and Laboratory Standards Institute standards. The multiple antibiotic resistance index (Parveen et al, 1997) was determined for all isolates. PCR analysis confirmed the presence of at least one methicillin-resistant *S. aureus* (MRSA) isolate. Seventeen cases of environmental vancomycin-resistant *Enterococcus* were observed. Documentation of antibiotic resistant bacteria in Bermudian waters supports the need for improved sewage treatment to ensure safe recreational use of these areas.

Global nutrient loading jeopardizes the performance of key nutrient-sharing mutualisms

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Nutrient-sharing mutualisms between phototrophs and heterotrophs, such as *Symbiodinium* and coral, underpin the functioning of many ecosystems. Mutualisms are critical for structuring communities, promoting biodiversity, and maintaining food security. Global nutrient loading may threaten these relationships by altering the costs and benefits of the interactions for each partner. We used meta-analyses to show an overall decline in mutualism performance across terrestrial and marine environments in which phototrophs benefited under nutrient enrichment at the expense of their heterotrophic partners. Heterotroph identity and the type of nutrients provided (e.g. nitrogen vs. phosphorus) mediated the responses of different mutualisms to enrichment. The impairment of nutrient-sharing mutualisms from alterations of the world's nitrogen and phosphorus cycles represents a potentially severe, yet unrecognized threat of global change.

What killed drift macroalgae prior to the seagrass die-off caused by the 2011 superbloom in the Indian River Lagoon, Florida?

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Unprecedented phytoplankton "super blooms" caused catastrophic loss of seagrass in the Indian River Lagoon, Florida, in 2011-2012. Curiously, the drift macroalgae (DMA) community declined precipitously in summer-fall 2010, prior to the seagrass decline. We have begun experiments to determine if one or more environmental extremes in 2010-2011 could have been responsible for the collapse or lack of seasonal resurgence of DMA. Single factor experiments under controlled light, temperature, and salinity conditions in 8-week experiments (1 week of acclimation, 4 weeks of exposure to treatments, 1 week of acclimation back to control levels, 2 weeks of recovery) have determined that: salinity extremes, as low as 12 and as high as 50, were unlikely, at least singly, to have caused the observed DMA decline; that significant DMA losses occurred at temperatures <10 °C, consistent with record-breaking low temperatures in winter 2010; and that low-light levels consistent with sustained low-light stresses present during the superbloom could also have caused significant losses of DMA. We will next examine multi-factor interactions of these stressors and provide estimates of nitrogen and phosphorus release/uptake rates by DMA. This project will contribute to understanding the dynamics and interactions between DMA, phytoplankton, and seagrasses in the IRL.

Cross-continental shelf trends in $\delta^{15}N$ of macroalgae, sponges, and soft corals on the Great Barrier Reef

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With the global surge of coastal development in recent decades, tracking the flow of nutrients through marine waters is of increasing importance. The use of $\delta^{15}N$ values as a tracer for anthropogenic nitrogen is particularly useful in coastal marine systems where increased nitrogen inputs are contributing to ecosystem decline. Continental reefs such as the Great Barrier Reef are not only susceptible to excess nutrient input but essential to study given their proximity to heavily developed coastlines. Here, we measured the $\delta^{15}N$ values of macroalgae, soft corals, and sponges from inner, mid, and outer shelf reefs off the coast of Townsville, during the austral summers of 2005 and 2006. In 2005, which experienced an average amount of precipitation, significant depletion and enrichment was detected on inner shelf reefs in macroalgae and sponges, respectively, relative to offshore sites suggesting incorporation of different N sources. However, these trends were not observed in 2006, which experience lower than average rainfall. Soft corals showed no change in $\delta^{15}N$ across the reef shelf for either year. Thus, isotope analyses can be useful proxies tracking land-based inputs during periods of average rainfall in certain functional groups, and "snapshot" assessments of isotope values should be interpreted cautiously.

The effects of temperature and CO_2-induced acidification on skeletal morphology of the reef-building coral *Siderastrea siderea*

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Siderastrea siderea is a common, Caribbean reef-building coral that is generally highly resilient to environmental stressors. However, recent experimental studies have demonstrated that calcification rates of *S. siderea* have reduced in response to ocean warming and acidification. This project aims to investigate relative difference in morphology of *S. siderea* corals reared in experimental seawaters for 95 days. Colonies of *S. siderea* were sectioned and placed into six treatments of varying temperatures and acidified conditions. Corals reared at three temperatures (25°C, 28°C and 32°C, all at a pCO_2 of 477 µatm) and four pCO_2 treatments (324, 477, 604, and 2553 µatm, all at a temperature of 28°C) were investigated. Individual corallites were imaged with a Nikon (SMZ1500) and converted into a black (empty space) and white (skeletal structure) image. The relationship of the ratio between coral skeleton and empty space was calculated to determine if there is a significant difference in the skeletal structure across treatments. This study will provide important information about the underpinnings of observed reduced calcification rates for corals exposed to ocean warming and acidification and it will provide insights into which stressors may be more influential on coral health.

Melting barriers to faunal exchange across ocean basins

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Accelerated loss of sea ice in the Arctic is opening up routes connecting the Atlantic and Pacific for longer periods each year. These changes will increase the ease and frequency with which marine birds and mammals will be able to move between the Pacific and Atlantic Ocean basins. Indeed, recent observations suggest these movements are already occurring. Reconnection of the Pacific and Atlantic Ocean basins will present both challenges to marine ecosystem conservation and an unprecedented opportunity to examine the ecological and evolutionary consequences of faunal exchange in real time. To understand these changes and implement effective conservation of marine ecosystems, we need to further develop modeling efforts to predict the rate of dispersal and consequences of faunal exchange. These predictions can be tested by closely monitoring wildlife dispersal through the Arctic Ocean and using modern methods to explore the ecological and evolutionary consequences of these movements.

Investigating estuarine acidification in northern California and its impact on native oysters (*Ostrea lurida*)

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Ocean acidification has been the focus of concern especially regarding impacts on nearshore habitats including estuaries. However, other processes influence carbonate chemistry in west coast estuaries including freshwater inputs during the winter wet season and advection of upwelled seawater during the early dry season. The natural spatial and temporal variability of carbonate chemistry is not well understood, though perturbations of carbonate chemistry are predicted to increase in intensity and frequency with climate change. We examined the spatial and temporal extent of fluctuating water chemistry in Tomales Bay, CA in order to understand the consequences of variability in pH and other parameters that may influence populations of native oysters (*Ostrea lurida*). We sampled the water column with the goal of understanding the influence of background diel cycling as well as influences due to tidal exchange. We observed substantial depth dependent swings in dissolved oxygen that co-varied with temperature and salinity. In order to understand how complex carbonate chemistry dynamics influence oyster growth, we outplanted juvenile oyster at all water sample sites. We predict that success of native oysters may be strongly influenced by water columns processes that vary substantially over short temporal and spatial scales.

How far can anthropogenic impacts reach? A case study from the Gulf of Mexico

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The Parque Nacional Sistema Arrecifal Veracruzano (PNSAV) is a marine protected area off the state of Veracruz, Mexico. It encompasses 28 reefs across an area over 52,000 hectares. The reefs are divided into two groups by the mouth of the Jamapa river. The north group (Vz) has 13 reefs and is located off the coast of the city of Veracruz (pop. 428, 323). The southern group (AL) has 15 reefs and is located 22 km south, off the coast of the town of Antón Lizardo (pop. 6, 000). Line-intercept transects and coral condition data have been collected at sixty-three sites throughout the PNSAV to describe its coral communities at two depth intervals (3–5 m and 10–15 m). Differences between the two groups have been determined for percent coral cover (Vz < AL), coral size (Vz < AL), instances of bleaching (AL > VZ), and disease incidence (AL > VZ). These differences could be attributed, on the one side, to the proximity to a large urban area, but their may also be density-dependent processes affecting some of the AL corals. Results suggest that management strategies should be deployed at least at the group scale in this area.

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Estimating disturbance impacts on rolling carbonate reefs: distribution, growth and biodiversity of temperate rhodolith beds, Santa Catalina Island, California

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Rhodolith beds are globally distributed macroalgal habitats highly susceptible to anthropogenic disturbance. These accumulations of branched, free-living, coralline red algae create mobile, heterogeneous habitat supporting high biodiversity. We investigated newly discovered beds in California with the goals of: 1) identifying bed distribution, disturbance levels and growth at Santa Catalina Island and 2) determining if benthic communities vary between rhodolith and disturbed sand habitat and taxa responsible. Seven highly disturbed beds were found composed of the coralline *Sporolithon australe*. Mooring chains disturbed all beds and experiments identified negative effects on 3-D rhodolith structure. Rhodolith growth was slow (1.2 mm/year), suggesting long habitat recovery times. Surveys of main functional groups found rhodolith beds consistently supported higher abundances (26,000 vs. 7,400 organisms/m^2), greater taxon richness and invertebrate recruitment pulses relative to sand. Multivariate comparisons of habitats revealed that invertebrate and macroalgae drove community differences. Infauna contributed most to abundance estimates in both habitats. Elevated infauna in rhodoliths may explain frequent foraging of commercially important fish sheephead *Semicossyphus pulcher* and kelp bass *Paralabrax clathratus* observed in this habitat. Despite disturbance levels California rhodolith beds create important benthic habitat and should be included in marine protected areas and considered for future monitoring.

Very long-lived bivalves from Northern Norway reveal North Atlantic climate dynamics: Evidence from seasonal to centennial scales

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Very few long-term, continuous and high-resolution records of marine environmental conditions exist within the Arctic. Hence, proxy-based records are needed to elucidate past marine climatic conditions. Our study uses the very long-lived marine bivalve, *Arctica islandica*, to investigate impacts of large-scale climate variability and local environmental drivers on shell growth in northern Norway. We use shell-based growth and shell geochemistry as proxies for regional ocean climate variability over longer scales (>1 year), while we also examine the specific mechanisms by which climate and shell growth are linked with a high temporal resolution *in situ* experiment measuring bivalve shell gaping activity simultaneously with several environmental parameters. A master shell growth chronology documents an annually resolved record of environmental conditions over 100 years, revealing a strong inverse relationship ($r = -0.7$) between the shell-based record and North Atlantic sea surface temperatures. The *in situ* experiment shows that the bivalve population is active and feeding during distinct periods of high florescence, i.e. when fresh phytoplankton is available, suggesting that growth is food-limited. Together these results suggest a complex interaction between annual scale sea temperature and sub-seasonal scale food availability on the growth patterns of this climate bioproxy.

Methane-influenced benthic macro faunal communities in Svalbard, Norway

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Recent discovery of extensive sub-seabed gas reservoirs in the Norwegian Arctic has led to increased focus on the response of gas hydrates to climate change. Gas hydrates are hydrocarbons, enclosed in ice, which are stable at high pressure and low temperatures. Rapid Arctic warming may destabilize hydrates, leading to increased seabed emissions. We document specialized benthic communities associated with methane seeps in western Svalbard and the Barents Sea. Highly elevated methane concentrations (up to 100x background) were measured in water column and sediment. Benthic communities in methane-rich areas showed clear sign of disturbance compared to non-impacted control sites: species diversity (H') (median=1.6 vs. 2.9) and species evenness (J') (median=0.40 vs. 0.71) were significantly lower, while overall abundance was significantly higher (median=1558 vs. 575 sample^{-1}). Multivariate analyses indicate that methane-impacted communities were characterized by substantial patchiness within stations. High densities (up to 7272 ind. m^{-2}) of specialized seep-related polychaetes (e.g. Siboglinid tubeworms) were found in the deep sea and at the shelf, as were novel species of methane-associated Thyasirid bivalves. These results reflect the complexity and patchiness of seep-associated benthos. Future work will focus on in-depth studies of Arctic seep-associated ecosystems and their responses to climate change.

Three decades of monitoring kelp growth and environmental conditions in an Alaskan Arctic kelp bed

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The Stefansson Sound Boulder Patch is the largest contiguous nearshore rocky reef in the Alaskan Beaufort Sea. This discrete rocky patch of boulders and cobbles supports a diverse and productive community unique to the region, dominated by macroalgae and epilithic invertebrates. The Boulder Patch is hypothesized to be a biogeographic "stepping stone" in the exchange of biota between the North Atlantic and North Pacific. This area is also of particular interest because of its proximity to offshore construction activities related to petroleum exploration and development. As changes in global climate and coastal development continue to affect the physical and chemical nature of the arctic marine environment, it is imperative that we establish solid environmental baselines and understand the relationships between environmental factors and biological productivity. We present results from three decades of environmental monitoring in this kelp bed habitat. *In situ* measurements of temperature, salinity, and irradiance show large variability over multiple time scales. Growth of the arctic kelp *Laminaria solidungula* also shows large interannual variation, some which is attributable to those abiotic drivers. Overall, this long term data set demonstrates the importance of mesoscale climatic factors (particularly wind speed) to local kelp production.

Reconstructing millennial-scale methane emission history from *in situ* core profiles of carbonate-bearing organisms and bacteria in the high Arctic

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Destabilization of methane hydrates in the past may have contributed to rapid climate change, and the relationship between ocean warming, methane release, and climate change is one of today's most pressing issues in climate science. Dense accumulations of methanotrophic bivalves are present only in discrete zones in 4-5m long gravity cores from the Vestnesa Ridge (1200m depth) off Western Svalbard (79° N), suggesting that the methane emissions supporting the bivalve community varied considerably through time. Bivalve horizons were composed of Vesicomyidae bivalves that lived approximately 17,500 ypb (corrected ^{14}C age). Shell $\delta^{13}C$ values ranged from -5.66 to 2.36‰ (inorganic) and -29.29 to -21.33‰ (organic). Foraminifera taxa in the bivalve horizons are common species in the Arctic ocean but their tests had lower $\delta^{13}C$ values (range -3.1 to -6.7‰) compared to the same species in normal marine environment (from -1 to 1‰). The depleted $\delta^{13}C$ values of both bivalves and foraminifera are indicative of ^{13}C- carbon associated with methane emissions and secondary methane-derived authigenic carbonate overgrowth. We are also examining samples for bacterial DNA sequences indicative of methanotrophs. These results suggest a period of intense and sustained methane release, possibly a consequence of local tectonic activity following the last glacial maximum.

Caloric content of Chukchi bivalves and impacts of shifting community composition on caloric resources for bivalve consumers

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Marginal arctic seas such as the Chukchi Sea have experienced significant changes in sea ice timing and extent in recent years. Alterations in sea ice dynamics can impact primary productivity and export of carbon to the benthos, affecting both benthic communities and higher trophic levels through bottom-up processes. In the northeastern Chukchi, bivalves are a dominant benthic taxa and a vital food source for consumers such as Pacific walrus (*Odobenus rosmarus divergens*). We conducted quantitative sampling of bivalves to examine abundance and distribution in the northeastern Chukchi Sea in 2009, 2010, 2012 and 2013 and created maps of mean abundance and biomass for ten taxa: *Astarte* spp., *Clinocardium ciliatum*, *Cyclocardia cebricostata*, *Ennucula tenuis*, *Liocyma fluctuosa*, *Macoma* spp., *Musculus* spp., *Nuculana* spp., *Serripes groenlandicus*, and *Yoldia* spp. We also measured whole-animal caloric content and developed weight-calorie relationships for these taxa. Significant differences in caloric density between taxa were observed, and strong weight-calorie relationships allowed accurate prediction of caloric content based on weight. By applying these relationships to the quantitative specimens, we produced calorie maps to identify high-value feeding areas for bivalve consumers and to examine the relative importance of various bivalve species as preferred food sources for higher trophic level consumers.

Trematode infection does little to hinder invasive green crabs in eastern North America

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A common signature of marine invasions is a significant loss of parasites in non-native host populations, which may enhance an invader's success. In eastern North America, *Carcinus maenas* has escaped more than two-thirds its native parasite load. However, one trematode species (*Microphallus similis*) can have high incidences of infection in the region; yet little is known of its effects on *C. maenas*. We employed a series of lab experiments to determine whether and how *M. similis* infection intensity influences *C. maenas*, focusing on physiological assays of body mass index, energy storage, and immune activation, and behavioral analyses of foraging, shelter utilization, and conspicuousness. We found little evidence for enduring physiological or behavioral impacts four weeks after experimental infection, with the exception of mussel handling time which positively correlated with cyst intensity. However, there was a significant response during early stages of infection for the crab's immune activation response and the crab's righting response time, which both increased in infected versus uninfected crabs. Considering *M. similis* is the only common parasite infecting *C. maenas* in eastern North America, our results for minimal lasting effects on *C. maenas'* physiology and behavior may help explain the crab's continued prominence in the region.

Herbivore deterrence in a potentially rapidly spreading native marine macroalga

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Invasive marine macrophytes can have major impacts on native herbivore communities, often through alteration of habitat structure and herbivore deterrence. Invaders from the genus *Caulerpa* such as *C. taxifolia* and *C. racemosa* are prime examples. In New South Wales, Australia the native alga, *C. filiformis*, which was historically sub-dominant, is now a dominant algal species across many locations in its native range. As *Caulerpa* is structurally different and highly chemically defended it has the potential to strongly influence herbivore communities. However, we know little about the response of native herbivore communities, and the mechanisms that may determine community responses, to the spread of this alga. We investigated the potential effects of the spread of *C. filiformis* on the common purple sea urchin, *Heliocidaris erythrogramma*. Specifically, and because *Caulerpa* is chemically defended, we hypothesised that 1) The density of urchins decreases as algal cover increases 2) Urchins preferentially eat other native species of alga and 3) Consumption of *C. filiformis* by urchins incurs a physiological cost. Surveys and laboratory and field experiments confirmed all our hypotheses. Here we show that the spread of native species can have similar effects on communities to those of invasive counterparts.

Invasion Expansion: Time since introduction best predicts global ranges of marine invaders

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Characteristics of invading species and the invaded environment have long been identified as two key attributes controlling biological invasion. The ability of these factors to predict patterns of invasion may, however, be dependent on adequate time elapsing for species to spread to all potential habitats. We tested how well biology, oceanography and the time since first recorded introduction of a species explain the non-native range size of 138 coastal marine invertebrate species. Time since introduction alone explained the largest fraction (20%) of the variability in the range size of non-native marine invertebrate species, which on average expand by ~40km for every year they have been introduced. We found significant, but minimal, influence of environmental and life history variables on non-native range size. The positive relationship between time since introduction and range size indicates that non-native marine invertebrate species are not at equilibrium and are still spreading, posing a major challenge for management of coastal ecosystems.

Are crab-crab interactions altered by the rhizocephalan parasite Loxothylacus panopei?

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Loxothylacus panopaei is a rhizocephalan (barnacle) parasite that infects at least nine species of xanthid crabs. Rhizocephalan parasites interfere with key functions such as molting, reproduction and the immune system. The first recorded occurrence of *Loxothylacus sp*. North of the Chesapeake Bay was in the Long Island Sound in October 2012. Field surveys conducted from May through November 2013 of intertidal sites in New York and New Jersey confirmed the rhizocephalan parasite's presence in the Northwest Atlantic. We investigated predation by two crabs (large *Carcinus maenas* and large *Hemigrapsus sanguineus*) on infected and uninfected mud crabs and small Hemigrapsus. Each predator was given 10 prey at least half their size, a combination of 2 out of 3 options; 5 *Eurypanopeus depressus* infected by *Loxothylacus*, 5 uninfected Eurypanopeus or 5 *Hemigrapsus*. Three trials were run over a period of 3 weeks using the same predators after a 3 day starvation period. Each trial lasted 96 hours. Overall the *Hemigrapsus* preyed heavily on *Eurypanopeus*, mostly on infected *Eurypanopeus*. *Carcinus* preyed on uninfected and infected *Eurypanopeus* equally. Both predator crabs preyed less on small *Hemigrapsus* than on *Eurypanopeus.* The parasites current distribution and prevalence in NY & NJ is still being studied as well possible impacts on other native crabs.

Effect of disparate disturbance regimes on recovery and expansion of Smooth Cordgrass

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In recent decades, cordgrass (*Spartina alterniflora*)-dominated salt marshes along North America's east coast have been impacted by a suite of disturbances, including prolonged drought and invasions of destructive nutria and feral hogs, which result in open mudflats. Cordgrass recolonization of mudflats after these disturbances occurs primarily by clonal expansion of remnant patches and may be driven by physiochemical substrate characteristics as well as individual patch characteristics. To test how physiochemical soil properties and patch size may interact to affect cordgrass recolonization, we transplanted patches of different sizes (n=88) into two mudflats, one drought-induced and one feral hog-generated, on Sapelo Island, Georgia, USA. Over one year, we monitored the rate of patch lateral expansion, ramet production, and biomass accumulation and characterized mudflat soil by analyzing a suite of physical and chemical properties of soil cores (n=8) from each site. We found that medium and large transplant size had some legacy effect on patch expansion at the drought-induced site and transplants in the anoxic hog-disturbed soils suffered severely stifled expansion rates compared to transplants grown in drought-induced mudflat. With this study we hope to better understand disturbance recovery and inform salt marsh management, bolstering recovery and resilience to future impacts.

Sex ratios and sexual dimorphism in *Petrolisthes armatus* in South Carolina oyster reefs

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The green porcelain crab, *Petrolisthes armatus*, is an invasive species in the South Atlantic Bight, whose northern range limit is thought to be determined by low winter temperatures. In South Carolina, knowledge of its distribution and ecology is restricted to a few studies that document *P. armatus* densities on intertidal oyster reefs. Little is known; however, about the *P. armatus* mating system and potential sexual dimorphism outside of its native range. We evaluated *P. armatus* sex ratios at four intertidal oyster reefs along a latitudinal gradient in South Carolina. Following a relatively cold winter in 2004, sex ratios were 1.1:1 (M:F) at the southernmost site and were increasingly male-biased moving northward, reaching 2.3:1 M:F at the northernmost site. Under milder winter temperatures in other years, sex ratios were approximately 1:1. *Petrolisthes armatus* sex ratios at two sites in Charleston, SC following a cold winter (2014) are expected to be male-biased, if biological responses to temperatures extremes influenced the trend observed in 2004. Sexual dimorphism, which occurs in *P. armatus'* native range, is also examined. Sexual dimorphism of the cheliped in this species, as well as congeners, can indicate male-male competition as part of the mating system.

Genetic evidence that the colonial ascidian *Botryllus schlosseri* is native to North America

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Evidence for classifying the colonial ascidian *Botryllus schlosseri* as an invader is extremely circumstantial. Nevertheless, over the last 15 years most research groups have accepted the scenario of human-mediated dispersal. Meanwhile, others have continued to consider this species native or cryptogenic. We address the invasion status by adding 174 sequences to the growing worldwide database for the mitochondrial gene cytochrome *c* oxidase subunit I (*COI*) and analyzing 1,077 sequences to compare the genetic diversity of a clade of haplotypes in the Northwest Atlantic with two hypothesized source regions (the Northeast Atlantic and Mediterranean). Our results lead us to reject the prevailing view of the directionality of transport across the Atlantic. We argue that the genetic diversity patterns at *COI* are far more consistent with the existence of at least one haplotype clade in the Northwest Atlantic (and possibly a second) that substantially pre-dates modern human colonization from Europe, with this native North American clade subsequently introduced to three sites in Northeast Atlantic and Mediterranean waters. However, we concur that some sites in the Northwest Atlantic have more recently been invaded by alien haplotypes, so that some populations are currently composed of a mixture of native and invader haplotypes.

Responses of an invasive crab, *Petrolisthes armatus,* to extreme cold temperature aberrations

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The invasive anomuran, *Petrolisthes armatus,* first appeared on South Carolina oyster reefs in high densities in the mid-1990's. Like other "Caribbean Creep" species, *P. armatus* appears limited in its poleward range expansion by its intolerance of extreme cold temperatures, which reduce population densities. We examined relative *P. armatus* densities across a latitudinal gradient along the South Carolina coast, as well as temporally (between 2002 and 2014) within Charleston Harbor. Results indicated that populations at higher latitudes experienced a greater density reduction than those at lower latitudes following cold winters. During the winter of 2014, Charleston Harbor experienced seven days of abnormally cold water temperatures below 10 °C, potentially resulting in *P. armatus* mortality and decreased densities on oyster reefs. *Petrolisthes armatus* densities and size distributions at two sites in Charleston Harbor were compared between 2013 and 2014. Maximum *P. armatus* densities exceeded 2000 crabs/m^2 in 2013, whereas native crab densities were less than 350 crabs/m^2. While analysis is currently underway, a decrease in *P. armatus* density or change in cohort composition is expected as a result of exposure to extremely cold water temperatures.

Loss of adult novel northern lineages of the invasive green crab, *Carcinus maenus*, along the Northwestern Atlantic Coast

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Carcinaus maenas, the common green crab, was introduced over 200 years ago to the East Coast of North America and now ranges from New York to Canada. In the 1980s, a secondary invasion of novel European lineages occurred in Nova Scotia. Young-of-the-year sampled in 2007 revealed that novel northern haplotypes of the cytochrome c oxidase I (COI) gene were present in low frequency at several Northwestern Atlantic sites as far south as New York; an increase in their range and frequency was predicted. We tested this prediction by sampling adults from 11 sites from Nova Scotia to New York in 2013 and 2014. Six haplotypes, encompassing previously identified northern haplotypes, one previously identified southern haplotype, and two novel southern haplotypes, were identified in 165 crabs. Northern haplotypes were only found in Nova Scotia, Beal's Island, Maine and Mount Desert Island, Maine at a frequency of 86%, 6%, and 33%, respectively; the remaining sites were predominantly composed of a singular southern haplotype. Thus, at the adult stage, the range of the novel haplotype is limited to north of Mount Desert Island. The loss of the northern haplotypes south of Mount Desert Island could indicate that the southern haplotype is selectively favored.

Increased susceptibility to infection in invasive versus native populations of the shore crab

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When invaders become established in novel environments, they often leave behind enemies such as predators and parasites that may regulate populations in the native range. Parasite escape can confer fitness benefits to invaders when they no longer experience infection pathology, and also because relaxed selection on immune defenses may promote resource reallocation towards growth or reproduction. However, this relaxed selection may ultimately lead to increased susceptibility upon exposure to parasites. We conducted comparative laboratory studies of shore crabs (*Hemigrapsus sanguineus*) from native (Japan) and invasive (USA) populations to test for differences in susceptibility to infection by a native rhizocephalan parasite, and to explore potential differences in immune characteristics and energy allocation. We found that invasive-range individuals showed greater susceptibility to infection than their native counterparts. Preliminary analyses of fitness measures showed higher growth rates and lower resting oxygen consumption in invaders compared to natives, although measures of immune responsiveness (hemocyte densities, encapsulation) show no appreciable difference between native and invasive-range individuals. Our results suggest that invaders' ability to defend against infection may be reduced in favor of increased growth, but further work is needed to identify the immunological underpinnings of this increased susceptibility.

Morphological and genetic characterization of introduced ascidians and their distribution patterns in North Carolina harbors and marinas

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Marine introduced species have become increasingly prevalent around the world, in both natural and artificial environments. Ascidians are successfully introduced in many areas due to their high reproductive capacity, population growth rates and tolerance for a wide variety of environmental factors, including those that characterize many artificial substrates. In this study, we assessed the biodiversity and distribution of ascidians in 17 marinas along the North Carolina coast. Ascidians were visually identified using appropriate morphological keys and species descriptions and by sequencing a fragment of the mitochondrial gene cytochrome oxidase I (COI). DNA sequences were compared to those in GenBank using BLASTn, and a taxonomic catalogue of DNA barcodes was assembled. Five sites had no ascidians, probably due to low salinity resulting from prolonged and unusually heavy rainfall during the previous months. Of the 12 sites with ascidians, the most widespread and abundant species was the non-native *Styela plicata* (11 sites). *Ascidia interrupta*, *Perophora viridis* and *Polyandrocarpa* aff. *maxima* were present at 6 sites; the former two are considered native, the latter cryptogenic. Further insights on the distribution patterns of native and introduced ascidians in North Carolina harbors and marinas will also be presented.

Variable habitat availability and invasion as drivers of biogeographic patterns of intertidal community structure

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At local scales, habitat availability influences interactions between native and invasive species. Habitat availability may also predict patterns in native communities and invasive species at biogeographic scales when native and invasive species have specific habitat requirements. The New Zealand porcelain crab, *Petrolisthes elongatus*, has invaded intertidal rocky shores around Tasmania, Australia, where it is found in high densities (>1800 m^2) under rocks. We used a hierarchical sampling approach to determine relationships among habitat-availability, *Petrolisthes* and native invertebrate communities at multiple sites in the north and south regions of Tasmania. *Petrolisthes* biomass and abundance and native communities were positively correlated to rock cover and patterns were consistent at the biogeographic scale (between regions) although, for native communities, the strength and direction of some of these relationships varied among sites within regions. Over and above the positive correlations with rock cover, native communities were also dependent on *Petrolisthes* biomass, indicating native communities are not solely influenced by rock cover as a limiting resource. Flat, strongly adhering gastropods (chitons and limpets) were positively correlated with *Petrolisthes* biomass, whereas mobile gastropods and crabs were negatively correlated *Petrolisthes* biomass. Despite local scale variability in native communities and habitat availability, there were consistent relationships between native communities and *Petrolisthes* biomass suggesting that the impact of invasive species may be more predictable at large spatial scales.

Introduction of the green mussel (*Perna viridis*) and its impacts on the eastern oyster (*Crassostrea virginica*) in Georgia, USA

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The eastern oyster, *Crassostrea virginica,* is a keystone species that provides many ecosystem services and is commercially important to local fishers and oyster farmers in Georgia, USA. Georgia once led the country in the harvesting of the eastern oyster in the early 1900's. However, after many years of overharvesting the abundance of oysters in Georgia has significantly declined. With the recent introduction of the invasive green mussel, *Perna viridis*, from the Indo-Pacific region to the Atlantic coast of Florida, the Georgia oyster population stands to be at risk of the northward advance of the green mussel which has been observed fouling and smothering oysters in Tampa Bay, FL. The purpose of our experiment will be to observe the interactions of *Crassostrea virginica* and *Perna viridis* in their natural environment as well as a controlled environment in order to determine if the Georgia oyster population is at risk of the invading green mussel.

Effect of *Gracilaria vermiculophylla* invasion on estuarine-mudflat metabolism and diversity

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The invasive Japanese seaweed *Gracilaria vermiculophylla* (hereafter *Gracilaria*) has established for several years in numerous European estuaries from Portugal to Norway. In France, it forms in several estuaries dense populations at the mud surface. The population dynamics of *Gracilaria* and the effect of its cover increase on the metabolism and biodiversity have been studied in the Faou estuary (Brittany, France). Community gross primary production (GPP) and respiration (CR), macrofauna and meiofauna diversity and abundance, chlorophyll-*a* content, and isotopic signatures of selected macrofauna and main food sources have been measured in winter, spring and summer 2014 at low tide, both in colonized areas and bare mud (controls). Results highlighted significant higher values of GPP and CR where *Gracilaria* was present than on controls in winter and spring whereas only CR was significantly higher in colonized mud in summer. Primary productivity (measured as $mgC.mgChla^{-1}.h^{-1}$) clearly showed a lag between controls (only microphytobenthos) and impacted (microphytobenthos + *Gracilaria*)areas with a higher productivity of colonized areas in winter, no differences in spring, and a higher productivity in controls in summer. Significant variations in abundance for meiofauna and macrofauna were also detected. Mechanisms interacting with functioning and diversity of the mud flat are discussed.

SAV, topography and flow characteristics in the Upper, Tidal Hudson River:

Progress toward a predictive habitat model

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Submerged aquatic vegetation (SAV) plays a critical role in biogeochemical cycling, primary productivity, and the dynamics of sediments and current flow. SAV communities in the Upper Hudson River Estuary are comprised of species assemblages dominated by two morphologically different species: the native *Vallisneria americana* and the invasive *Trapa natans*. Using characteristics of modeled tidal/riverine flow, we examined the distribution and composition of the predominant SAV in the estuary. The distribution of *Trapa* was completely absent north of 42.4° latitude. SAV habitat space was, on average, well described by depth and flow. From a hydrodynamic standpoint however, the two species occupied very similar niches. Species-specific distribution patterns and co-occurrence rates did not appear to be strongly controlled by physical tolerances of topography or flow. Other ecological drivers such as disturbance regimes, dispersal strategies, plant-animal interactions, and sediment chemistry and composition might explain distribution patterns and *Trapa* expansion more accurately, rather than hydrodynamics alone. Sixty years after its settlement in the Hudson River Estuary, *Trapa natans* may have reached a northern limit for its distribution. Future management of the invasive plant should consider all ecological impacts on the environment, particularly those that may provide benefits to the ecosystem as a whole.

Habitat preference and tidal variation in native and invasive shrimp along the Long Island coast following the invasion of *Palaemon macrodactylus*

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The recent invasion of the Asian grass shrimp *Palaemon macrodactylus* to Long Island could potentially impact native shrimp populations through increased competition for resources. Our study compares the abundances and habitat distributions of three species of native palaemonid grass shrimp, a native sand shrimp, *Crangon septemspinosa*, and *P. macrodactylus* in man-made and natural habitats. A dip net was used to sample shrimp at three different habitat types: floating docks, seawalls/bulkheads, and natural habitats, at high and low tides. Several possible predictor variables were also explored to help explain abundance differences across habitat types and tides, including vegetation cover, protection, wave energy, salinity, and temperature. The results showed that native palaemonids were most abundant along seawalls/bulkheads, *C.* septemspinosa was only found in natural habitats, and *P. macrodactylus* was most abundant along floating docks. Abundances were higher for all species at low tide along seawalls/bulkheads and in the natural habitat. The distributions of native palaemonids and *P. macrodactylus* were also influenced by the level of protection and vegetation cover in each habitat. Altogether, our observed differences in habitat preference could be due to different habitat requirements for native versus invasive shrimp or due to competition among the shrimp for habitat space.

Using native herbivores to mitigate Eurasian watermilfoil invasion success in New England

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Eurasian watermilfoil (*Myriophyllum spicatum*) is a nuisance species in many coastal areas, leading to costly and often ecologically harmful eradication efforts. We explored the use of herbivores native to Connecticut as an alternative to chemical treatment or mechanical removal of Eurasian watermilfoil, as well as investigating the role of chemical interactions in *M. spicatum*'s invasion success. We used a series of laboratory feeding experiments to determine which native herbivores consume *M. spicatum*. To gain a more complete understanding of milfoil's impacts, we conducted field surveys to document herbivore community composition in invasive milfoil- and native *Elodea*- dominated areas. The amphipod *Hyalella azteca* and physid snails significantly reduced milfoil biomass in feeding trials, and they consumed similar quantities of milfoil alone and in combination. Amphipods showed no preference for either milfoil or *Elodea* in choice feeding experiments, although milfoil contained more total reactive phenolics than *Elodea*. *In situ* community composition did not differ significantly between milfoil and *Elodea* patches, suggesting that milfoil has not reduced consumer populations at our site. Our results suggest that native herbivores may be useful in reducing milfoil's ecosystem impact and that chemical deterrents may play a role in its invasion success.

Invasive Indo-Pacific lionfish (*Pterois volitans*) causes local extinction of a native coral reef fish (*Coryphopterus glaucofraenum*)

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Invasive Indo-Pacific lionfish (*Pterois volitans*) are highly effective predators that represent a substantial threat to reef fish populations in the greater Caribbean region. Their high feeding rates and large densities may lead to changes in community structure by altering the regulatory processes that contribute to population persistence of native species. We quantified changes in the local abundance of a common, native species, the bridled goby (*Coryphopterus glaucofraenum*), for both unmanipulated and manipulated populations in the presence vs. the absence of lionfish. On Bahamian patch reefs, we found that a single lionfish significantly reduced the abundance of bridled goby consistently across years, ranging from 80% (5 weeks) to 100% (10 weeks). Additionally, lionfish elevated the per capita mortality of bridled goby close to 100%, which was about double the effect size compared to an ecologically similar native predator, the graysby grouper (*Cephalopholis cruentatus*). We also found that juvenile lionfish <14 cm are restricted to a 0.42 ratio of prey size to lionfish size, but large lionfish can consume all but the smallest bridled goby. Thus, lionfish not only cause large reductions in the abundance of native prey, but also cause sufficiently high mortality to extirpate local populations.

Genotypic diversity facilitates growth rate of the non-native seaweed Gracilaria vermiculophylla

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Species diversity affects community and ecosystem processes such as productivity, nutrient cycling, and resistance to stressors. Recent evidence indicates that genotypic diversity within populations of keystone and numerically-dominant species may play analogous and equally important roles. We tested whether intraspecific diversity within a numerically-dominant population of non-native seaweed alters community-level processes. The Asian red seaweed Gracilaria vermiculophylla occurs in virtually every temperate estuary of the Northern Hemisphere. In South Carolina and Georgia, estuarine mudflats are historically-devoid of native seaweeds, and currently Gracilaria represents 90-100% of the standing biomass. Two field surveys indicated that genotypic diversity (as determined by 7 microsatellite markers) at small (0.04 m2) spatial scales did not correlate with epibiotic abundance nor diversity nor bacterial abundance. When we outplanted monocultures and polycultures (8 genotypes) of Gracilaria, we found that polycultures tended to have higher net growth rates. This was likely due to complementarity effects over selection effects. Species and genetic diversity generally tends to promote ecosystem functioning, including resistance to invasions, however genetic diversity within non-native species may have the opposite effect by facilitating invader fitness and promoting its spread.

Introduced species increase complexity and biodiversity of rocky subtidal seascapes

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A major issue confronting marine and terrestrial researchers is addressing questions related to alterations in the organization and structure of communities as a result of introduced species. Many of these alterations are reflected in replacements, additions or losses of habitat-forming species that perform essential ecosystem services. In the Gulf of Maine, subtidal rocky macroalgal communities have substantially changed since the 1970s, with 50-80% of shallow subtidal communities covered by non-native species. While detecting changes in species composition as a result of introduced species is obvious, shifts in the morphological structure (ie, architecture) of the community or in diversity of species at the base of the food web is more difficult to assess. We investigated the effects of long-term shifts (> 45 yrs.) in macroalgal composition on habitat structure, abundance and diversity of species that occur at the base of the food web. Our results indicate that non-native algal species have increased the complexity of rocky subtidal communities with concurrent increases in the abundance and diversity of invertebrates and vertebrates. This study serves to identify the degree to which non-native species alter the structure and function of subtidal macroalgal habitats.

Is the Asian tiger shrimp (*Penaeus monodon*) a real predatory threat to native shrimp and blue crabs or just a paper tiger?

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In 2011, the Asian tiger shrimp, *Penaeus monodon*, was identified as a potentially invasive species when it appeared in commercial shrimp catches from North Carolina to Texas. Their presence in US waters is ecologically concerning because the tiger shrimp's large body size, broad diet, aggressive omnivory, and estuarine distribution suggest they may consume native shrimp or juvenile blue crabs and be highly disruptive to community structure. To determine if tiger shrimp represent a significant predatory threat to native brown and white shrimp or other estuarine species, we performed mesocosm experiments examining: a) the predation rates of tiger shrimp on adult and juvenile native shrimp; b) the behavioral responses of native shrimp to tiger shrimp, and; c) tiger shrimp diet preferences in multi-species estuarine environments. Predation rates on native shrimp species were generally low with the highest predation rates occurring on small juveniles. However, despite their success at evading most tiger shrimp predation attempts, native shrimp often displayed avoidance behaviors that displaced them from their preferred habitats. Although predation rates on shrimp remained low in multi-species predation experiments, tiger shrimp were highly effective predators on juvenile blue crabs suggesting tiger shrimp will have species dependent impacts to commercially important crustaceans.

Sorry we crashed the party folks: The distribution, abundance, and rates of parasitism of native and non-native shrimp in Long Island and the Bronx NY

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Ballast water mediated invasions are a threat to native ecosystems worldwide. In this study, a recent Asian grass shrimp invader *Palaemon macrodactylus* and native Western Atlantic palaemonid shrimp (*Palaemon vulgaris*, *Palaemon mondusnovus*, and *Palaemon pugio*) were studied in summer 2014 in Long Island and the Bronx, NY (proposed first site of introduction for *P. macrodactylus* in 2001) to determine relative abundance and distribution of the species in the region and analyzing size, sex, species, and rates of parasitism (primarily by trematode parasites). We discovered very low (n=3) abundance of invasive *P. macrodactylus* across 9 sites versus high average abundances (n=53.1±28.4) for the natives. June data (just for the natives) show an even ratio of males to females (with low abundances of ovigerous females), relatively high (51%) parasite prevalence averaged across all sites, and trematode parasite infection concentrating primarily in abdominal muscle tissues. Preliminary analyses of samples collected in July and August suggest greater abundances, distributions, and rates of parasitism in the non-native *P. macrodactylus* as the summer progressed. Our study represents the first extensive survey of these species in the Long Island region at a very early stage of invasion for *P. macrodactylus*, providing important baseline data for future investigations.

Effects of multiple stressors on interactions between an invasive herbivore and native SAV in Southwest Florida estuaries

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The island apple snail, *Pomacea maculata*, is native to South America. It is an invasive pest in freshwater ecosystems all over the world and may also invade estuaries. By overgrazing submerged aquatic vegetation (SAV) they have reduced ecosystem function and threatened key species such as Tapegrass (*Vallisneria americana*). Abiotic stressors appear to strongly influence both the grazing rate of *P. maculata* and the ability of tapegrass to endure grazing. We examined the role of stressors on the outcome of *P. maculata* herbivory on *V. americana* using laboratory, mesocosm, and field studies. In no-choice feeding trials, salinity decreased grazing rate and elevated temperatures increased grazing rate. In choice feeding trials, the snail exhibited an affinity for *V. americana*. In the mesocosm experiment, elevated salinity and snail presence had negative impacts on above ground biomass of *V. americana*. The salinity tolerance of P. maculata was surprisingly high, comparable with that of *V. americana*, indicating that the plant may have no estuarine refuge from this invasive grazer.

Habitat-associations of an invasive, native macrophyte

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Invasive macrophytes often spread rapidly because they are highly tolerant to changing environmental conditions. A growing phenomenon is the rapid spread of native species, whose impacts can rival those of non-native invaders. However, we know little about mechanisms underlying the spread or the impacts of native invasive macrophytes, although we may predict that they have broad tolerance to a range of environmental conditions, similar to that shown for non-native invasive macrophytes. The marine alga *Caulerpa filiformis* (Suhr) Hering, native to south eastern Australia, has become more abundant within and is spreading outside what is considered its natural distribution. First, we show that at broad-spatial scales *Caulerpa* is more abundant on narrow rocky reefs with a higher proportion of sand, suggesting high tolerance to sedimentation. A lab experiment confirmed *Caulerpa*'s high tolerance to sedimentation via morphological adaptions. Second, at smaller scales (i.e. within reefs), *Caulerpa* is present in a range of habitats but is in higher abundance in habitats with higher sand fraction. Habitats where *Caulerpa* was dominant also had low diversity of the seaweed community. We suggest that *Caulerpa*'s ability to withstand sedimentation, trap sediment and its rapid morphological adaptations are contributing to its potential.

Competitive interactions between the invasive Asian shore crab *Hemigrapsus sanguineus* and juvenile American lobster *Homarus americanus*

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The Asian shore crab *Hemigrapsus sanguineus* was first introduced to the northwest Atlantic coast in the late 1980s, and has quickly become the most abundant intertidal crab species throughout much of southern New England. Observational data revealed that intertidal abundances of both native crab species and juvenile American lobster *Homarus americanus* have declined in the shallow intertidal where Asian shore crabs are highly prevalent. *H. sanguineus* and *H. americanus* have similar habitat and diet preferences, suggesting that the two species are competitors and may engage in agonistic interactions. We conducted two mesocosm experiments to test the hypothesis that Asian shore crabs outcompete juvenile lobsters for shared resources. First, we evaluated whether the two species compete for food resources and found that juvenile lobsters spent significantly more time feeding and instigated significantly more agonistic interactions than the invasive crab. Next we examined if they compete for shelter and found that, regardless of which species was acclimated to the shelter prior to initiating the experiment, lobsters spent significantly more time occupying the shelter. These results suggest that *H. sanguineus* are unlikely to outcompete juvenile *H. americanus*, and that lobsters may constrain the Asian shore crab to its current depth distribution.

Can competition with invasive lionfish lead to dietary shifts of a native predator?

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One of the primary disturbances posed by invasive Indo-Pacific Lionfish (*Pterois spp.*) is the potential for competition over shared resources with native predators. Although studies have identified dietary overlap between Lionfish and native species, targeted research has yet to show whether coexistence can lead to niche partitioning by either species. Using a recently developed form of stable isotope analysis involving fish eye lenses, we are testing whether the diet of the native Graysby (*Cephalopholis cruentata*) changes in response to an experimentally driven gradient of Lionfish density on contiguous reefs in south Florida. Measuring $\delta^{13}C$ and $\delta^{14}N$ in discrete layers of the eye lens, we can chronicle the trophic histories of individual Graysbys and Lionfish which have each experienced different competition regimes. Simultaneous ageing via otolith ring counts will ground truth the timeline of lens layer deposition, allowing direct comparison of tissue created pre- and post-Lionfish removal. This study will clarify how Lionfish affect native mesopredators, an important question for conservation, management, and invasion ecology. Our results will also shed light on the strengths and limitations of eye lens analysis, a potentially powerful technique for future ecological research.

Invasion strategies differ across biogeographical regions: early invasion strategies of the invasive alga, *Dasysiphonia japonica*

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The impacts of non-native marine invasions have become an important focus of research on global change. However, we know little about invasion-mediated changes that occur early in the invasion process at the community or individual level. We tracked abundances of a recent algal invader, *Dasysiphonia* (formerly, *Heterosiphonia*) *japonica* in two biogeographic regions in the western North Atlantic Ocean. Consistently higher abundances of the invasive alga north of Cape Cod, Massachusetts suggested that differences in abiotic and biotic factors between the two regions may contribute to the success of the invader. As expected, we found differences in abiotic conditions (temperature and salinity) between the two biogeographic regions. *Dasysiphonia* grew 10 times faster in the northern region than south of Cape Cod. Consumption of *Dasysiphonia* tended to be lower in the north, which may contribute to the observed higher abundances, although this was not statistically significant. These different responses and roles of *Dasysiphonia* north and south of Cape Cod may result in important community level differences, as biodiversity declined in the northern region following the invasion of *Dasysiphonia*, whereas diversity did not appear to be impacted south of Cape Cod.

A taste for aliens? Incorporation of a novel prey item into native fishes diet

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Non-indigenous species (NIS) are known to induce a variety of changes to food web structure and function in their new environments. Changes are potentially more pronounced with functionally novel invaders, such as the omnivorous Harris mud crab (*Rhithropanopeus harrisii*) in the Northern Baltic Sea. The area lacks any native crab species, providing an excellent opportunity to observe how invasion of a functionally novel species changes the food web. The predatory role of novel NIS in aquatic environments is more commonly studied, but their role as a prey item for native predators is largely unknown. In fall 2013 in the annual Archipelago Sea (Finland) coastal fish monitoring, 1286 fish stomachs of 17 species were inspected for mud crabs. Fishermen previously reported finding mud crabs in perch and pikeperch stomachs, but our study also found crabs in four-horned sculpin and roach. Four-horned sculpin appeared to be the most effective predator. Even at the most dense mud crab sites, only 10% of the perch had consumed mud crabs whereas at same sites 90% four-horned sculpins contained mud crabs. Results highlight the need to understand the process of native predators learning to prey on novel NIS and native predators potential for controlling NIS populations.

Oceanic rafting of coastal marine bryozoa: Lessons from Japanese tsunami marine debris

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The Tohoku Earthquake and Tsunami of March 11, 2011 ejected into the North Pacific Ocean a vast debris field which began drifting toward North America and Hawaii. The size (number of objects, weight, and volume) of the field is unknown. This is the first such event in marine biological history permitting multi-year tracking of transoceanic rafting based upon a debris field generated from a known source at a known time. Since 2012 approximately 300 Japanese Tsunami Marine Debris (JTMD) objects (forensically identified) with living biofouling have been intercepted from Alaska to California and Hawaii and are being analyzed for their species composition (morpho- and genotaxonomy), reproductive status, and other phenomena. Of 250 coastal species determined to date, 16% are represented by 41 species of shallow-water and near-shore bryozoans with living tissue, brown bodies (regressed tissue) and/or embryos. Two additional species of oceanic bryozoa also recruited to the debris. The JTMD event has permitted a rare window into understanding the potential for the role of high seas rafting in creating intrabasin biogeographic patterns. The list of JTMD bryozoa further provides a target inventory of non-native species to be searched for in North America and Hawaii.

Evidences of a potential Atlantic origin of *Carijoa riisei* (Octocorallia, Alcyonacea) in Colombian tropical eastern Pacific

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The decline of octocoral populations caused by mass mortalities, microbial diseases and invasive species, such as *Carijoa riisei,* is noteworthy in the tropical eastern Pacific (TEP). This octocoral is considered invasive in Colombian TEP, however since now no study of its origin existed. We conducted phylogenetic analysis in order to resolve the biogeography source (Atlantic or Pacific) of *C. riisei* at Colombian TEP. We obtained new sequences of *C. riisei* from Colombian TEP and Colombian Caribbean for nuclear (SRP54 and ITS2) and mitochondrial (ND2) markers. For the first time, we report ITS2 sequences and their secondary structure. Phylogenetic analysis obtained for SRP54 showed resolved trees with well supported clades grouping Colombian TEP and Atlantic sequences (from Western Atlantic and Colombian Caribbean), for both maximum likelihood and Bayesian inference approaches. These preliminary results would indicate a possible Atlantic origin of *C. riisei* in Colombian TEP. Additionally, analysis of molecular variance will be carried out to understand the genetic differences among Atlantic, Pacific and TEP populations. This is the first study about the origin of *C. riisei* at TEP and is essential for the reliable description as invasive species in this region, which will allow henceforth the implementation of first management strategies.

Relative importance of native and non-native prey naïveté in marine invasion success

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Prey naïveté, or the absence of anti-predator behavior between native and non-native species, influences invasion success. An understanding of its relative importance at different timescales since introduction and across trophic levels, however, is lacking particularly in marine systems. We examined naïveté across three trophic levels of marine invertebrates, including the hard clam as native basal prey, two intermediate non-native crab predators (one recently-introduced and one long-established), and a native crab species that is both an intermediate and top predator, testing two hypotheses: 1) naïveté decreases with time since introduction, and 2) naiveté leads to a resource-driven increase or a predator-driven reduction in invasion success. We conducted laboratory behavioral experiments, assessed predation pressure on focal consumers in the field, and modeled the effects of these tritrophic behavioral interactions on the population of the recently-introduced non-native intermediate predator crab. We found support for our first hypothesis across all trophic levels, however our model predicted population growth that is independent of naïveté. These results suggest that physiological traits of the non-native species may drive its population growth more so than behavior. Examining additional components of the food web will be increasingly important in developing a broader understanding of species interactions within invaded communities.

A molecular analysis of green crab diets in Casco Bay, Maine

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A new wave of green crabs *Carcinus maenus* is sweeping through the Gulf of Maine (GOM). While first reports of green crabs in the GOM date from the early 1900s, populations in southern GOM have exploded in the last five years. In the Casco Bay region, this unusually high abundance is associated with poor commercial shellfish landings and the decline of eel grass habitat (*Zostera marina*). To determine the mechanistic roles green crabs play in direct and indirect ecological interactions, it is important to understand diet breadth, and how feeding preferences change in response to ecological context. Since green crabs are omnivorous, traditional approaches to diet analysis via hard parts suffer from substantial bias. We are using DNA barcoding and next generation sequencing (NGS) to analyze green crab diets from a longitudinal sampling design in Casco Bay. In addition to a temporal dimension, our design includes two habitats: clam flats and eel grass beds. We have now sampled ~ 1000 crabs and have processed 460 individual stomachs from a range of sizes and both sexes. Here we will present: our sampling design, our NGS pipeline, and preliminary analysis from a lobster-specific (*Homarus americanus*) probe.

Reappearance of the introduced nudibranch *Tritonia plebeia:* A new introduction or a case of switching prey?

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Nudibranch Mollusks are typified by ephemeral life spans especially in highly seasonal temperate environments such as the Gulf of Maine. They often become abundant to take advantage of seasonal prey such as hydroids and other benthic sessile fauna. Once the prey is consumed, predator numbers decline and remain at low numbers in refuge populations until the next buildup of prey species. During the period from 1983 to 1986, the European nudibranch, *Tritonia plebeia*, appeared in the southwestern Gulf of Maine. The nudibranch preyed on the octocoral, *Alcyonium digitatum* (=*A. siderium*), which is the typical prey in Europe, and prey populations crashed at locations where the nudibranch was common. In 2011, specimens of *Tritonia plebeia* were collected at a study site in Eastport, Maine. The species has been observed through fall 2014, though there has been a significant decline in soft coral populations. Two possible hypotheses will be discussed: (1) that this represents a new introduction or (2) that the nudibranch has adapted to a new prey source (*Gersemia rubiformis*), which has allowed it to persist in the Gulf of Maine region.

Do non-indigenous bivalves alter the benthic environment they invade?

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Bivalve invaders are common to freshwater, estuarine and coastal ecosystems globally, with the capacity to change the environment through feeding, excretion and bioturbation. For infaunal species these activities can alter sediment silt, oxygen, organic and water content. To assess potential impacts of non-indigenous bivalves we investigated the influence of several suites of native and non-native clams associated with shellfish farms in Baynes Sound, British Columbia. Four clam assemblages were held in the lab and field: 1) High densities of the non-native Manila clam (*Tapes philippinarum*); 2) Mixture of Manila and native Pacific littleneck clams (*Protothaca staminea*); 3) High densities of non-native varnish clams (*Nuttallia obscurata*); and, 4) Control with no clams. Changes in sediment (e.g. particle size, organic and water content) and pore water properties (e.g. temperature, salinity, pH, dissolved oxygen) were monitored. No significant changes in either sediment or pore water properties were observed between the four different treatments. Results indicate that sediment properties are not altered significantly by invasions of these non-indigenous species over the study duration of one year. To investigate the potential of longer term impacts field treatments are being continued.

Heterspecific competition and conspecific tolerance as a mechanism for the invasion success of the crab *Hemigrapsus sanguineus*.

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The success of the invasive Asian shore crab, *Hemigrapsus sanguineus*, now commonly found along the rocky shores of the northwestern Atlantic and elsewhere, includes the ability to exclude other species from preferred rocky and cobble intertidal habitat. This study sought to test preference and competition for habitat types (cobble vs. sand) for *H. sanguineus* and two competitor species; the resident green crab, *Carcinus maenas*, and the native rock crab, *Cancer irroratus*. We paired similarly sized heterospecifics and conspecifics from each species, and also grouped combinations of *C. maenas* and *H. sanguineus* in sets of four, to test competition within and between species at different densities. In individual controls, all three species significantly preferred cobble substrate. With paired conspecifics, both *H. sanguineus* individuals significantly preferred cobble, whereas *Carcinus* and *Cancer* excluded conspecifics from the cobble. Similarly, *H. sanguineus* significantly excluded heterospecifics from cobble. In larger assemblages, *H. sanguineus* significantly grouped under cobble, whereas *C. maenas* were more evenly distributed among habitat types. These patterns illustrate a clear mechanism for changes in distribution and niche use seen in the wake of the introduction of the Asian shore crab in New England coastal systems.

Suitability of the exotic macroalga *Gracilaria vermiculophylla* as a nursery habitat for juvenile blue crabs *Callinectes sapidus*

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Juvenile blue crabs *Callinectes sapidus* may be using the exotic red alga *Gracilaria vermiculophylla* as nursery habitat as it emerges in Chesapeake Bay. This study aimed to assess growth rates of juvenile crabs associated with *G. vermiculophylla* compared to other habitats. In 2012, juvenile crabs < 30 mm CW were collected from the lower York River, VA, while in 2014 crabs < 50 mm CW were collected and tagged with microwires for identification. Plastic and VEXAR cages (SA ~0.34 m^2) were deployed with solitary tagged crabs near the mouth of the York River and in upriver locations in *G. vermiculophylla*, seagrass, and unvegetated habitat. After approximately 4 weeks, tagged crabs were collected from cages by suctioning through a 3 mm mesh bag. Juvenile crab growth was not significantly different between years. Growth was significantly greater in upriver unvegetated habitat compared to downriver unvegetated habitat (p-value = 0.039) likely due to prey availability; however, growth rates in all other habitat types were not significantly different than downriver unvegetated habitat. The exotic alga *G. vermiculophylla* seems to provide a suitable and important emerging structural nursery habitat to juvenile blue crabs in areas where seagrass is declining.

Effects of the Red Tide *Karenia brevis* on early life stages of the Asian green mussel *Perna viridis*

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Karenia brevis is a bloom-forming toxic dinoflagellate common along the central and southwest coasts of Florida. It produces a suite of neurotoxins known as brevetoxins (PbTx) that can be devastating to a wide variety of organisms including plankton, bivalve mollusks, marine mammals and humans. The green mussel, *Perna viridis*, was recently introduced to Southwest Florida from the Indo-Pacific. It has become a problematic invasive species with the potential to outcompete the native oyster *Crassostrea virginica* for space and other resources. Field observations have indicated high mortality in green mussel populations during red tide events, suggesting that *K. brevis* may help to control this invasive bivalve. We assessed the growth and survival of early life stages of *P. viridis* to bloom concentrations of *K. brevis* and found that the mussel is highly vulnerable to the dinoflagellate's toxicity.

Invasive European green crabs muscling their way north in Maine?

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The European green crab (*Carcinus maenas*) first invaded the Atlantic coast of the U.S. during the nineteenth century. Cold temperatures that affect feeding rate and survival apparently limited their northward expansion. However, recent reports and observations suggest that *C. maenas* populations are increasing along the coast of Maine, perhaps as a result of climate change, and may be responsible for declines in native bivalve species. We conducted field surveys at six sheltered rocky intertidal sites in central Maine, both west and east of the Penobscot River, in order to characterize *C. maenas* population structure, associated community structure and compare with similarly sampled past studies of *Carcinus*. *C. maenas* densities ranged from 12-18 crabs $\cdot$ m^{-2} across the six sites representing a doubling of crab abundance in the past decade. Crabs 10-20 mm carapace width occurred most frequently and sex ratios were even across all populations, but populations east of the Penobscot had larger crabs. Crabs eat small mussels more than large ones, which may contribute to the declines observed in mussel abundance in Maine. The implications of a boom in green crab abundance to native bivalve populations and community structure in Maine is currently being investigated.

Comparing demographic data and genetic diversity of the introduced barnacle, *Megabalanus coccopoma*, at on and offshore structures in the southeast US

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The barnacle *Megabalanus coccopoma* is a recently introduced species to the southeastern U.S. Their large body size and rapid range expansions have heightened concerns that *M. coccopoma* may outcompete native sessile invertebrates on hard substrata. In addition, yearly range expansions indicate the potential for local larval sources. We hypothesize that *M. coccopoma* populations on offshore structures are acting as a larval source and thus have higher genetic diversity and mean shell sizes than onshore populations due to overlapping generations of mature, breeding adults. To assess this hypothesis we collected demographic data including density and mean shell size from each of 4 shoreline sites and 4 offshore sites. Additionally, we sampled ~25 individuals biannually for two years from each site for genetic analysis using microsatellite markers. Demographic data supports our hypothesis indicating that offshore populations consist of larger, more mature individuals suggesting a stable adult population at these sites. To date microsatellite data shows high diversity at all sites with the mean average alleles per locus ranging from 13.15±4.83 to 18.92±7.89. All sites also show significant deviation from Hardy-Weinberg Equilibrium, which may be the result of recent founder events or a population admixture from multiple source populations.

Influence of habitat modification on the recovery of benthic communities following the eradication of an invasive ecosystem engineer

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Estuarine plants can strongly influence the abundance and diversity of benthic communities. There is a particular need to understand this relationship following the eradication of invasive ecosystem engineers to determine the rate and extent of subsequent recovery. In 2013, we designed a field experiment to quantify the legacy effects, both aboveground and belowground, of the removal of invasive cordgrass (hybrid *Spartina*) in San Francisco Bay, CA, USA. We sought to understand how changes in the physical structure following eradication of the invasive plant influences rates of recovery of benthic communities, and how colonization by invertebrates influences the physical and chemical environment. We established experimental treatments to either slow the recovery process using structural plant mimics above and below ground as well treatments to hasten recovery using sediment aeration in a marsh in Alameda, California, USA. After 270 days, the presence of below- and aboveground structure influenced the abundance and composition of infauna, while epifauna were primarily driven by aboveground structure. Experimental results also indicate that infaunal responses were likely directly, and not indirectly, mediated by habitat structural changes. Our results indicate that legacy effects the ecosystem engineer will result in slower recovery as a result within these communities.

Relative abundances of the recently introduced barnacles, *Megabalanus coccopoma* and an unidentified species of *Megabalanus*, in the southeastern U.S.

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Megabalanus coccopoma is an abundant introduced species currently found along the southeastern U.S. coastline. Recently, among collected samples thought to be *M. coccopoma*, several individuals of an unidentified species of *Megabalanus* were found. To date we have been unable to identify the samples to species level due to unknown origin, morphological variation, and inconsistent taxonomic keys. Cytochrome Oxidase I (COI) sequences show >10% divergence between the unidentified species and *M. coccopoma*, providing an easy tool for distinguishing the two taxa. In this study we used a restriction enzyme digest of COI to estimate the relative abundance and distribution of the two *Megabalanus* species off the coast of Georgia and South Carolina. Specimens were sampled from 4 coastal and 4 offshore sites. To date, from the offshore sites 73% of the specimens collected were identified *M.coccopoma* and 27% were identified as the unidentified species. Therefore, the unidentified species is limited to offshore sites only where *M. coccopoma* occurs at both offshore and coastal sites.

Comparing performance, dispersal, and population dynamics of two competing invasive *Dreissenid* mussels

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In the early 1990's, the Eurasian zebra (*Dreissenia polymorpha*) and quagga (*Dreissenia bugensis*) mussels were introduced to the Saint Lawrence River, a system which had previously been devoid of epifaunal mussels. The establishment and subsequent dominance of these two efficient filter feeders has led to changes in water quality and the benthic community along the river. Both species are highly fecund and enjoy a lack of predation pressure in North America, which further adds to their ability to spread to other waterways. However, because the two species differ in growth, resource allocation, and dispersal strategies, they have not followed the same invasion pathway. Because zebra mussels colonies have exploded across lakes and river systems in the U.S. and Canada, it was originally believed that they arrived before quagga mussels. More recent work suggests, however, that both dreissenids were likely introduced together, and further, that *D. bugensis* are slowly displacing *D. polymorpha* in the SLR. The goal of this study is to determine what abiotic factors (eg flow rate and turbidity) affect performance and dispersal of each species, and thus contribute to the shifting dominance between invasive mussel species.

Plenty of tunicates in the sea: Distribution of and relationship between larval supply and recruitment with respect to depth

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The use of settlement plates and the collection of plankton samples are common methods to monitor for invasive tunicates species. The determination of an optimal depth range for monitoring can be a time- and cost-effective strategy to increase the probability of species detection (larval supply and recruitment being proxies) given that species presence and abundance may vary with respect to depth. We hypothesised that tunicate recruitment is greater at shallower depths than at deeper depths due to the role of phototactic and geotactic behaviours during settlement regardless of the vertical distribution of larvae. We tested our hypothesis by comparing the larval distribution and recruitment of *Botryllus schlosseri* in a marina on the Bras d'Or Lake, Nova Scotia, Canada. Settlement plates were deployed at six different depths (range: 0.5-3.0 m) for six days in September 2014. At the location of each plate, larval supply was determined by sampling plankton at three different depths (range: 1.0-3.0 m), repeated three times on different days. As predicted, larval supply and recruitment tended to be greater at shallower depths than at deeper depths, but there was only a statistical significant difference in the vertical variability in recruitment. Larval supply (mean over three days) and recruitment were, however, positively correlated. Our findings support efforts to deploy plates and sample for larvae (e.g., to look for eDNA) at shallower depths to maximise the probability of detecting tunicate species.

Can life history traits help explain the efficiency of field methods for early detection of aquatic invasive species?

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Early detection of newly introduced or spreading aquatic invasive species (AIS) focuses on centers of human activity such as marinas. Artificial structures in such places can host a great diversity of organisms, known collectively as the fouling community, making early detection an issue of finding AIS while they are rare. To be successful, a multispecies detection approach must make efficient use of resources by maximizing the species richness per sampling effort. We compared two multispecies collection methods with high resolution at a local scale by saturating a marina in British Columbia, Canada, with settlement plates deployed at three time intervals and quadrat samples scraped from floating docks. We hypothesized that observed species assemblage and richness is strongly biased by the sampling technique itself (long-term assemblages on structures versus early-successional assemblages on plates), and that the difference can be explained by species life history traits. Using rarefaction, we examine the detection efficiency of each method for the known invasive species as well as for all rare species with "invasive" life history traits (e.g. high dispersal ability) in order to determine whether the methods are strongly biased or if they can be combined to reduce total sample effort.

Are there general spatial patterns of mangrove fringe forests structure and composition along estuarine salinity gradients?

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Species distribution and structural patterns of mangrove fringe forests along three tropical estuaries were evaluated in northeast of Brazil (Todos os Santos Bay) and were related with interstitial water salinity, percentage of fine sediments and organic matter content. In all estuaries (Jaguaripe, Paraguaçu and Subaé) it was observed similar distribution patterns of four mangrove species and these patterns were significantly related with interstitial water salinity for Jaguaripe and Paraguaçu estuaries. Considering live basal area, *Rhizophora mangle* and *Avicennia schaueriana* tended to dominate sites under greater marine influence, while *Avicennia germinans* and *Laguncularia racemosa* dominated areas under greater freshwater influence, although the latter showed a wider distribution over the estuarine gradients. Jaguaripe and Subaé showed higher structural variability than at Paraguaçu. Therefore, while it was observed some consistent patterns of mangrove tree species distributions, there were no structural gradients along the estuarine systems. These patterns of species distributions can be related to interspecific differences in salt tolerance and competitive abilities and they are likely to be found at other tropical Atlantic estuaries. It is suggested future studies to investigate possible relationships with others environmental variables, to elucidate anthropic influences and causal processes. Our results will assist in restoration programs.

Ecological traps for juvenile Caribbean Spiny Lobsters

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First described by ornithologists in the 1970's, "ecological traps" are now a well-known phenomenon in terrestrial and freshwater ecosystems but less so in the sea. The term refers to situations in which the evolved behavior of an animal that is normally advantageous becomes disadvantageous under different circumstances. Although many ecological traps are anthropogenic in origin, they need not be. Among social spiny lobsters, the chemical odors produced by conspecifics are an irresistible siren's call that draws individuals together to dwell in dens that protect them from predators. But in nursery areas, large dens occupied by large lobsters are a death trap - an ecological trap - for juvenile lobsters. Adult and subadult lobsters congregate in large dens, and their scent entices juvenile lobsters to join them from the surrounding nursery habitat. However, large fishes that are predators of juvenile lobsters are also attracted to those dens. Our field, mesocosm, and laboratory research demonstrates that small lobsters are absent near natural ecological traps because of increased mortality by piscine predators, which are chemically undetectable by juvenile lobsters. An anthropogenic-induced parallel to this natural ecological trap exists when artificial structures used by fishermen are deployed in nursery habitats.

Infection by the parasitic isopod, *Anilocra haemuli* on French grunt (*Haemulon flavolineatum*) is associated with changes in host movement patterns

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Risk of parasitism may be an important contributing cause or consequence of animal movement patterns. The diel movement patterns of French grunt, a common Caribbean coral reef fish, are well documented and known to connect reef and seagrass habitat. In the northeastern Caribbean, French grunt are known to be infected by *Anilocra haemuli*, one of the largest, most conspicuous ectoparasitic isopods. Studies on *Anilocra* infection have demonstrated that infection reduces host-swimming performance and may alter host behavior. We tested predictions of the hypothesis that *A. haemuli* infection influences the movement patterns of host French grunt, specifically whether short-distance daytime movements and/or reef-seagrass migration was associated with infection. We conducted focal observations on infected and uninfected fish during daytime resting and dusk migration periods. We also conducted daytime and nocturnal reef surveys, documenting changes in *A. haemuli* prevalence of infection. We found infected fish move significantly less than uninfected conspecifics during the day, and observed 100% of uninfected and 37.5% of infected fish departing the reef during dusk. Prevalence of infection was significantly greater at night compared to daytime. We suggest *A. haemuli* infection alters host movement patterns and parasitism may therefore indirectly influence trophic connectivity between reef and seagrass ecosystems.

Mechanistic underpinnings of prey consumption and size selection in a major echinoderm predator

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We used two laboratory experiments to test the effects of water temperature, starvation, and body size on mussel (*Mytilus edulis*) consumption and size selection in the common sea star, *Asterias rubens*. Consumption of medium (15-30 mm) mussels by small (9-15 cm) stars fed or starved moderately (for three weeks) during summer was not affected by temperature (8, 11, and 15°C), and was twice higher than in winter (2°C). Starvation did not affect consumption in both seasons. Mussel consumption was similar among small stars fed or starved moderately or severely (for six weeks). However, large (25-30 cm), moderately starved stars consumed respectively six times and twice more mussels than large, fed and severely starved stars, indicating that the need to feed after a moderate period of starvation was higher in large than small stars. Consumption of small (5-15 mm), medium, and large (30-45 mm) mussels was respectively affected by the star's size only, size and starvation independently, and size and starvation interactively. Collectively, our findings indicate that starvation, body size, and their interaction are key determinants of feeding in *A. rubens*.

Impacts of wintering Redhead Ducks on seagrasses of the Northern Gulf of Mexico

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While it has been well established that waterfowl can control the distribution and abundance of seagrasses in other regions, less is known about their effects in the northern Gulf of Mexico. This is likely because herbivorous waterfowl are only present during winter when typically less fieldwork has been done. We are evaluating the effects of waterfowl (specifically redhead duck (*Athya Americana*)) feeding on mixed shoalgrass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*) beds using caging experiments at several locations along the northern Gulf coast. Time-lapse photography is providing estimates of the abundance and feeding activities of the birds. Additionally, samples of seagrass biomass have been taken five times throughout the year: time zero (before waterfowl presence), one month post bird presence, following northward bird migration in the spring, during peak summer seagrass reproduction, and finally in early fall at peak seagrass biomass. Waterfowl gut contents are also being examined to determine the type and amount of seagrass consumed. Results show that ducks actively feed in the study areas and that seagrass biomass seems to be reduced in uncaged areas. Based on year one results, the experiment is being repeated and the focused on those locations showing the greatest grazing activities.

The influence of off-shore aquaculture on American lobster (*Homarus americanus*) movement

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Mussel aquaculture tends to aggregate lobsters due to the provision of physical structures (anchor blocks) and food resources (mussel fall-off and aggregation of benthic species). In this study, acoustic methods were used to determine the affinity of lobsters to an off-shore mussel culture site in Îles de la Madeleine, Canada. The tested hypothesis is that the movements and home ranges of lobsters are smaller under a mussel farm because of the proximity and abundance of shelter and prey. Lobster movements were followed within 3 arrays of 1 km^2, where each contains 10 fixed receivers. One of them was under the mussel farm and the other two experimental areas were adjacent to the farm site. Acoustic transmitters were attached to 15 lobsters found within the culture site and 15 lobsters found in each of 2 other areas outside the culture site and placed back to where they were captured. A further 15 lobsters were caught outside of the mussel farm, and placed within the farm site. After 2 months, the receivers were recovered and lobster movements were determined from recorded signals. Contrary to expected results, some results show that 85% of lobsters leave the mussel farm in less than a week.

Observations of Black Gill in White Shrimp (*Litopenaeus setiferus*) from South Carolina: Molting, Mortality, and Mobility

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Black gill disease (BGD), caused by an apostomate ciliate that induces inflammation, melanization, and necrosis of gill tissue, approaches nearly 100% prevalence in South Carolina's white shrimp, *Litopenaeus setiferus*, during summer and fall. While BGD does not impact shrimp taste, it is unsightly and fishermen claim that summer and fall catches are comprised mostly of dead BGD shrimp, which they cannot sell. How BGD directly impacts shrimp health and survival is poorly understood, but preliminary studies suggest it interferes with oxygen consumption. This has important economical and ecological implications, as BGD may impair normal physiological functions, which could contribute to higher predation rates and increased vulnerability to changing environmental conditions. Over four months in temperature controlled aquariums, we observed no mortality but an increase in molting frequency in BGD shrimp compared to control "clean" shrimp. In addition, BGD shrimp reached exhaustion more quickly (as early as 1 hour) and exhibited more exhaustive behaviors compared to control shrimp when exercised on a treadmill. Finally, whole body lactic acid concentrations were measured as an indicator of stress in both BGD and control exercised shrimp. These data will be used to discuss the ecological implications of BGD in white shrimp.

Costs of autotomy: major claw autotomy causes cessation of feeding and onset of the molting cascade in male fiddler crabs.

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The ability to voluntarily shed body parts (autotomy) is widespread across the animal kingdom and is generally used as a defensive mechanism when grasped by a predator. Autotomy can, however, impose significant costs. We examined the costs of major claw autotomy in male fiddler crabs *Uca pugilator*. Fiddler crabs are sexually dimorphic; females possess two small feeding claws, while males possess a single small feeding (minor) claw and one greatly enlarged (major) claw that is used for mate attraction, combat, and thermoregulation. Although the costs are expected to be high, major claw autotomy is common in nature. Male crabs that were induced to autotomize the major claw ceased feeding, and this effect continued for at least 96 h. Autotomy of a walking leg did not affect the feeding response. This response to major claw autotomy is hormonally driven, as female crabs also ceased feeding when injected with hemolymph of claw-autotomized males (but not when injected with hemolymph of leg-autotomized males). Autotomy of the major claw thus imposes a feeding cost on male fiddler crabs, likely due to initiation of the molting cascade, which is necessary for regeneration. This feeding cost may result in further effects on growth and reproductive success.

Interactive effects of body size and eelgrass structural complexity on fish habitat preference and predation risk

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Seagrass habitats form critical nurseries for many juvenile organisms, providing them with foraging opportunities and refuge as they grow and mature. Many juvenile fishes found in seagrass beds are considered mesopredators and their success at recruiting to adult habitats, as well as the value of seagrass as a nursery habitat, depend on both their foraging abilities and predation risk. As juvenile fishes grow from small newly settled recruits to larger juveniles, the effect of seagrass structural complexity on their interactions with the environment and in turn their habitat preferences, survival, and growth may change dramatically. We conducted (1) a lab experiment to determine whether eelgrass (*Zostera marina*) structural complexity preference differed among three size classes of juvenile giant kelpfish (*Heterostichus rostratus*), and (2) a field experiment to determine if the effects of eelgrass structural complexity on juvenile kelpfish survival varied with fish body size. We found clear shifts in habitat preference, with smaller fish preferring high structural complexity eelgrass and larger fish preferring low structural complexity eelgrass. Preliminary results from the predation risk experiment suggest that larger fishes experience lower predation risk, which may allow them to inhabit low structural complexity seagrass where foraging may be more efficient.

Impact of weather on the behavior of the gastropod *Littorina sp* in the intertidal.

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Physical environment affects the behavior of organisms living in the intertidal ecosystem. High relative humidity provides a microclimate that stimulates gastropods movement. However, during low tide meteorological conditions modify the evaporation rate. This study aims to analyze how the movement of the gastropod *Littorina sp*. changes according to the evaporation rate. Sun radiation and wind speed were manipulated by using screens in order to evaluate their effect on substrate desiccation and on snails behavior (measured by displacement speed). Data were obtained directly n the intertidal by using time-lapse photography, a weather station, and a portable anemometer. Results showed that meteorological conditions were effectively modified by our treatments, although there were no significant differences in either the evaporation rate, or the displacement speed. Nonetheless, relative humidity had a significant impact on both evaporation rate and displacement speed between days. In summary, this approach seems useful for studying the interaction of environmental conditions and intertidal gastropods behavior. Measures in the field must be companied of laboratory experiments in order to obtain more precise replicates.

Seagrass community and benthic macrofaunal structures in Bolinao, northwestern Philippines: implications for mariculture-induced pollution

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Excess development of fish mariculture enhanced nutrient and organic matter loading in coastal area of Bolinao, northwestern Philippines. We surveyed variation in seagrass species composition and associated benthic macrofaunal community along pollution gradient in 2010 and 2011. Seagrass species richness decreased from seven to two with the increasing pollution intensity. Macrofaunal species diversity also declined with more pollueted sites, while abundance increased towards polluted sites. Analyses on multivariate dispersion also showed decreasing species variability (beta diversity) towards polluted sites, implying a negative effect of organic pollution to species turnover. This study suggests that mariculture-induced pollution impacts seagrass and its associated benthic macrofaunal community structures in Bolinao. Our result will contribute to the conservation and management of seagrass ecosystem in this area.

The benefits of multiple moms: genetic diversity of seagrass seeds influences seedling morphology and biomass

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Genetic identity and diversity can have significant effects on plant morphology and productivity, with cascading effects on associated species. Seagrass systems provide some of the best evidence for the ecological effects of genetic diversity among mature shoots, yet we know relatively little about whether and how early the genetic diversity of seeds and seedlings influences seagrass ecology. We tested the effects of seagrass (*Zostera marina*) seed diversity on germination, seedling morphology, and seedling productivity by comparing experimental assemblages of seeds collected from single reproductive shoots ("monocultures") to assemblages of seeds collected from multiple reproductive shoots ("polycultures"). There was no difference in the proportion of seeds that germinated in monocultures and polycultures. However, seedlings from polycultures had larger shoots on average than seedlings from monocultures at the end of the one-year experiment. There were also diversity effects below ground: polyculture seedlings had longer roots and greater belowground biomass. Genetic relatedness of the reproductive shoots used to create each polyculture was not predictive of polyculture morphology or biomass. Our results suggest that effects of seagrass genetic diversity on morphology and productivity manifest themselves long before shoots are fully mature.

Leaving a legacy: the long-term effects of seagrass genetic diversity on productivity

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The effects of genotypic richness on population, community, and ecosystem processes have been demonstrated across a range of species and systems. However, the persistence of diversity effects and whether environmental conditions may moderate their duration merit further investigation. Genotypic richness may have "legacy" effects on ecological processes, persisting across seasons or generations, even as genetic diversity itself changes. To examine whether the effects of genotypic richness persist through time, we measured genetic diversity, productivity (shoot density and percent cover), shoot morphology, and above-/below-ground biomass of the seagrass *Zostera marina* in seven sites in Nantucket Harbor from 2013-2014. In fall 2013, there was a significant relationship between fall genotypic richness, productivity, and morphology. In spring 2014, spring genotypic richness was a strong predictor of morphology, but not of seagrass productivity. Instead, genotypic richness from the previous fall predicted spring productivity. Fall 2013 genotypic richness continued to explain variation in productivity in summer 2014, but there was also an effect of depth on shoot density and percent cover. Our results demonstrate that genetic diversity may have prolonged effects on community and ecosystem processes and that environmental conditions can influence the strength and direction of this legacy.

Identifying anthropogenic drivers of changes in local scale marine diversity

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Biodiversity is declining—globally. Locally, however, recent syntheses have revealed that, on average, species richness has not changed over time. The data is highly variable. This variability indicates that local scale drivers determine the magnitude and direction of species richness change. Human impacts affect local species richness, yet datasets recording species richness trajectories are often biased to include low or moderately impacted areas. To evaluate the effect of human impacts and climate on local marine diversity we performed a meta-analysis on a novel dataset collected from the literature, of species richness change over time in marine ecosystems. We tested the effects of local, direct events and two large-scale covariates: human cumulative impact values and climate velocity on local marine diversity. Our dataset contained 290 sites from 77 studies of which 95 sites come from studies where direct impacts (e.g., dredging) were explicitly identified by authors. Initial results suggest that changes in local diversity are context dependent and can be driven by the level of human impact, rate of climate change, and initial community properties. Our findings begin to explain the high variability that has been observed in species diversity at local scales and reframe previous findings in a human context.

Century-scale species incidence, rareness and turnover in a high diversity Northwest Atlantic coastal embayment

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The increased chance of extinction for rare species jeopardizes the resilience of high diversity coastal ecosystems where the uncommon often hold key roles which sustain ecosystem functioning. The deep (~2 centuries) zoological record of Cobscook Bay (44.91°N, −67.06°W), a biological hotspot in the Northwest Atlantic, provides the opportunity to assess species rareness and turnover in a high diversity coastal ecosystem. This well-studied macrotidal embayment in the lower Bay of Fundy has 874 macroinvertebrate species known from 3,767 records and an extrapolated maximum species richness of approximately 1,175 species. The chronology of its historical record of species incidence features some striking patterns. Approximately one-third of identified species have yet to be confirmed, with 88 last seen prior to 1900. Sampling effort, species ranges, endemicity and stochastic larval settlement do not adequately explain why so many species are rare. Instead, evidence of late 20th-century species turnover coincident with diversification and intensification of commercial fisheries suggests that local extinction is the primary cause for species rareness. In addition, present-day species assemblages have significantly altered taxonomic structure and trophic composition. The implications of rare species loss on the stability and function of this highly productive estuary illustrate the need for ecological conservation to protect the substantial contribution of Cobscook Bay to the biodiversity of the Gulf of Maine.

Novel commensal amphipod species discovered in endemic tunicate *Cnemidocarpa bicornuta* in New Zealand

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Description of novel species and their ecology is essential in monitoring changes in regional marine biodiversity. A new species of amphipod in the genus *Leucothoe* is reported from New Zealand. This commensal amphipod, collected from the New Zealand endemic tunicate *Cnemidocarpa bicornuta*, shares characteristics with other species in the genus, *L. nagatai, L. obuchii,* and *L. rudicula*. However, this species differs from all members of the genus in having an apically extended lobe on the inner margin of the outer plate of the maxilliped. Previous taxonomic surveys in New Zealand waters failed to document this species. Its absence from these prior studies indicates the species could be introduced. Images and illustrations have been produced by digital photography and Z-stacking photo algorithms and distribution and ecology of this interesting amphipod will be presented. These efforts illuminate the presence of a newly recorded commensal amphipod species in New Zealand waters and highlight the importance of biodiversity monitoring and taxonomic surveys.

Patterns of diversity across scales in epifaunal eelgrass communities

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Biodiversity varies across temporal and spatial scales; the scale at which diversity varies may indicate the nature of the processes that structure a community. However, the patterns and drivers of biodiversity across marine landscapes, and the scales at which they operate, are poorly understood. We tested the hypothesis that patterns in eelgrass-associated epifaunal biodiversity could be explained by abiotic variation, with the corollary that meadows with similar abiotic conditions would have similar biodiversity and composition. We sampled epifaunal invertebrate communities from eelgrass *Zostera marina* meadows in Barkley Sound in a hierarchical design to estimate plot- and meadow-scale biodiversity and test 1) how epifaunal communities vary within and among meadows, and 2) what factors drive community composition and diversity at the meadow scale. Our results show that epifaunal diversity and community composition are not clearly explained by temperature or salinity, leaving open the possibility that landscape-scale processes such as connectivity and metacommunity dynamics drive spatial and temporal patterns in biodiversity in seagrass landscapes. These findings suggest that seagrass conservation that considers meadows as networks of connected habitats could be effective for protecting seagrass-associated biodiversity.

Distant intertidal communities differing in species composition are more similar in trophic structure

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We used information on species richness, species diversity, functional groups, and trophic links to study community similarity in two contrasting intertidal environments from the same biogeographic region: the St. Lawrence Estuary (SL) and the Atlantic Nova Scotia coast (NS). Both environments exhibited a similar species pool, dominated by canopy-forming macroalgae (*Fucus* spp. and *Ascophyllum nodosum*). We measured species abundance in 30 cm x 30 cm quadrats and collected tissue samples for stable-isotope analyses. We contrasted with multivariate analyses the two communities using different data resolution: abundance structure in species (all species, canopy associated species, functional groups) and in trophic structure with stable-isotope signatures (for same species). Our results showed that both SL and NS communities had distinct species abundances, functional groups and isotopic signatures. Interestingly, average Bray-Curtis dissimilarities among communities from the two regions switched from 88 and 80 when structure in all species or associated species are considered respectively, to only 18 and 15 when functional groups and stable isotope data structure are used. This suggests that two communities sharing similar species pools would depicted stronger differences in species structure while more resemblance in their functional (guilds and trophics) characteristics.

Deep-water benthic megafauna in Baffin Bay (Canada) from ROV observations

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Surveys on the deep-water benthic diversity in the Canadian Arctic have mainly focused on soft bottom areas, with less effort toward hard bottom areas. In July 2014 we used a remotely operated vehicle (ROV) aboard the CCGS *Amundsen* to video-survey two mainly rocky locations in western Baffin Bay, Canada: Home Bay and Scott Inlet. Transects were 2.2 and 2.7 km long, targeting steeply sloping bottoms at depths ranging 700-750 m and 475-600 m for Home Bay and Scott Inlet, respectively. Both locations have diverse and abundant benthic megafauna with at least 50 and 44 taxa observed in video at Home Bay and Scott Inlet, respectively. Averaged density was 0.4 organisms/m^2 for Home Bay and 1.1 organisms/m^2 for Scott Inlet. In Home Bay sponges were the most abundant organisms, followed by sea anemones and echinoderms including the basket star *Gorgonocephalus* sp. (only seen at this location). In Scott Inlet sea anemones were the dominant megafauna. The carnivorous sponge *Chondrocladia* sp. was seen in both sites, and *Cladorhiza* sp. was only seen in Scott Inlet. The structure-forming biota observed did not have exposed calcium carbonate skeleton. These video observations will contribute to increase the knowledge on the benthic diversity in Baffin Bay.

Genetic diversity in eelgrass ecosystems: maintenance and functioning from local to global scales

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Genetic diversity in foundation species like seagrasses plays an important role in the functioning of many coastal ecosystems. Challenges remain in both developing a mechanistic understanding of these patterns, understanding the drivers of genetic diversity, and in assessing their relevance at global scales. In this talk, we synthesize results of small-scale mechanistic experiments with global scale surveys done by the Zostera Experimental Network. Our goal is to explore the processes that maintain genetic diversity in eelgrass (*Zostera marina*) as well as those that link genetic diversity to epifaunal communities and ecosystem functioning. In experimental field plots with high genotypic richness, increasing trait diversity led to greater plant biomass, presumably due to niche complementarity. Yet in pairwise trials, increasing trait differences among genotypes increased probability of competitive exclusion by one of the genotypes. The apparent contradiction between these findings suggests a role for non-additive or intransitive interactions in multigenotype stands or environmental heterogeneity. At larger scales increased genotype richness was strongly correlated with faunal abundance. Continuing analyses examine whether similar correlations hold for plant abundance and productivity across sites and the degree to which patterns of plant genetic structure and animal community structure are coincident.

Ultrastructure study of spicules in the nudibranch *Doriopsilla pharpa* (Marcus, 1961) and its sponge prey *Cliona celata* Grant 1826

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With the evolutionary loss of the shell in opisthobranch mollusks, many species have evolved alternative defense mechanisms to avoid predation. In this study we examined the presence of spicules in the nudibranch, *Doriopsilla pharpa* and its prey sponge, *Cliona celata* to determine 1) the location of spicules in the body, 2) the structure of spicules and 3) the similarity in spicule structure in the nudibranch and its prey. Spicules were isolated and examined using the compound microscope and scanning electron microscope (SEM). Five spicule types were documented in the dorsum, margin, foot, and rhinophores of *D. pharpa*. Four of these spicules types are unique to *D. pharpa.* One spicule type was isolated from both *C. celata* and the rhinophores of *D. pharpa*. Due to the location of these spicules on *D. pharpa* it is likely that *D. pharpa* may sequester them from their prey during feeding.

Impacts food availability on prey defenses in Eastern oysters Crassostrea virginica

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Many prey species must balance the benefits of defending against predators with the costs of producing these defenses. As predation risk increases, the benefit to organisms, in terms of increased survival, is assumed to outweigh the cost of sacrificing growth and fecundity. Such relationships have been demonstrated for many model systems under simplified laboratory conditions. However, predator prey interactions occur against a background of environmental conditions and the cost of defending is like to change as these conditions shift. Sacrificing opportunities for energy acquisition, for example, will become more costly as resources become scarce. Therefore, under these conditions, induced defenses to predation risk are expected to decrease. The role of inducible defenses under conditions of changing food availability were investigated using Eastern oysters *Crassostrea virginica* and the Atlantic mud crab *Panopeus herbstii* as a model system. Preliminary analysis suggests oysters produce defenses in response to predators but that defenses are weaker when food levels are low. These results highlight the importance of investigating inducible defenses under naturally relevant conditions to determine the importance of defensive responses and predatory interactions on community structure.

Positive feedback between consumptive and non-consumptive predator effects

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Chemical cues have ubiquitous effects on direct and indirect interactions in aquatic communities. Dietary metabolites from predators produce many behavioral or other changes in the focal prey that cascade to affect organisms interacting with these prey (i.e. non-consumptive effects or NCEs). Despite the obvious importance of chemical cues, we know almost nothing about the predator properties that control NCE strength. Using blue crab predators, their mud crab prey, and oysters that are basal resource for mud crabs, we show that increasing blue crab consumption of mud crabs increases strength of both focal NCEs and effects on the basal resource in the field. Blue crabs fed ad libidum mud crab diets produced cues that increase mud crab refuge use and decrease mud crab consumption of oysters to a greater extent than blue crabs fed a restrictive diet. Blue crabs fed ad lib diets were perceived over a greater distance. Thus, NCEs and CEs are positively coupled, and may fluctuate in synchrony in nature, with periods of strong effects being followed by weak ones. These dynamics are liable to have different consequences than sustained periods of moderate effects, given the non-linearity of many biological processes.

Nutrient enrichment increases the abundance of toxic cyanobacteria in a tropical seagrass bed

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Benthic filamentous cyanobacteria are becoming increasingly abundant in tropical and subtropical waters worldwide and may be expected to increase in abundance in response to climate change. Nuisance blooms of *Lyngbya*, *Symploca*, *Okeania* and other genera occur regularly throughout Florida and the Caribbean. Many of these cyanobacteria produce a diversity of bioactive secondary metabolites, some of which can be toxic or deter feeding by grazers. In an experimental study in seagrass beds in Key Largo, FL, we observed a clear increase in epiphyte abundance (biomass/shoot) under nutrient enrichment, along with a decline in seagrass shoot density. Abundance of mesograzers at the site was low and there appeared to be little top-down control of epiphyte abundance. Cyanobacteria, which were not detectable before the experiment began, were abundant at the site after nutrient enrichment. One common species was cytotoxic, which might limit the ability of consumers to control its abundance. The chemical basis of this toxicity is currently under investigation.

Mercury contamination in blue crabs from Rhode Island coastal waters

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The blue crab (*Callinectes sapidus*) has supported lucrative commercial and recreational fisheries in the middle- and southern Atlantic Coast and Gulf of Mexico. Blue crab populations have also recently increased in southern New England coastal waters, which will likely elevate their fishery status in this region. With an emerging Rhode Island (RI) crab fishery, research is needed to quantify possible contaminants in this species. In this study, blue crabs were collected from Narragansett Bay and associated coastal ponds and tidal rivers (Seekonk and Taunton Rivers). The claw muscle tissue of each crab was excised and analyzed for total Hg using automated atomic absorption spectroscopy. Bioaccumulation of Hg was evident in crabs from the Seekonk and Taunton Rivers, but not in conspecifics from the bay or ponds. Taunton River crabs also had a significantly higher mean Hg concentration relative to the other habitats (mean Hg: Taunton = 0.82 ppm dry wt; Other = 0.21 ppm dry wt). Spatial variations in crab Hg levels were attributed to habitat-specific Hg burdens in their prey, including shrimp, bivalves, and gastropods. Prey Hg concentrations were also significantly related to localized sediment Hg and methylmercury concentrations and grain size. With only 2.2% of legal-size blue crabs (> 127 mm CW) exceeding the U.S. Environmental Protection Agency action level, crabs from RI coastal waters present minimal risk to human consumers.

Effects of herbivory and habitat type on the recruitment and succession of epibenthos in the eastern Gulf of Mexico

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Marine epibenthic communities are shaped by a wide variety of pre- and post-recruitment processes. For example, the environmental cues that attract marine larvae (pre-recruitment) and the predation of juveniles (post-recruitment) may differ across season and habitat type. Determining the relative influence of these processes and whether they vary between natural and artificial reefs is important to our understanding of how different habitats function within an ecosystem. Using *in situ* surveys and settlement plates, this study aims to identify patterns in the recruitment and succession of the epibenthos in the eastern Gulf of Mexico (eGOM). While many studies have been conducted to examine these processes in temperate and tropical ecosystems, little is known about the factors that influence epibenthic development in subtropical communities, such as in the eGOM. Considering that the structure of the epibenthos can have a strong influence on the associated faunal communities, it is important to understand the potential that these processes have in affecting community development. By investigating how season, habitat type and herbivore communities influence epibenthic community composition, the results of this study will fill a critical gap in the knowledge of ecosystem dynamics in a region of economic and ecological importance.

Defense by association: sponge-eating fishes alter the small-scale distribution of Caribbean reef sponges

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Sponge-eating fishes have recently been shown to control Caribbean sponge community composition through predation. Palatable sponges—in contrast to those that use secondary chemistry to deter predation (i.e., defended sponges)—are typically grazed off the reef by spongivores, but can sometimes be found in close association to sea whips, fire-corals, stony corals, and defended sponges. In the absence of sponge predators we would not expect this pattern of association with refuge organisms because palatable sponges would be relieved of top-down control and allowed to persist wherever they settle. We conducted 30m belt transect surveys of sponge abundance in relation to refuge organisms on the overfished reefs in Bocas del Toro, Panama and reefs in the Florida Keys where spongivores are common. Palatable sponge species in Panama were randomly distributed and none exhibited a significant trend of association to refuge organisms. In Florida we found the opposite trend where the palatable sponges exhibited a significant trend of association with refuge organisms. While previous studies demonstrated that predation alters sponge community structure between sites across the Caribbean, these data show that predation alters the meter-scale pattern of sponge distribution on reefs where spongivores are present.

Variation in recruitment and the establishment of alternative community states

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We have hypothesized that mussel beds and fucoid stands are alternative states on intertidal shores in New England, and here we test if variation in recruitment drives their development. Ice scour opens patches for development of alternative states, and in 1996, experimental clearings were established to mimic ice scour. Half of the plots were re-cleared in 2010. Recruitment data for barnacles, mussels and fucoids collected from 1997 to 2012 were used to (1) estimate sources of variation, (2) test the prediction that the past does not predict the future, which would be expected for alternative states, and (3) fit data to a cusp catastrophe. Barnacles and mussel recruitment varied among years and sites, and showed consistent long-term patterns with respect to clearing size. Average recruitment prior to re-clearing predicted recruitment afterwards. In contrast, over 50% of the variance in fucoid recruitment was unexplained, and past fucoid recruitment was a poor predictor of future fucoid recruitment. The fitting of recruitment and abundance data to a cusp catastrophe revealed alternative states that were defined by fucoid recruitment. The unpredictability of fucoid recruitment suggests development of alternative states is highly dependent on starting conditions that vary on a very small scale.

Modular mobile foundation species as reservoirs of biodiversity

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As human impacts accelerate the loss of foundation species, we need to identify the general characteristics of previously unrecognized species that can fulfill the role of habitat provider. We conducted surveys and experiments to test whether the slate-pencil urchin (*Eucidaris galapagensis*) acts as a foundation species on subtidal walls in the Galapagos. The spines of slate-pencil urchins are > 90% encrusted with a diverse epifauna, and a single urchin can host over 20 species. Like many other foundation species, urchins can provide substrate and a predation refuge. Urchins are consistently abundant throughout the Galápagos, and the total surface area of urchin spines can rival that of the primary rock substrate. Our experimental manipulation of spine configuration and exclusion of predators revealed that urchins also enhance epifaunal diversity by providing a predation refuge. Unlike previously recognized foundation species, however, the urchin habitat is modular and mobile, and has the potential to redistribute associated epifauna. Characterizing how previously overlooked foundation species can act as reservoirs of biodiversity in ecosystems, such as the Galapagos where other foundation species such as coral have declined, has important implications for how we identify foundation species, predict ecosystem stability, and prioritize conservation efforts.

Turbidity flattens trophic pyramids through mesopredator release

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Biodiversity is often maintained by apex predators that alleviate consumption on lower trophic levels by controlling the abundance of intermediate or mesopredators. When top predators are removed, intermediate trophic levels proliferate. Known as mesopredator release, this phenomenon can decimate lower trophic levels and reduce biodiversity. In estuaries, fishes promote biodiversity by direct predation on crabs (i.e. mesopredators) and by releasing exudates that suppress crab foraging. Recently, we found that mesopredator release occurred by a previously unrecognized scenario. In estuaries, elevated turbidity attenuated predation by fishes that hunt using visual cues, causing fish abundance to decline while increasing the abundance of crabs that fish prey upon. Crabs locate prey by chemoreception and were unaffected by changes in turbidity. Increased crab abundance increased overall predation levels and significantly lowered biodiversity. Crab exudates are known to affect growth of bivalves and other organisms, and they were copious in higher turbidity. We found that eastern oysters *Crassostrea virginica* reacted to crab exudates by growing thicker shells at a cost of reduced growth and fecundity in turbid waters. Thus, turbidity significantly altered estuarine trophic interactions and biodiversity and indirectly altered the growth patterns of oysters, an important ecosystem engineer.

Relative Importance of Biotic and Abiotic Forces on the Composition and Dynamics of a Soft-Sediment Intertidal Community

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Using multivariate statistical analyses, we examined the association between biotic (top-down, bottom-up and middle-out) as well as abiotic factors to infaunal population and community dynamics on intertidal mudflats in the Bay of Fundy, Canada. A statistical relationship was observed between community and biotic plus abiotic factors; however, these factors accounted for a minority of the variation when compared to structural factors like site and plot. A similar trend was observed when taxa were analyzed individually. We posit that population and community dynamics are relatively uncoupled from biotic and abiotic factors in this system. This is likely a result of high concentrations of resources, as in resource-pulse ecosystems, sustaining high densities of infauna, as well as minimizing competition. We also observed variation in trends among taxa, as well as between taxa and the community. Similar taxa, performing similar ecological functions but which were associated with a different suite of factors suggests that potentially structuring forces may have to be identified for individual taxa. Community level analyses may also suffer from obscuration of trends/associations of relatively uncommon taxa by trends/associations of more abundant taxa. Whether or not this represents a serious limitation of multivariate analyses at the community level must be further evaluated.

Getting to the root of the problem: Black Mangrove expansion into Southeast Texas saltmarshes

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Climate change is enabling the redistribution of foundation species with potential consequences for ecologically and economically important ecosystem functions and organisms that are a part of these environments. One example of this distribution shift is evident in the black mangrove expansion into Gulf of Mexico saltmarshes. While the climate mechanism facilitating black mangrove expansion is understood, less is known about the consequences for replacing salt marsh habitat with black mangroves. Since salt marshes are essential habitats to many key species, such as blue crabs and Panaeid shrimp, understanding how vegetation shifts influence these species is of both economic and ecological importance. We sampled both benthic and nektonic species and found that salt marsh habitats contain a higher density of shrimp, polychaetes and tanaids when mangroves are not present. These changes could have far reaching effects on trophic interactions within the ecosystem. No significant salinity or temperature differences were found between sites, suggesting that vegetation differences underlie these patterns. Future experiments will determine how the difference in structural complexity between the two habitats influences marine food webs.

Is a warmer world a sicker world? Temperature effects on host-parasite dynamics

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Intertidal organisms experience harsh and variable conditions during air-exposure that influence species interactions, including host-parasite interactions. Climate induced increases in air temperatures may benefit parasites by weakening host immune responses or may benefit hosts by 'sweating' out parasite infections. In the Southeastern US, the Eastern oyster, *Crassostrea virginica*, inhabits intertidal mudflats and is plagued by the lethal parasite, *Perkinsus marinus*. As effects of intertidal air temperature on *C. virginica – P. marinus* dynamics have not been clearly identified in the field, the current study used laboratory experiments to determine differential temperature tolerances of host and parasite. Air-exposure was simulated in the lab using heat chambers from 27-53°C. Results show that oyster host survival declines sharply between 39-43°C, but that *P. marinus* infection severity decreases earlier at 35-39°C, though infections are still viable at these temperatures. Preliminary analyses also suggest that oyster immune response may decrease with increasing temperature, possibly leaving hosts more vulnerable to other parasites or physiological stress. Our results suggest that neither the host nor the parasite are likely to benefit from increases in temperature as conditions necessary for either to have a biologically significant advantage over the other occur at the limits of the species' biological capacities.

Top-down control of algal blooms in the Indian River Lagoon

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Harmful algal blooms have become increasingly more common in the Indian River Lagoon over the past few decades. These huge events have led to significant attention both from the general public and the academic world. Previous research has been concerned with the formation of these blooms but not on the community-level effects these blooms may have. In addition, little is known about how phytoplankton blooms may be controlled in natural communities. As part of the IRL Algal Bloom Investigation (IRLABI), epifaunal and infaunal community sampling is being undertaken quarterly across the northern Indian River Lagoon for the duration of the project. Using the first years survey data we have identified key filter feeding species within the community assemblages. These key species will be used in grazing experiments to determine how grazers function in bloom conditions and if they have the potential to control bloom forming species.

Effects of wave velocity and density on displacement and abrasion of rhodoliths (*Lithothamnion glaciale*) from Newfoundland

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Rhodoliths are non-geniculate, free-living nodules of red coralline algae that presumably depend on displacement and abrasion to maintain photosynthetic tissue, avoid burial, and remove biofouling. Knowledge about factors and processes that promote displacement and abrasion is limited to a few studies that suggest the hydrodynamic environment plays an important role in this respect. We carried out an experiment in an oscillatory wave tank to test the effects of wave velocity (0, 0.1, 0.2, 0.3 m s^{-1}) and rhodolith density (44 and 100 individuals m^{-2}) on displacement and abrasion of rhodoliths (*Lithothamnion glaciale*) from southeastern Newfoundland, Canada. Displacement increased with wave velocity evenly at both densities in a characteristic banding pattern. Abrasion increased linearly with wave velocity, being 140% higher at 0.3 than 0.1 m s^{-1}, regardless of density. Differences in the position of tagged rhodoliths and water flows at three depths (12, 16, and 20 m) within a large rhodolith bed confirmed the hypothesis that rhodolith displacement is respectively negatively and positively related to depth and water flow. Collectively, results provide the first quantitative demonstration that water motion is a key determinant of rhodolith displacement and abrasion that may lead to degradation of rhodolith beds under ongoing global shifts in sea state.

Changes in faunal community structure after heat induced die-offs in a Chesapeake Bay eelgrass bed (*Zostera marina* L.)

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Recent extreme temperature events have driven local die-off of the temperate eelgrass (*Zostera marina* L.) in the Chesapeake Bay, but to date, little is known about the consequences and recovery of associated epifaunal communities. We sampled community properties in a local eelgrass bed at Goodwin Islands, York River Estuary, Virginia, USA monthly for 15 years, capturing two die-off events in 2005 and 2010. Generally post die-off, we witnessed a decline in eelgrass biomass, an increase in epiphytic microalgae, and a significant decrease in both epifaunal biomass and diversity. However, the identity of the affected epifauna changed between die-offs, with the caprellid amphipod *Caprella penantis*, the isopod *Idotea balthica*, and the gastropod *Crepidula fornicata* exhibiting the strongest declines in 2005, and the gastropod *Bittiolum varium* actually increasing post-2010. An analysis of functional trait diversity revealed significant overlap among epifauna in their potential ecological roles, suggesting that high functional redundancy in this system buffers against long-term loss of ecosystem functioning after temperature-induced die-offs.

Plant species interactions at the landward ecotone of migrating salt marshes

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Sea level rise is pushing coastal wetlands inland and upslope, where they come into contact with upland plants. The upland marsh ecotone is a dynamic boundary that is vitally important in mitigating sea level rise-driven wetland losses occurring at the seaward margin and marsh interior. Ecological interactions at the upland marsh ecotone have been understudied due to a focus on interior marsh plant zonation. This study investigated the biotic and abiotic limits on marsh plants in transitioning conditions. In the greenhouse, I examined plant productivity when plants of four native marsh species were grown with two species found just upslope of migrating marshes in the Chesapeake Bay, native switchgrass *Panicum virgatum* and invasive *Phragmites australis*. To test the effect of light availability and salinity, two factors proposed to affect marsh plant success in the uplands, species pairs were subjected to three light levels and three salinity levels in a randomized block design, and harvested after four months. *Phragmites australis* showed a surprisingly strong negative response to direct competition with marsh species. Results from this experiment describe ecological interactions at the upland marsh ecotone and are used to develop management tools that can actively facilitate marsh migration into low-lying uplands.

Experimental predator removal causes rapid salt marsh die-off

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Salt marsh habitat loss to vegetation die-offs has accelerated throughout the western Atlantic in the last four decades. Recent studies have suggested that eutrophication, pollution and/or disease may contribute to the loss of marsh habitat. In light of recent evidence that predators are important determinants of marsh health in New England, we performed a total predator exclusion experiment. Here, we provide the first experimental evidence that predator depletion can cause salt marsh die-off by releasing the herbivorous crab *Sesarma reticulatum* from predator control.

Excluding predators from a marsh ecosystem for a single growing season resulted in a >100% increase in herbivory and a >150% increase in unvegetated bare space compared to plots with predators. Our results confirm that marshes in this region face multiple, potentially synergistic threats.

The plant – animal interactions your mamma warned you about: suspension-feeding bivalves effecting *Zostera marina* reproductive growth spurts

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The presence of suspension-feeding bivalves associated with seagrass beds are known to increase porewater nutrients, which can be used by seagrass to enhance vegetative leaf growth. To test for a morphological response of seagrass reproductive shoots to bivalve presence, five small patch replicates (<2.0 m^2) were selected within a developing *Zostera marina* meadow for each of six treatments including fertilizer addition, live hard clams, clam shell, clam shell and fertilizer, mussels, and ambient. Fertilizer stakes consisted of a nutrient N:P:K ratio of 15:3:3 and were placed in the sediment in the late fall 2013, early spring, and mid-summer. Live hard clams and shells were placed in the patches at four times the density of the fertilizer in late fall. Mussel spat naturally settled in the patches in spring 2013, grew to adult sizes and migrated to sediment by late fall that year. In June 2014, at three consecutive week time-points, ten flowers per patch were collected and morphometrics analysed as well as the stage of ovary development. Flower morphology influencing seed output was altered, indicating bivalves' natural presence in seagrass meadows could result in hot spots of reproductive success with important consequences for meadow development, maintenance and stability.

Hydrodynamic and thermal environments mediate foraging and kelp bed destruction by a dominant grazer in reef communities

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Recent field studies in eastern Canada suggest that wave action, but not sea temperature, mediates destruction of kelp beds by the green sea urchin, *Strongylocentrotus droebachiensis*. We carried out experiments in an oscillatory wave tank to study effects of wave velocity on urchin aggregation, microhabitat selection, and aggregative feeding on the kelp *Alaria esculenta*. We also tested the hypothesis that temperature modulates the strength of urchin-kelp interactions in habitats dominated by low hydrodynamic forces. Urchins in the tank formed larger, denser aggregations with increasing wave velocity from 0 m s^{-1} to 0.3 m s^{-1}. Twice more individuals moved from flat surfaces to crevices at 0.3 m s^{-1} (40%) than at 0 m s^{-1} (20%). Aggregative feeding was negatively related to velocity, being four times higher at 0 m s^{-1} than at 0.3 m s^{-1}. Observed and expected rates of kelp loss to grazing at the lower edge of a sheltered *A. esculenta* bed based on sea temperature and urchin density and size structure at the front were highly correlated (r^2=0.878). Collectively, results indicate that wave action is a key determinant of foraging in *S. droebachiensis* and that water temperature, and not only hydrodynamic forces, can predict kelp bed destruction by grazing fronts.

Threshold effects of habitat fragmentation per se on fish diversity at landscapes scales

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Habitat fragmentation involves habitat loss concomitant with changes in spatial configuration (habitat fragmentation per se), often confounding research into mechanistic effects of habitat disturbance on biodiversity. To isolate the separate or interactive effects of changes in habitat area and habitat fragmentation per se on biodiversity, we surveyed fish communities in seagrass landscapes in North Carolina of equal size (16,000 m^2) spanning a range of total seagrass habitat area (2-60% cover). Across this range, we sampled beds that were composed of one patch (contiguous) or many discrete patches (fragmented) of seagrass habitat. We found that fish species richness was lower and structure of the community shifted within fragmented beds with total cover of seagrass <25% relative to other landscape configurations, with the other landscapes being more similar in richness and community structure. This pattern was driven by an absence of cryptic species in fragmented, low-seagrass-cover beds, which were less likely to move between seagrass patches. Increasing patch isolation and decreasing patch sizes below this apparent cover threshold may underlie loss of vulnerable taxa. These results suggest that habitat fragmentation per se may have negative effects on biodiversity, especially in systems already experiencing relatively high levels of habitat loss.

Asymmetric, large-scale community responses to climate oscillations in Galapagos subtidal ecosystems

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Climate events such as El Niño Southern Oscillations (ENSOs) can drive ecosystems to a tipping point as thresholds are exceeded and a sudden transition to a different state (regime) occurs. We monitored benthic communities and oceanography in Galapagos rocky subtidal ecosystems at 12 sites for 13-16 years to test the hypothesis that ENSO's create non-linear effects leading to a regime change. Extensive bleaching of massive (*Porites, Pavona*) and branching (Pocilloporid) corals occurred during the La Niña phase of the 2006-2008 ENSO and again, during the 2010-2011 La Niña in response to unusually large temperature variability (30.0 -14.0^{o} C). Surprisingly, large increases in barnacle (*Megabalanus*) abundance coincided with coral bleaching during both La Niñas, suggesting higher barnacle recruitment during these productive periods. The asymmetric yin-yang of ENSO effects was apparent in the negative impacts on corals via bleaching but positive, bottom-up effects on benthic food webs dependent on the large barnacles. Barnacle abundance on rock walls has attained all time high abundance of 60-80 % cover at some sites in recent years concomitant with a greater proportion of corals overgrown by barnacles, suggesting a shift to a regime characterized by declining coral populations and increasing barnacles and their predators.

The influence of offshore mussel aquaculture on the diversity and spatial variation of epibenthic macrofaunal predators in îles de la Madeleine, eastern Canada.

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Mussel farming may influence the benthic environment by organic loading and the addition of physical structure within aquaculture leases. This study evaluates meso-scale (inside vs outside) and near-field (distance to *Mytilus edulis* longlines and anchor blocks) effects of an offshore mussel lease in îles de la Madeleine on benthic epifaunal predator communities and the seasonal variation in these communities. Benthic communities were evaluated by underwater visual counts using SCUBA. The mussel farm influenced benthic communities at all scales evaluated. Overall, predators, including crabs (*Cancer irroratus* and *Pagarus pubecsens*), starfish (*Asterias rubens*), moon snails (*Polinices heros*), and American lobsters (*Homarus americanus*) were more abundant inside the mussel lease than outside of it. No clear trend was observed for winter flounders (*Pseudopleuronectes americanus*). Spatial structure in the distribution of predators was evident within the aquaculture lease as most predators were more abundant close to and below mussel lines and anchor blocks. There was no spatial structure in non-farm sites. Temporal variation in community structure was evident, suggesting that the studied species undertake seasonal migrations within and around the mussel lease. Further investigation is needed to evaluate if mussel farms serve as ecological traps for the species that congregate within them.

Positive interactions expand habitat use and the realized niches of sympatric species

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Niche theory, the oldest, most established community assembly model, predicts that in sympatry, the realized niche will contract due to negative interspecific interactions, but fails to recognize the effects of positive interactions on community assembly. The stress gradient hypothesis predicts that positive interactions expand realized niches in stressful habitats. We tested the predictions of the stress gradient hypothesis in a cobble beach model system across both physical and biological stress gradients. We transplanted seven common littoral species within, adjacent to, and below cordgrass stands in control, cage control, caged, shaded, and shaded cage treatments to test the hypothesis that cordgrass expands intertidal organism habitats. On cobble beaches, cordgrass ameliorates physical and predation stresses, expanding the distribution and realized niches of species to habitats in which they cannot live without facilitation, suggesting that niche theory and species distribution models should be amended to accommodate the role of positive interactions in community assembly.

Parental effects enhance risk tolerance and performance in offspring

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Predation risk can strongly influence community dynamics by affecting whether prey forage in a risky habitat or remain in the safety of refuge. Although the within-generation effects of risk on prey performance are well appreciated, the effects of parental experience with risk on offspring decision-making and growth are poorly understood. The capacity of parents to prepare their offspring for potential risk exposure may be 1) adaptive when the likelihood of eventual risk exposure is high and 2) instrumental in shaping how offspring allocate their foraging effort and habitat use under risk. Using a simple rocky intertidal food chain, we examined the influence of parental exposure to predator risk cues on the behavior, foraging, and tissue maintenance of offspring exposed to the presence and absence of risk. We found that offspring of risk-experienced parents were bolder. When confronted with risk, these offspring spent more time out of refuge habitat, foraged more, and maintained more tissue than offspring of risk-free parents. Importantly, this effect only occurred when offspring were confronted with risk. These results suggest that parental experience with predation risk and its influence on offspring traits may represent an important pathway for the transmission of risk effects in ecological communities.

The cascading effect of sea anemones on epiphyte biomass in a eelgrass meadow

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The predator sea anemone *Anemonia sulcata* can be abundant on the leaves of the eelgrass Zostera marina. Yet, its ecological role is little studied. We found relatively large abundances of this species (mean±SE: 3.0±0.5 gDW^{-1} of Zostera leaves) in the eelgrass meadows of the Mediterranean lagoon of Thau, France. We, therefore, investigated whether sea anemones could affect epifauna grazers and show cascading effects on epiphyte biomass. As a preliminary approach, we run a mesocosm experiment with *A. sulcata*, the gastropod *Jujubinus striatus* and the amphipod *Gammarus* sp., combined in 8 different treatments with seagrass leaves. Preliminary results indicate an overwhelming negative effect of gastropods on epiphyte biomass, which is, however, mitigated by sea anemones. The results also indicate less epiphyte biomass when the three species are together than when anemones are removed. Anemones did not reduce gastropod abundance or biomass, while they clearly affected amphipod survival. Possible explanations, such as changes of animal feeding behavior are discussed to explain this complex patterns of response.

Byssogenesis and movement in two size classes of the blue mussel, *Mytilus edulis*, in response to herbivorous and predatory gastropods

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Blue mussels (*Mytilus edulis*) can alter the characteristics of their byssal thread attachment in response to predator presence, with the ability to attach threads to the shells of predatory and even herbivorous gastropods to immobilize them. In laboratory studies, we quantified byssal thread production, attachment strength, and movement in two size classes of blue mussels upon exposure to the dogwhelk, *Nucella lapillus*, and the periwinkle, *Littorina littorea*. After 24h, small mussels formed and released more byssus bundles compared to large mussels, which indicates increased movement. Mussels exhibited the highest degree of movement upon exposure to dogwhelks, followed by periwinkles, and the least movement under the control treatment. Mussels exposed to dogwhelks deposited and released a higher number of byssal threads directly to the snail shell compared to those in contact with periwinkles, however snail type did not influence mussel attachment strength overall. Our results suggest that while mussels can attach byssal threads directly to snails of different feeding habits, the amount of movement and number of threads produced is related to the magnitude of the predatory threat, while the quality of individual threads does not change.

The importance of dispersion and habitat heterogeneity in structuring soft-bottom communities

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Modern metacommunity framework points dispersion and habitat heterogeneity as key factors structuring natural communities. To investigated how spatial patterns of coastal soft bottom communities relate with dispersion and habitat heterogeneity we sampled meiofauna communities and sedimentary parameters from three coastal habitats with different degrees of exposure to hydrodynamics (mangrove, estuarine sand-bank and sandy-beach) in three spatial scales (hundreds of kilometers, hundreds of meters and tens of meters). We hypothesized that community composition from exposed habitats would be more homogeneous due to higher habitat homogenization and/or species dispersion through the water column, whereas communities from more protected habitats would be more dissimilar since species are dispersion limited and the habitat highly heterogeneous. Results showed that communities from protected habitats were more variable at all scales compared to those from the more exposed sandy beach. Besides, we found lower local diversity relative to the total species pool and higher turnover of species in the protected habitats indicating dispersion limitation. Variance-partitioning analysis showed that although the variability in species composition were mostly explained by the environmental variables for all habitats, the spatial distance (dispersion) also significantly explained the variability of sand bank and mangrove but not sandy beach communities.

Foraging ecology of blue crabs (*Callinectes sapidus*) and their potential impact on local benthic communities

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The blue crab, *Callinectes sapidus*, is a temperate species that is expanding its geographic range northward, thus possibly altering benthic community structure in Southern New England coastal habitats. This study examined the potential impact of blue crabs on local fauna by analyzing blue crab diet and overall abundance and size structure. Potential predation of blue crabs on winter flounder (*Pseudopleuronectes americanus*) was of particular interest due to locally declining populations of this species. The Rhode Island Department of Environmental Management and Roger Williams University seine surveys recorded spatial and temporal dynamics in blue crab abundance and size frequency in Narragansett Bay and its tidal rivers and coastal ponds. Stomach contents were extracted, visually analyzed, and prey were identified to lowest practical taxa with aid of stereomicroscopes. Prey importance was quantified by volumetric contribution to total stomach contents. Primary prey items in all three habitats were crustaceans, crabs, and bivalves. Size frequency was consistent across habitats. Crabs were much more abundant in the tidal rivers than the other two habitats. Future research will further examine the foraging ecology of blue crabs via genetic analysis of stomach contents and analysis of stable Carbon and Nitrogen isotopes in crab muscle tissues.

How a recreational marina affects larval recruitment and the effects of predation on benthic communities?

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Marine facilities in coastal waters promote several physical and chemical disturbances, such as increased turbidity and reduced turbulence. To understand how those disturbances affect sessile organisms we tested how the locality where the community occurs (inside a recreational marina vs. on the marina breakwater) affects larval settlement and community development. Since those disturbances can also affect the abundance and identity of predators, causing indirect effects on communities of sessile organisms, we conducted an orthogonal experiment where 12 settlement plates were disposed in each one of the localities, half of them protected against predators. Recruitment, composition and abundance were assessed after 15, 30 and 90 days. Recruitment of long-lived larvae, such as barnacles, was more intense on the breakwater than inside the marina, where settlers of bryozoans were more abundant. However, initial recruitment was unimportant for the community structure after 3 months. In both areas, the bryozoan *S. errata* dominated communities exposed to predators, while ascidians dominated protected communities: *D. perlucidum* in the breakwater and *Clavelina oblonga* and *Herdmania pallida* inside the marina. Our results suggest that the construction of coastal facilities changes larval supply affecting the organization of benthic communities, mainly under no effect of predation.

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The effects of the DWH oil spill on the distribution of crab megalopae, mussels, and snails within Terrebonne Bay, LA four years after the spill

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The impacts of the Deepwater Horizon oil spill on the distribution of marsh organisms after the spill is relatively unknown. These data are part of a field study examining the distribution of crab megalopae, mussels (*Geukensia demissa*), and snails (*Littorina irrorata*) in Terrebonne Bay, Louisiana after the DWH Oil Spill. Crab megalopae were collected at six marsh sites over a one-week period in August 2013 and August 2014. Mussels and snails were collected along 10 m transects at four marsh sites in April 2013, October 2013, and October 2014. Sediment samples were collected at each site and tested for aromatic and alkane hydrocarbons. Preliminary analysis suggests that the distribution of these organisms is not affected by the oil spill three to four years later. Other variables such as hydrodynamics, sediment properties, and vegetation cover may have a greater influence on the distribution of these organisms after the spill. Future research will examine the oil's sublethal effect on megalopal crab settlement behavior as well as hydrocarbon accumulation within mussel and snail shells.

Using field data to identify various seagrass community changes across three years in the Laguna Madre, Texas, USA

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The Laguna Madre is an expansive, hypersaline estuary spanning the southern half of the Texas coast that is home to the majority of the state's seagrasses. The seagrass beds in the Laguna have a dynamic history, characterized by large changes in species composition and percent cover, many of which can be attributed to shifting salinity regimes. In the summer of 2011, researchers at the University of Texas Marine Science Institute began a statewide seagrass monitoring program. Seagrass percent cover data from 2011-2013 show strong spatial and temporal patterns and changes. In Upper Laguna Madre, there was a dramatic decline of *Syringodium filiforme* cover due to high (>50) salinities, coupled with a steady increase in *Halodule wrightii* cover. In Lower Laguna Madre, coverage of *H. wrightii* also increased, but *Thalassia testudinum* and *S. filiforme* showed differential changes in percent cover based upon location. These data indicate that changes in the seagrass communities of the Laguna Madre occur across small temporal and spatial scales, and will serve as a valuable baseline for future studies in the region. This is the first study in Texas to analyze trends in seagrass coverage along the whole coast using data from an annual field-based monitoring program.

Do eelgrass edges elevate prey mortality? A global test

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Ecological processes often vary with proximity to patch edges. Edges are prominent features of many seagrass habitats and may strongly influence predator-prey encounter rates, but the magnitude of "edge effects" may be dictated by seagrass structural complexity. As part of the *Zostera* Experimental Network (*ZEN*, www.zenscience.org), we conducted a global test of whether proximity to eelgrass patch edges affects predator-induced mortality risk for epifauna, and whether any such edge effects depend on structural complexity. Working at 11 sites on three continents, we exposed mesograzers to predators by tethering them in small plots of artificial seagrass (at two levels of shoot density) placed at patch edges and in patch interiors. We also compared the mortality risk for mesograzers tethered in seagrass compared to those tethered in adjacent, unvegetated sediment. Proximity to edges and the presence of eelgrass affected mortality risk at most sites; however, the odds of mortality were elevated along edges (and outside of seagrass) at some sites, whereas the converse was true at others. Though artificial shoot density had minor effects on mortality risk, it affected the strength of edge effects in some instances. Mortality risk decreased slightly with latitude, but increased strongly with structural complexity of surrounding eelgrass.

Investigating a potential mutualism between *Solemya velum* and *Zostera marina* mediated by symbiotic sulfide-oxidizing bacteria

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Sulfide accumulation in sediment porewater can hinder the growth and survival of eelgrass (*Zostera marina*). We hypothesized that a facultative mutualism between eelgrass and a solemyid clam (*Solemya velum*), which derives sustenance from symbiotic sulfide-oxidizing bacteria in its gills, would benefit eelgrass through a reduction in sediment sulfide concentrations and *Solemya* through increased nutrition. In two pilot outdoor mesocosm studies, we measured porewater sulfide concentrations, eelgrass photosynthetic efficiency, eelgrass growth, and *Solemya* condition across four treatments: control, eelgrass only, *Solemya* only, and eelgrass +*Solemya*. Preliminary analyses suggest that sulfide porewater concentrations were significantly reduced and eelgrass was less photosynthetically stressed when *Solemya* was present. However, our data also suggest greater aboveground eelgrass productivity in the summer trial in treatments with *Solemya* but lesser productivity in the fall trial under the same conditions. Furthermore, eelgrass appeared to negatively affect *Solemya* condition. We tentatively conclude that this association benefits primarily eelgrass and that in the fall trial, reduced sediment sulfide concentrations in treatments with *Solemya* allowed eelgrass to devote more resources to belowground biomass in preparation for overwintering.

Structural differences in the microbial symbiont community of a marine sponge from intertidal and subtidal habitats

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Sponges host diverse and complex communities of microbial symbionts that display a high degree of host specificity. Some host sponges maintain a stable microbiome across distant locations; however, few studies have examined the effects of localized environmental variation and none have examined the effect of tidal exposure on sponge microbial symbiont assemblages. We characterized the microbial communities in subtidal and intertidal individuals of the sponge *Hymeniacidon heliophila*, ambient seawater, and sediment from a North Carolina oyster reef habitat using partial (Illumina sequencing) and near full-length (clone libraries) 16S rRNA gene sequences. Sediment and seawater samples yielded clearly distinct microbial communities from those found in *H. heliophila*. Despite the close proximity of the sampled sponges, next-generation sequencing revealed significantly higher taxonomic richness and diversity in the microbial community of subtidal sponges. Significant differences in microbial community structure were also observed between subtidal and intertidal sponges, driven by changes in the relative abundance of the more common symbiont taxa, including a nitrate-reducing alphaproteobacterium, as well as the presence or absence of rare species. These findings suggest that periodic exposure to air in intertidal habitats affects the structure of sponge-associated microbial communities and may beget functional changes such as nitrogen cycling.

The sensitivity of an inducible seaweed defense varies with biogeography

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Within-species variation in defense mechanisms has important implications for population and community regulation. Although the incidence of herbivore-induced defenses is well documented, we have limited knowledge of the factors that affect the strength of herbivore-induced responses within and among populations. To address this, we exposed Northern and Southern California populations of the seaweed *Silvetia compressa* to five different densities of the snail *Tegula funebralis*, under ambient environmental conditions for each region. We found that while southern seaweed palatability only decreased with high grazing pressure, all levels of herbivory induced defenses in northern seaweeds. Constitutive defenses of the seaweeds did not explain these patterns, as *Silvetia* from the south was more palatable to snails than *Silvetia* from the north. To better understand why seaweed responses differed at low levels of grazing, we conducted additional experiments under common garden conditions, manipulating environment and herbivore source. Results were consistent with initial experiments, however, eliminating these factors as driving geographic differences in defense sensitivity. Instead, this variation in induction strength may be due to long-term abiotic and/or biotic differences in environmental history between populations, including temperature stress and nutrient limitation in the south and higher grazing pressure in the north.

Response of the sponge microbiome to nutrient additions

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Marine sponges are known to host large and diverse microbial communities, with the composition of these communities remaining fairly stable across large spatial and temporal scales. Sponges inhabiting the coast of Oregon, USA host bacteria capable of numerous nitrogen transformations, so it is hypothesized that the bacterial community would change as ambient nutrient conditions change. To test this hypothesis, we placed nutrient addition devices (NAD) at Netarts Bay, Oregon for six weeks to increase the nutrient load. We assessed bacterial abundance and diversity within individuals of *Haliclona* sp. A, the dominant sponge at the site, using scanning electron microscopy (SEM), denaturant gradient gel electrophoresis (DGGE), and microbiome analysis using illumina sequencing. We also collected ambient and exhalent water samples to assess the nutrient fluxes through the sponge. SEM results suggest that treated individuals had significant declines in their bacterial loads. DGGE and microbiome analysis confirm these decreases in bacterial load and show decreases in bacterial diversity. In addition, we found significant changes in nitrate and total nitrogen fluxes between control and NAD treated sponges, suggesting that bacterially-mediated nitrogen cycling was significantly modified by the nutrient addition. Thus, increased nutrient loads appear to detrimentally affect sponges and their associated microbial communities.

Spartina alterniflora genetic identity affects plant-plant and plant-animal interactions in an experimental marsh community

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Both intraspecific genetic variation and the biotic environment (i.e. competitors and herbivores) can shape plant phenotypes, though few studies have explored their interaction. Saltmarsh communities are an ideal system to study these questions, as they are dominated by a foundation plant, *Spartina alterniflora*, with high levels of genetic diversity and considerable morphological variation among genets. Furthermore, consumer pressure and plant-plant interactions influence both plant zonation patterns and *Spartina* productivity, but how genetic variation and associated phenotypic traits alter these interactions remains unclear. We conducted a one-year field experiment in St. Joseph Bay, FL to examine the role of genetic variation in plant-plant and plant-animal interactions by manipulating *Spartina* genetic identity, plant neighbor (*Juncus roemerianus*) presence, and consumer (*Littoraria irrorata*) pressure. Over the course of the experiment, *Spartina* genetic identity, consumer pressure, and neighbor presence each independently affected *Spartina* performance, and the relative strength of these relationships changed over time. When we focused on individual time points, interactions between *Spartina* genetic identity and neighbor presence or consumer pressure emerged, but they were typically driven by a small subset of genotypes. Taken together, our results suggest that trade-offs among morphological traits can explain the response of *Spartina* genotypes to their biotic environment.

Geographic variation in the effects of algal canopy on understory species interactions

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The canopy-forming macroalgae, *Ascophyllum nodosum*, is a key foundation species on rocky shores in the Gulf of Maine (GOM). To examine the effects of algal canopy on understory species interactions across a broad geographic range we conducted a study at sites in the northern and southern GOM separated by ~350 km. At each site we established plots with *Ascophyllum* either intact or removed and measured the survival and feeding rate of the predatory snail, *Nucella lapillus*, during both the summer and fall. In the southern GOM, algal canopy had a positive effect on *Nucella* feeding during the summer by reducing thermal stress but had no effect during the fall. In the northern GOM, algal canopy had a positive effect on *Nucella* feeding during both the summer and fall and limited the growth of ephemeral green algae by reducing the penetration of light to the substrate. An additional experiment that included an ephemeral algae removal treatment confirmed that the abundant growth of ephemerals typical of canopy removal plots in the northern GOM reduces *Nucella* feeding. These results indicate that algal canopy affects understory species interactions through different mechanisms in the northern and southern GOM, with potentially important implications for community assembly.

Bacterial populations in the sea anemone *Aiptasia pallida.*

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Corals and sea anemones host bacterial populations that can provide a variety of benefits to the hosts, including nutrition and protection from host pathogens. In this study, we identified bacteria resident in cultured specimens of the sea anemone *Aiptasia pallida.* DNA harvested from bacteria cultured on marine agar as well as from intact sea anemone tissue was amplified using the 16S rDNA primers 16F and 1542R. Sequence analysis allowed us to identify a variety of bacterial populations, several with possible metabolic or defensive roles in sea anemone biology. We are continuing to explore the functional roles of these bacteria.

Structural complexity and location affect habitat value of restored oyster reefs: implications for restoration

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Oyster reefs provide a suite of invaluable ecosystem services, such as water filtration, sequestration of carbon, de-nitrification, and provision of habitat and foraging grounds for benthic organisms. In the Chesapeake Bay, < 1% of the historic oyster population remains, which has had both negative economic and ecological impacts. In response, efforts to restore oysters and the services they provide have increased. Building reefs that successfully provide ecosystem services, such as benthic habitat, may require different techniques than those used previously. Success of these efforts may depend on reef morphology, location, and environmental conditions. In a field survey, benthic settling trays were embedded into previously restored reefs of varying degrees of structural complexity in two rivers in the Chesapeake Bay. Trays were collected after 6 weeks, sorted, and species identified and biomassed to obtain species diversity, abundance and biomass. We hypothesize that all three measures will increase with increasing structural complexity (rugosity) and oyster volume, and that species diversity will be greater on higher salinity reefs. Therefore, more complex reefs will provide higher quality habitat supporting more prey resources for foraging predators. These results will have important implications for oyster reef restoration management and design.

Temporal trajectories of benthic communities following multiple disturbances

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Many ecosystems are facing environmental changes and anthropogenic pressures that may affect communities on both structure and/or functions. Understanding their response facing multiple disturbances is necessary for the evaluation of their resilience. The resilience of a rocky intertidal subarctic community dominated by a macroalgae canopy (*Fucus* spp.) was followed in structure and functions during 14 months using an orthogonal factorial experiment where one pulse- and three press-disturbances were applied (in 0.25 m^2 plots): removal of all material to bare rock and burning (pulse, before starting experiment), enrichment (slow nutrient diffusion), grazer reduction and canopy removal. Main and interactive effects of the three disturbances were evaluated for species structure (% cover and biomass) and in productivity. Resilience of the control plots was completed after 12 months (no significant differences with references plots). The canopy removal induced strong changes on structure and function with noticeable change in dominance among grazers; it brought less invertebrates and more ephemeral algae to the plots. The inclusion of multiple disturbances in field experiments will help gaining better understanding of mechanisms that shape community structure and their function following disturbances.

Does settlement plate material matter? The influence of substrate type on fouling community development

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Benthic community composition and ascidian abundance can differ dramatically between adjacent man-made and natural substrates. Although multiple factors, including light exposure, surface orientation, predation exposure, and habitat type, are known to contribute to these patterns, few studies have directly tested the influence of substrate identity on community development. We compared fouling communities on settlement plates composed of commonly occurring natural (granite) and artificial (concrete, high density polyethylene, and PVC) marine materials deployed from late May to mid November 2014 from a floating dock in Newcastle, NH. We sought to determine if observed patterns resulted from differential recruitment onto substrate materials or post-settlement survival and growth. To do this, half of the plates were cleaned during bi-weekly examinations, and half were left un-cleaned. Preliminary analyses indicate that community composition on concrete plates differs from that on all other substrate materials. These results will help us to understand how substrate features contribute to non-native species establishment and habitat dominance, and may inform decisions regarding material usage in marine construction. These findings also underline the importance of settlement substrate choice in scientific studies, as plate material may influence experimental conclusions.

Herbivore impacts on marsh production depend upon a compensatory continuum mediated by salinity stress

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The consequences of stressors on plant communities depend upon the ability of plants to respond to herbivores. Previous studies found that herbivore impacts on plants can vary from negative to positive because of environmental control of plant compensatory responses, a.k.a. the Compensatory Continuum Hypothesis. However, these influential studies largely focused on the impact of resource limitation. This bias limits our ability to predict the role of other environmental factors. We examined the effect of salinity stress on interactions between cordgrass and an abundant scale insect. In mesocosms, the impact of scales on plants switched from positive to neutral with increasing salinity stress because plants no longer overcompensated for herbivory. In field studies of intermediate salinities, scales reduced cordgrass growth and increased senescence. Salt additions at this site returned the impact of scales to neutral. Because salinity decreased scale densities, the switch in impact of scales on cordgrass with increasing salinity was not simply a linear function of scale abundance. Thus, herbivore effects depended strongly upon environmental context because intermediate salinity stress prevented plant compensatory responses. Understanding this context-dependency will be required if we are going to successfully predict the success of restoration efforts and the ecological consequences of anthropogenic disturbances.

Fiddler crab morphology, behavior and phylogenetic relatedness drive bacterial community assembly.

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Animal hosts harbor diverse communities of microorganisms. Similarities in bacterial community composition are often attributed to evolutionary mechanisms driving physiological, immunological, behavioral and ecological aspects of the host species. However, variations in host's intraspecific traits are common among conspecifics and the resulting influence on associated bacterial communities is unclear. This study shows that fiddler crab-associated bacterial communities are influenced by the host's phylogenetic kinship and individual host's physiological, morphological and behavioral traits. The fiddler crab species *Uca panacea* and *U. rapax* live in marine marshes where they feed on detritus and marine bacteria from the sediment. These two species share the same habitat, yet have marked sexual differences in morphology and behavior. Bacterial communities associate with different crab tissues and may be influenced by distinct constraints dependent on the tissue's function. We determined the influence of phylogenetic kinship and sex on bacterial communities associated with the gut and carapace of fiddler crabs. Results suggest that phylogenetic relatedness interacts with sex-specific traits in driving bacterial communities associated with fiddler crabs. Additionally, we found differences in how bacterial communities associated with each tissue responds to host's traits and relatedness. The prevalence of these differences implies that intraspecific trait variability and phylogenetic kinship may play an important role in host-microbial community interactions.

Specificity and sensitivity of a PCR-based approach for detecting winter flounder in blue crab stomachs

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Increasing water temperatures in the Northwest Atlantic have resulted in blue crabs (*Callinectes sapidus*) extending their geographic range northward to Southern New England coastal habitats, including the Narragansett Bay Estuary (RI, USA). The increased abundance of blue crabs may adversely affect juvenile winter flounder (*Pseudopleuronectes americanus*) populations via trophic interactions. This study used Polymerase Chain Reaction (PCR)-based methods to detect blue crab predation on juvenile winter flounder. To evaluate the sensitivity and specificity of the approach, a winter flounder-specific (WF208) primer set was tested against winter flounder, blue crab, and alternative prey items. The effect of digestion time on detecting flounder DNA in crab stomachs was determined through laboratory feeding experiments (0-10 hr post-feeding). DNA extractions of tissue and gut contents were carried out using a Qiagen DNeasy Blood and Tissue Kit and the 208 base-pair primer set. WF208 primers successfully and exclusively amplified winter flounder tissue (high sensitivity and specificity). The DNA concentration and quality of digested flounder tissue consistently declined as digestion time increased. PCR results were more variable with flounder DNA being positively detected in 50-100% of crab stomachs examined post-feeding. In the future, this protocol will be tested with field collected blue crab stomach samples.

Measuring non-additive selection from multiple species interactions

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In natural communities, species interact with many others, causing indirect ecological effects that have important fitness consequences. Given that indirect ecological effects are common in nature, the non-additive selection they impose may also be common, and thus critical for predicting evolution in natural multispecies communities. Here I develop a method for testing for non-additive selection and consider how it affects adaptation in multispecies communities. The simulation model used to validate the null hypothesis indicates that fitness must be standardized across, rather than within, experimental treatments. I also quantified the strength of non-additive selection in two case studies. In one case, insect herbivores and an invasive plant imposed strong non-additive selection on herbivore resistance in a native plant. In a second case, three pollinators imposed strong non-additive selection on anther exsertion in wild radish. These results suggest that non-additive selection may be common in nature, and may be as important as pairwise selection in predicting evolution in natural communities. I call for further studies using this methodology to determine how common non-additive selection is and under what conditions it is most likely to occur.

Impact of invasive crabs on juvenile lobsters (*Homarus americanus*)

Impacts of major storm events on gelatinous zooplankton and planktonic community structure in Barnegat Bay, NJ

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Gelatinous zooplankton are experiencing distributional and abundance shifts on local scales resulting from anthropogenic forces such as eutrophication and land use alteration. These may have direct and indirect impacts on planktonic community structure that may result in strong top-down control by gelatinous species. In Barnegat Bay, NJ, the scyphozoan *Chrysaora quinquecirrha* and the ctenophore *Mnemiopsis leidyi* are the most abundant forms of gelatinous zooplankton and play important roles in planktonic food webs. Data collected in 2012 indicated significant inverse spatial and temporal distribution of these species, suggesting the exertion of top-down pressure of *C. quinquecirrha* on *M. leidyi*. However, storm events may also restructure communities in unplanned ways. Hurricane Sandy made landfall in New Jersey on October 29th, 2012. After Sandy, the relative distributions of these two species were similar, but muted. Additionally, different species of gelatinous zooplankton were observed. In 2014, this pattern repeated with even further decrease in *C. quinquecirrha* and *M. leidyi* and regular occurrence of more coastal ocean species.

Tale of two rockweeds: different successional stages or different alternative states?

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Two species of rockweeds, by *Ascophyllum nodosum* or *Fucus vesiculosus*, dominate the mid-intertidal zone of sheltered rocky shores of the Northwest Atlantic Ocean. The occurrence of *Fucus spp*. on sheltered shores is thought to be a successional stage leading to an endpoint of *Ascophyllum* either by facilitation or tolerance, but the mechanism of succession has never been tested explicitly. We designed an experiment to test whether recruitment of *A. nodosum* is facilitated or inhibited by, or tolerant of, the prior establishment of *F. vesiculosus*. Tiles were set out on the shore in September 2011 to be colonized by *F. vesiculosus* at a time when *A. nodosum* does not recruit. In the following spring, tiles with and without *F. vesiculosus* (1-4 cm in length) were seeded with experimentally generated zygotes of *A. nodosum*. Tiles were immediately censused, placed in cages and returned to a sheltered mid-intertidal zone habitat. Tiles were then censused at 4, 12 and 15 months. *Fucus* inhibited *Ascophyllum* recruitment, survivorship and growth. The almost complete inhibition of *A. nodosum* by *Fucus* suggests *Fucus* is not an intermediate successional stage, but may represent a third alternative state in sheltered bay ecosystems of the Northwest Atlantic.

The relationship between near-shore hard-bottom exposure and benthic community composition and distribution in Palm Beach County, FL

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Shifting sediments and sedimentation on near-shore hard-bottom habitats can significantly impact the health and recruitment of corals and other sessile organisms. These frequently bury and expose near-shore hard-bottom in Palm Beach, Florida. Monitoring frequent sediment movement in large areas is economically and logistically challenging. In this study we used periodic near-shore hard-bottom habitat delineations derived from remotely sensed digital photography from 2010-2014 to determine temporal differences. Areas that appeared in the map frequently were considered high exposure and vice versa. *In situ* survey locations were randomized proportionally across three exposure categories (>60%, 40-60%, <40%) and three depth categories (<4m, 4-8m, >8m) to estimate several population metrics (percent cover, density by size class) and community composition (macroalgae, corals, gorgonians, hydroids). Seven coral species were found and small (<5 cm) *Siderastrea spp* comprised 81% of the corals. Higher coral and gorgonian density, coral richness, and macroaglae and hydroid cover were found at higher exposed sites. Depth didn't appear to contribute to community differences yet deeper sites generally had higher exposure. Shallow, high exposure sites lacked larger, more established communities, presumably due to the higher energy environment. The relationships found suggest that this methodology can be useful in monitoring long-term effects of sedimentation.

Exploring if habitat complexity influences bay scallop population dynamics in Nantucket Harbor

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An understanding of how habitat complexity influences survivorship of a species is profoundly important to understanding the dynamics of any ecosystem. Despite the existence of a large body of literature on the effects of eelgrass (*Zostera marina*) habitat complexity on bivalve population dynamics along the coast of southeastern U.S., there is a dearth of field studies investigating the role that eelgrass shoot density and blade length have on of the northern bay scallop (*Argopecten irradians irradians*) in southern New England. An exploration into the impacts of eelgrass habitat complexity on the survivorship and growth of the northern bay scallop was carried out in Nantucket, Massachusetts. Juvenile bay scallops were tethered in natural eelgrass beds with a range in shoot density and blade length as well as artificial seagrass units of varying shoot density and blade length. The data revealed a positive relationship between the size of scallops and survivorship, but a negative relationship between size and percent growth in shell height. Survivorship was significantly related to eelgrass shoot density but this relationship differed between October of 2013 and July of 2014. Overall, the data suggests that eelgrass shoot density may play a role in predator-prey interactions along the coast of the northeastern United States.

Distant intertidal communities differing in species composition are similar in trophic structure

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We used information on species abundance, functional groups, and trophic links to study community similarity in two contrasting intertidal environments from the same biogeographic region: the St. Lawrence Estuary (SL) and the Atlantic coast of Nova Scotia (NS). Both environments were dominated by canopy-forming macroalgae (*Fucus* spp. and *Ascophyllum nodosum*) and exhibited understory algae and invertebrates. We measured species abundance in 30 cm x 30 cm quadrats and collected tissue samples for stable-isotope analyses. We contrasted with multivariate analyses the two environments using data for different complexity levels: abundance of species (all species and only understory species), abundance of functional groups, and stable-isotope signatures for species corresponding to different trophic levels. Both community types differed greatly in species composition. Differences at the functional-group level were smaller and differences based on isotopic signatures were lowest. Overall, average Bray-Curtis dissimilarities between both regions switched from 88 and 80 when structures in all species or associated species were considered, respectively, to only 18 and 15 when functional groups and isotope data were used. This study indicates that community similarity increased from considering simply species identities to functional groups to the trophic structure of the communities.

Fungal and plant responses to experimentally increased resource availability and physical stress in a salt marsh

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Investigating the effects of abiotic factors on species interactions can lead to a more mechanistic understanding of interactions and their outcomes. In particular, plant-fungal symbioses can have strong consequences for community and ecosystem processes, and they are sensitive to variation in abiotic factors. We investigated how a symbiosis between the salt marsh plant *Spartina alterniflora* and root-associated fungi (RAF) responded to changes in resource availability (nutrient levels) and physical stress (salinity). We conducted a field experiment examining the independent and interactive effects of increased nutrient availability and sediment salinity on fungal colonization and plant morphology in St. Joseph Bay, FL. As expected, plants responded positively to nutrient enrichment, and this response depended on physical stress for some traits. Increased resource availability decreased the prevalence of RAF hyphae, but it did not influence fungal reproductive structures, which were marginally increased by salinity. Our results suggest that increased nutrient levels are likely to alter partner investment in this symbiosis, and the ultimate outcome may also depend on ambient stress. Further, these findings are suggestive of the importance of this poorly understood symbiosis in salt marshes.

Spatial and Temporal Distribution Patterns of the Trematode Parasite, *Zoogonus rubellus*, and its Intermediate Hosts in Great Bay Estuary, NH

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Parasites can indirectly affect community structure through alteration of the host phenotype. Helminth parasites, in particular, have the potential to cause significant impacts due to their complex life cycles. The trematode *Zoogonus rubellus* sequentially infects two intermediate hosts: first intermediate host, the Eastern mud snail *Ilyanassa obsoleta* and second intermediate host, a common nereid baitworm species *Alitta virens*. Extensive surveys of *I. obsoleta* indicate that *Z. rubellus* is widespread, but nothing is known about its distribution patterns within second intermediate hosts. Field surveys in Great Bay Estuary, NH during the summers of 2012-2014 indicate that infection prevalence among intermediate hosts is spatially patchy, but high infection prevalence in the first intermediate was positively correlated with infection prevalence in second intermediate hosts. Seasonal surveys conducted in 2014 also indicate that infection among nereid worms increases across the summer, following changes in temperature and the winter migration of *I. obsoleta*. These results indicate that the distribution of *Z. rubellus* is locally variable in both space and time, and thus any parasite-mediated indirect effects of *Z. rubellus* should similarly vary on a local scale.

Stone crab predation and residency on intertidal oyster reefs

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Anecdotal evidence suggests that stone crab (*Menippe mercenaria*) density and range is expanding in North Carolina. Stone crabs often live and feed on intertidal oyster reefs valued for their ecosystem services such as shoreline stabilization, water quality enhancement, and fisheries enhancement. To investigate stone crab influence on intertidal oyster reefs we surveyed 1km of reef for stone crab and tested oyster consumption by multiple sizes of stone crab in mesocosms over a 24 hour period. Crabs smaller than 7cm carapace width must pick isolated oyster typically less than 40mm long. However, crabs larger than 7cm are capable of preying upon oyster of any size and their feeding mode becomes more destructive. Crabs of this size make up 30% of the resident population on intertidal reefs and could have a large effect on reef structure.

Ocean warming hotspots, phase shifts and large-scale degradation of Nova Scotia kelp bed ecosystems.

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Many kelp bed ecosystems have been degraded over the last decades through a combination of human and natural disturbances. In Nova Scotia, warming temperatures, invasive species and storm events have combined to devastate most kelp beds, whose standing biomass has declined from ~10 kg m^{-2} in the 1970s to less than 0.2 kg m^{-2} today. The results presented here summarize coastal surveys from 1982, 2000, 2007 and 2014 along 145 km of coastline, and repeated collections from 3 long-term sites beginning in 1949, 1968, and 1984, and ending in 2014. A dramatic phase shift has occurred, producing a system dominated by opportunistic turf-forming algae and invasive macroalgal species. Kelp loss, and the associated increase in turf-forming algae, was most pronounced in protected bays where blade fragmentation due to warming sea temperatures and heavy encrustation by an invasive bryozoan is prominent. Sites with high turf biomass also had high sediment trapping, which may prevent kelp re-establishment. It appears that while colder, exposed kelp beds are demonstrating some resilience to the ongoing perturbations in Nova Scotia, much of the more sheltered coastline is experiencing a substantial loss of habitat structure and productivity, which could have far-reaching consequences for the ecosystem at large.

Top-down versus bottom-up control of a temperate eelgrass system: insights from a 15-year ecological survey

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Temperate eelgrass systems (*Zostera marina* L.) have provided a model for the investigation of resource versus consumer control, especially in light of anthropogenic nutrient loading and overfishing. We used data from a 15-year ecological survey to understand relationships among predator and grazer abundance and biomass, epiphytic algal and eelgrass biomass, and community diversity in a local eelgrass bed in the York River Estuary, Chesapeake Bay. We integrated this information with environmental data on temperature, light, and nutrients using structural equation modeling to rigorously disentangle the drivers of ecosystem properties. We found evidence for biological control, with top-down processes most in the summer and fall, but the relative magnitude of these effects were almost always exceeded by environmental drivers. We found no evidence of species richness and functional diversity on grazer biomass and predator abundance. Overall, based on a observational data, this system appears to be primarily controlled by variation in abiotic variables, principally temperature and light, whose influence changes seasonally. Long-term ecological datasets such as this provide complementary insight into the role of biology in the face of natural variation in environmental parameters.

Oceanographic and meteorological processes mediating sea urchin disease outbreaks in Nova Scotia

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Along the coast of Nova Scotia disease outbreaks in sea urchins are linked to North Atlantic hurricanes and warm sea temperatures. The pathogen (*Paramoeba invadens*) is unable to withstand minimum sea temperatures along this coast, and is reintroduced periodically with storms during periods of peak temperatures. We conducted a 5-year field experiment (2010 – 2014) monitoring disease outbreaks in and around St. Margarets Bay, Nova Scotia, and analyzed these data in combination with reports of hurricane activity and available oceanographic (sea temperature, waves) and meteorological (winds) data to: 1) evaluate the reliability of a logistic regression model linking disease outbreaks to hurricanes and warm sea temperatures, and 2) test hypotheses for a mechanism of introduction of *P. invadens* with storms. Disease outbreaks were observed in 4 years. We found strong support for the logistic regression model to predict a disease outbreak based on hurricane activity and sea temperature in 2010 and 2011. In 2012 a disease outbreak occurred in the absence of a storm and was preceded by a strong positive anomaly in winter sea temperature, suggesting survival of the pathogen from the previous year. In 2014 a disease outbreak occurred in association with a strong fall storm that was not categorized as a hurricane. Available physical data favor the hypothesis that *P. invadens* originates in warm offshore surface waters that are horizontally transported to the coast during a storm.

Multiple stressors and metal pollution in coral disease and immunity

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Pathogens are important members of ecological communities that should not be overlooked. Disease-causing organisms, whether infectious or otherwise, help regulate populations in healthy ecosystems of all kinds. However, the role of pathogens in stressed ecosystems is not well understood, especially when considering multiple stressors that may have synergistic effects. Our research investigates the effect of multiple stressors on host-pathogen interactions using the Caribbean sea fan, *Gorgonia ventalina*, infected with a Labyrinthulid, a marine stramenopile. In previous work on this system, we detected environmental drivers of disease and immunity and linked the Labyrinthulid infection to host immune suppression. The 2014 field survey of 15 sites in La Parguera, Puerto Rico and the controlled, clonally replicated laboratory experiment illustrate the importance of both demographic and environmental factors for coral-pathogen relationships. This is the first exploration of the effects of metal pollution on coral disease and immunity. The pairing of field and laboratory data will help elucidate the role of multiple stressors in marine disease dynamics.

Herbivore preference for reproductive structures limits potential fecundity of canopy-forming kelp

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Algal reproductive structures are expected to be more heavily defended against herbivory, although a higher nutritional content may increase their attractiveness to grazers. We examined intra-plant feeding preferences of the gastropod *Lacuna vincta* during the seasonal reproductive period of the kelp *Saccharina latissima* in Nova Scotia. Feeding choice experiments in the laboratory revealed a strong preference for tissue bearing mature sporangia over sterile tissue directly adjacent to kelp sori. Consumption of the two tissues did not differ when presented singly, indicating an active preference. This preference is reflected by a shift in the distribution of grazing damage away from blade margins toward the centre of reproductive kelp thalli compared to non-reproductive thalli collected from 5 sites during months of peak spore production. Results are interpreted in light of tissue-specific variation in C:N and phlorotannin content. The extent of grazing on kelp sori varied among sites over the reproductive period by as much as 2.5-fold, and represents on average a 30.3% reduction in potential fecundity. Decreases in magnitude of propagule supply are anticipated to impede recovery of kelp beds in Nova Scotia by limiting recruitment rate and dispersal distance and thus population connectivity.

The interactive effects of structural complexity and biodiversity on seagrass ecosystem function

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Seagrass habitats are an integral coastal marine ecosystems, promoting increased species diversity and high primary productivity. Both top-down and bottom-up processes may regulate seagrass growth, abundance, and structural complexity. Epiphytic algae, which grow on seagrass blades, are capable of outcompeting and effectively smothering seagrasses when nutrient loads are high. However, mesograzers, small invertebrate herbivores, consume epiphytic algae, promoting seagrass growth. In turn, dense, structurally complex seagrass may house diverse and abundant mesograzer assemblages, potentially resulting in a positive feedback loop that maintains dense seagrass patches. In light of this, we assessed how structural complexity (shoot density) affects the functional roles of mesograzers in terms of their effect on epiphytic algae abundance and seagrass productivity. We transplanted eelgrass (*Zostera marina*) from San Diego Bay, CA into laboratory mesocosms at two shoot densities; 400 and 1200 shoots m^{-2} and quantified the grazing impact of three prevalent seagrass species on epiphyte abundance and seagrass productivity: the carinate dove shell snail, *Alia carinata*; grass shrimp, *Hippolyte californiensis*; and amphipods, *Gammaridae spp*. Our data strongly supports that shoot density affects grazing rates across both species composition and richness. This study is pertinent to seagrass conservation as well as understanding the principles governing consumer-prey interactions.

Quantifying the relative importance of positive interactions across a stress gradient in the rocky intertidal zone

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A conceptual model by Bertness and Callaway predicts that the frequency of positive (versus competitive) interactions in ecological communities should increase with increasing environmental stress. A review of more than 50 published tests of this model in marine intertidal systems suggests that it has strong empirical support, based on the various authors' interpretations of their results. However, in many (if not most) cases, the response variable assessed was the relative *intensity*, not *frequency*, of facilitation or competition. To confuse matters even more, many of these papers discuss expected and observed variation in the relative *importance* of positive interactions. Given that frequency, intensity and importance are clearly different concepts that may not be correlated, it is essential to distinguish among them and to evaluate them separately. Brooker and colleagues have proposed a new index to quantify the relative importance of different ecological interactions across a gradient of physical stress. We are using this index to assess changes in the importance of facilitation, competition, predation, and recruitment for the California mussel, *Mytilus californianus*, across a gradient of wave exposure (thermal stress) in the rocky intertidal zone. We will then compare how variation in importance relates to changes in interaction intensity or frequency.

Functional role of mesograzers in *Zostera marina* meadows at two coastal lagoons of Baja California, Mexico

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We compared the ability of mesograzers to control algae in *Zostera marina* meadows from two coastal lagoons of Baja California (Mexico). These meadows represent the southernmost populations of the sites considered in the Zostera Experimental Network (ZEN), a collaborative partnership addressing questions on eelgrass structure and functioning from a global scale perspective. At our low latitude sites it is expected high predation intensity on mesograzers, which could lead to low control over algal biomass. However, we could also expect strong algae control due to high diversity of mesograzers at lower latitudes. We analyzed these seemingly contradictory effects in relation to productivity differences between sites: San Quintín Bay (SQB) with high productivity due to the direct influence of high-nutrients cold upwelling waters; and Punta Banda Estuary (PBE), a warmer estuary less influenced by enriched ocean waters. PBE was characterized by higher mesograzers abundance and diversity. While predation risk there was high, mesograzer assamblage was capable to control a bloom of drifting filamentous algae attached on the eelgrass leaves. At SQB, higher macroalgal and epiphyte biomass were related to higher mesopredators abundance. Alternating patterns of abundances between successive trophic levels at both sites suggest strong trophic control of primary productivity.

Bigger the better? Intraspecific competition in green sea urchins

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In the St. Lawrence (Quebec, Canada) nearshore ecosystem there are very few kelp beds that provide good quality food for the large numbers of urchins found there. Thus, is probably that in barren grounds, intraspecific competition for food could become important. Larger urchins could have a competitive feeding advantage over smaller sizes and, in consequence, the growth of smaller sizes might be affected when larger sizes are present. We hypothesized that are two types of competition that could occur separately or jointly between large urchins and smaller sizes: interference and exploitative. A field and a mesocosm experiment were carried out to determine the effect of large individuals (50-55 mm) on gonad production and growth rate of small (10-15 mm) and medium-sized urchins (25-30 mm). Results showed the presence of exploitative and interference competition between large urchin and small-size individuals, but none between large and medium-size urchins. Small size urchins reduced growth rates, gonad production and foraging behaviour in treatments where large adult where present compare to controls without large individuals.

Spatial and temporal dynamic of wrack macroalgae in the St. Lawrence Estuary: Is sea ice key factor of wrack input?

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Seaweeds are the main source of primary production in rocky shore environments. Seasonal loss of algal biomass due to physical disturbance provides energetic subsidies to surrounding communities. In boreal and subarctic ecosystems, wave action and ice scour dislodge plants and allow their export to other localities. The importance of ice scour in the production of macroalgae subsidy remains poorly understood and in previous studies has not been considered as a main factor. We evaluated the role of ice scour on the spatial and temporal patterns of wrack macroalgae (WMA) input in the coastal zones of the St. Lawrence Estuary. Monthly sampling (April-November) were done at 9 beaches during 2013 and 2014. WMA biomass reached the maximum values in late winter to then diminish to a constant level until late August, where WMA increase, but never reached the initial amount. Sheltered beaches accumulated more WMA in both years. WMA composition showed that *Fucus* spp. are the dominant species then followed by *A. nodosum* and kelps. This pattern remained steady over time for both years of the study. Ice scour during winter defoliated the macroalgae beds, thus higher WMA biomass are deposited on shore during late winter. Given the predicted decrease of ice forming due to global warming, the intensity of ice scour could decrease. Consequently, algae supply to recipient communities could be affected.

Can oysters provide a refuge for coastal biodiversity in a changing world?

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Intertidal organisms are highly susceptible to climate warming as many already live close to their thermal limits. Shading provided by the complex three-dimensional structure of oysters may enhance the adaptive capacity of intertidal invertebrates to climate warming, but this depends on the oyster's ability to persist under warmer conditions. This study assessed: 1) the ability of the Sydney Rock Oyster, *Saccostrea glomerata*, to persist and form three-dimensional habitat under warmer conditions; and 2) whether there are particular oyster genotypes that display greater thermal tolerance, and could benefit restoration projects targeting climate change adaptation. Juvenile *S. glomerata* that had either been selectively bred for rapid growth and disease resistance or that were wild-type were exposed to a temperature gradient by attaching them to white, grey and black pavers that reached high temperatures of 36°C, 47°C and 60°C during summer low-tides, respectively. After 12 months, selectively bred oysters showed higher mortality and reduced growth rates at higher temperatures, resulting in greater habitat provision by wild-type oysters. Cooler microclimates were recorded among wild-type oysters on grey and black pavers, presumably due to increased habitat cover. Potentially, selection for fast growth and disease resistance has come at the cost of tolerance to extreme temperatures.

Characterizing the benthic food resources and habitat utilization of Black Drum (*Pogonias cromis*) in Baffin Bay, TX

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Black Drum, *Pogonias cromis*, are large-bodied sciaenid fish that occur throughout warm-temperate to subtropical estuaries in the northwest Atlantic and Gulf of Mexico. Black Drum constitute important commercial and recreational fisheries, with approximately 1.7 million pounds of Black Drum landed in Texas in 2010, earning ~$1.6 million. The ecology of Black Drum remains poorly characterized across the vast majority of its range, particularly along the Texas coast. The Baffin Bay Complex (BBC) supports the highest catch per unit effort of Black Drum in Texas. However, in the past year, large numbers of fish have been observed with abnormal physical characteristics and emaciated morphology. The working hypothesis is that Black Drum exhibit strong fidelity to the BBC and may have been affected by changes in availability and identity of prey resources, which in turn exhibit distribution patterns related to local ecological and water quality conditions. Seasonal benthic surveys are being conducted to determine the distribution and abundance of potential prey items. Black Drum are also being collected from throughout the BBC for visual and stable isotope analysis of gut contents. Acoustic telemetry is being used to quantify Black Drum distribution and habitat use. The results of this study will provide a better understanding of the linkages between water quality, benthic prey, and Black Drum ecology in the BBC.

Genetic diversity of the Atlantic Horseshoe Crab (*Limulus polyphemus)* in South Carolina

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The Atlantic horseshoe crab (*Limulus polyphemus*) is a valuable species environmentally, commercially, and biomedically. Because of their biomedical importance, Atlantic horseshoe crabs are harvested from beaches during the breeding season in order to be bled for the production of *Limulus* Amebocyte Lysate (LAL). Although harvest mortality is relatively low, vast numbers of crabs are harvested and some studies have examined sublethal effects that may impact populations negatively. This project used a suite of 11 microsatellite loci to analyze samples collected from the Coffin Point and Harbor Island horseshoe crab spawning sites in St. Helena Sound, South Carolina. Genetic structure was analyzed along with various genetic diversity metrics. Results indicated that the two sites represented a single population (Jost's D=0.0019, p=0.2679; F_{ST}=0.0058, p=0.2385). The population analyses showed moderately high diversity (H_E= 0.762), no inbreeding (F_{IS}= -0.0057), and a large effective population size (N_e) based on the lower bound of the 95% confidence interval obtained from linkage disequilibrium-based estimates of N_e (N_e > 2240.7). These are all positive indicators for the adaptive potential of the population. The results of this study serve as an important baseline for future conservation and management of horseshoe crab populations.

Rugosity is related to oyster spat and associated resident fauna on intertidal oyster reefs

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Habitat vertical complexity is an important physical feature of many marine hard bottom communities that influences factors such as predator-prey interactions and larval recruitment. High vertical structure on intertidal Eastern oyster, *Crassostrea virginica*, reefs is beneficial to both fishery and habitat functions. Quantifying oyster size frequencies and associated fauna typically requires destructive sampling (e.g., excavating quadrats). Measuring reef rugosity (*Rq*) with a chain is an alternative, non-destructive method for quantifying vertical complexity. Relationships between rugosity and oyster size frequencies, recruitment, and associated faunal assemblages were investigated in the summer of 2013 using experimental trays deployed for twelve weeks at two sites in Charleston Harbor, South Carolina. Spat and resident macrofauna were counted and measured and macrofauna were identified to the lowest taxon possible. Rugosity was positively related to abundances of spat ($r^2 = 0.93$) and some crab species; e.g., *Petrolisthes armatus* ($r^2 =0.83$) and *Eurypanopeus depressus* ($r^2 = 0.63$), but not others, e.g., *Panopeus herbstii* ($r^2 = 0.39$). To compare experimental results with other oyster habitat, rugosity was measured on restored reefs over quadrats before excavation. The rugosity metric is a reliable management tool for characterizing oyster habitat vertical complexity and habitat provision for associated resident macrofauna.

Population assessment of Horseshoe Crabs (*Limulus polyphemus*) in South Carolina, USA, using an integrated approach

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The Atlantic horseshoe crab, *Limulus polyphemus*, is important ecologically, as a crucial source of food for migrating shorebirds, and economically and medically, as a harvested natural resource. In South Carolina (SC), *L. polyphemus* is hand-harvested and bled to produce *Limulus* amoebocyte lysate, which tests for bacterial endotoxins. Lethal and potential sublethal effects of bleeding and increasing harvests in some areas have raised concerns over the long-term sustainability of horseshoe crab populations. A previous assessment estimated the Mid-Atlantic horseshoe crab breeding population to be a maximum of 361 individuals. To assess the status of horseshoe crabs in SC, in 2014 the SC Department of Natural Resources began an integrated monitoring program, including tagging studies, egg density surveys, and population genetic analyses. During April-June 2014, 1557 individuals were tagged in collaboration with the U.S. Fish and Wildlife Service's *Limulus* tagging program. Initial egg density surveys showed no significant difference in egg or trilobite densities between harvested and unharvested beaches. Population genetic data suggest a relatively large horseshoe crab population, with moderate to high levels of genetic diversity, no evidence for inbreeding, and effective population sizes of at least 2000 individuals. Our data provide an important baseline for future monitoring and species management.

The Water Institute of the Gulf:
A new mechanism for partnerships to support coastal management

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The Water Institute of the Gulf is a not-for-profit independent research institute dedicated to advancing the understanding of coastal, deltaic, river and water resources along the Gulf Coast and around the world. Our mission supports the practical application of innovative science and engineering for developing tools to achieve sustainable coasts and deltas, options for supporting coastal communities and strategies for sound water resource management. Through identifying expertise and forming collaborations with partners across disciplines of academia, NGOs, industry and government agencies, The Water Institute is able to focus efforts on crucial challenges to coastal systems and build strategic capacity to support management and restoration. Current research in the Coastal Ecology Program at The Water Institute includes developing a System-Wide Assessment and Monitoring Program for coastal Louisiana and Habitat Suitability Indices for key fisheries species, tracking carbon cycling in marsh systems, examining the wave attenuation potential of mangroves, and determining the ecosystem services provided by submerged aquatic vegetation. This information will be used to inform and improve predictive modeling capabilities for future coastal scenarios and inform the development and implementation of best management practices for a sustainable coastline.

An evaluation of schemes for classifying estuarine ecosystems

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The goods and services provided by estuaries are underpinned by the abundance and diversity of habitats present. Estuarine habitats are, however, increasingly under threat from coastal development and climate change and require effective conservation management. Typological classification schemes for coastal waterways have been implemented in many countries to assist decision makers. Most such classification schemes group estuaries by their hydrological and geomorphological properties. Here we assess the extent to which an Australian estuarine classification scheme, based on differences in hydrology and geomorphology, also represents differences in their ecology. The OzCoasts Estuarine Typology classification scheme divides Australian estuaries into seven classifications based on major hydrological forcings and geomorphological features. The Australian National Land and Water Resources Audit provides data on the areal extent of major habitat types present in individual Australian estuaries. Multivariate PERMANOVA analyses assessed whether the seven geomorphological categories of estuary differed in habitat assemblages present. Assemblages of key habitats differed significantly among estuarine types, with post-hoc pairwise testing showing differences between the ecology of most classifications. This suggests that hydrology and geomorphology exert strong controls on estuarine communities. Conservation managers are therefore, adequately served by typology schemes that focus on the hydrological and morphological features of estuaries.

Interacting effects of geomorphological and ecological processes guide conservation and restoration of intertidal oyster reefs

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Geomorphological processes, such as the interaction of wave energy with estuarine topography, are important disturbance agents in estuarine systems. Improved understanding of the interactions between geomorphological and ecological processes is an important goal for both ecology and geomorphology. In this study, we quantified the relationship between wave energy and the distribution and quality of an essential estuarine habitat type, intertidal oyster reefs, in the Core-Albemarle-Pamlico Estuary System (CAPES) of NC. We found that wave exposure (quantified using NOAA's Wave Exposure Model) is a major driver of natural intertidal oyster reef distribution and population demography. Conversely, oyster distribution and population demography on hardened shoreline structures (i.e., bulkhead and riprap) is unrelated to wave exposure, and these structures can host comparable oyster densities to natural intertidal oyster reefs. Given their broad distribution and the high oyster densities found on intertidal oyster reefs (upwards of 200 m^{-2}) within the CAPES, intertidal oysters on both natural reefs and hardened shorelines might serve as key larval contributors within the overall CAPES oyster metapopulation. An understanding of the interactions between geomorphological processes (e.g., wave exposure) and ecological processes (e.g., local demography) is essential to guide successful efforts to conserve and restore shoreline habitats.

Improved seagrass classification using linear spectral unmixing

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Classification of seagrass from low resolution, multi-spectral imagery using traditional techniques often obscures the patchy nature of seagrasses. Thus, visual photointerpretation of high resolution aerial photography remains the most widely adopted approach for seagrass mapping but requires painstaking manual delineation of general seagrass habitat that typically overestimates actual coverage. Semi-automated classification of seagrass from aerial photography is uncommon and varies widely in scope and accuracy. Here, we evaluated a linear spectral unmixing (LSU) classifier where representative endmembers (seagrass and sand) were chosen directly from aerial photos and LSU reported endmember proportions present in each image pixel. Seagrass pixel proportions were evaluated in 0.1 increments (0-1) using confusion matrices, Receiver Operating Characteristic curve analysis, and Euclidean distance to determine optimal seagrass pixel proportions for classification. When used in combination with photointerpretation, LSU successfully classified North Carolina seagrasses and distinguished small patches. Selection of optimal pixel proportions required analyst knowledge of the system and an evaluation of tradeoffs among overall thematic accuracy and the costs of failing to detect seagrass versus costs of false detection. LSU can improve seagrass maps providing resource managers with more accurate estimates of coverage and the classified raster layers can be used in seagrass spatial pattern analyses.

Demographic assessment of the pillar coral, *Dendrogyra cylindrus*, along the Florida Reef Tract

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The pillar coral, *Dendrogyra cylindrus*, has been commonly described as widely distributed, but rare throughout the Caribbean. In Florida specifically, there have been few observations of pillar coral but the current population status is relatively unknown, although geologic records indicate that historical abundance may have been higher. Having recently been listed as Threatened under the US Endangered Species Act, efforts to better understand population status is needed to promote species conservation and population recovery. In our study, submissions of pillar coral locations from the scientific and lay community were compiled, and 573 *D. cylindrus* colonies along the entire Florida Reef Tract (FRT) have been identified. For each colony habitat type, depth, and demographic and condition data were recorded in a comprehensive database including size (length, width, and height), colony type (morphology), percent mortality, presence and severity of disease and bleaching. Size and condition of colonies varied between regions along the FRT with a high prevalence of disease recorded in the southern portion of the reef tract in the Florida Keys. Results from this effort provide essential data to support future conservation and management strategies for this FRT population and comparative data for other Caribbean populations.

The mismanagement of *Limulus polyphemus* in Long Island Sound: What are the characteristics of a population in decline?

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Over the past 15 years, horseshoe crabs in Long Island Sound (LIS) have steadily declined. While management plans mandated by the Atlantic States Marine Fisheries Commission have resulted in increasing populations in Delaware Bay, management of LIS horseshoe crabs by both Connecticut and New York for LIS have not produced similar results. Sustainably managing the LIS horseshoe crab population first requires determination of local population dynamics and then modification of management practices to maximize reproductive success. Here we examine a long-term data set collected by Project *Limulus*. Horseshoe crabs in LIS are one discrete management unit. The population is rapidly aging with low recruitment and reproducing well below its maximum rate. Low spawning densities, increasing numbers of single females on the beach, and < 6% polyandrous mating behavior indicate the population is approaching a threshold where recovery may be limited at best. Clearly current harvest quotas and management techniques are not sustainable. We recommend the implementation of a unified management plan for LIS with one shared harvest quota for the entire population. We also suggest increasing the number of no-harvest zones on both sides of the Sound and an immediate ban on harvesting females.

A molecular probe finds evidence of NIX pathogen in Pacific razor clams (*Siliqua patula*) in Oregon

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The Pacific razor clam, *Siliqua patula*, is an important recreational fishery species that lives in the intertidal zone of sandy beaches from Alaska to central California. Populations have had periodic, but significant, declines over the past 30-40 years. These declines have correlated with an increase in the presences of an unidentified, intranuclear bacterial parasite known as Nuclear Inclusion X (NIX). NIX, which was first identified in 1986, has generally been screened using a histological approach. We developed a PCR-based screen to reduce both the time and cost of identifying infected clams. Use of this screen resulted in amplified sequences with a 97% match to the previously published 16S rDNA sequence for NIX. The sequence data supports placement of NIX into the gamma-proteobacteria, and suggests that it is related to isolates from diseased corals. Clams collected from the northern coast of Oregon showed ~50% infection rate using the PCR screen. This is the first report of NIX present in clams from Oregon, as all previous work had been in the state of Washington. Future work will identify the incidence rate and geographical spread of the NIX parasite throughout Oregon and Washington.

Building the bridge between preservation of biodiversity and human activities

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The Magdalen Islands were identified as prime candidates for Québec's commitment of protecting 10% of its coastal and marine environment by 2020. Preserving both ecological integrity of benthic fauna and fisheries is crucial, as benthic invertebrates and demersal fishes are significant elements of the madelinian ecology, economy and culture. The objective of this project was to identify areas of ecological interest including the region's biodiversity while minimizing conflicts with fisheries. We used Marxan, a decision support tool that identifies areas meeting a suite of ecological targets while minimizing costs (e.g. size and overlap with local activities). A total of 90 ecological attributes were used in an ecological analysis exclusively considering ecological targets and an integrated analysis further including 20 fisheries. Solutions meeting all ecological targets were obtained for both analyses. Overlap with individual fisheries decreased and size of solutions increased between the ecological (37 ± 3% and 4664 ± 35 km^2) and integrated (23 ± 1% and 5382 ± 101 km^2) analyses. Our results suggest that it is realistically feasible to promote conservation while minimizing impacts to fisheries, effectively addressing the gap between the preservation of our natural heritage and the sustainable use of its resources.

New Insights to Horseshoe Crab Spawning Behavior: Implications for Management

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Due to over-harvesting as bait, American horseshoe crab (*Limulus polyphemus*) populations in regions along the U.S. Atlantic Coast have been declining and trends have not reversed despite state-by-state quotas and regulations. Current management of horseshoe crabs in most states includes closing the harvest during the weeks of new and full moons of their spawning season (typically late spring and early summer when they are most visible on shorelines) and surveying; these methods were originally based on data from Delaware Bay populations indicating peak horseshoe crab spawning occurred during those times. However, previous studies investigating spawning behavior in other locations, and a recent New Hampshire study evaluating the temporal and spatial distribution of spawning activity, indicate that increases in spawning horseshoe crabs did not always occur during the new and full moons. This may be due to the physical characteristics of the location and local adaptation. Generalizations of scientific information could lead to ineffective decision-making in the management of a species, especially a species that is vulnerable during spawning and mating. Rather, spawning behavior and activity of regional horseshoe crab populations need to be investigated that then may contribute to the conservation of horseshoe crabs overall.

Spatiotemporal dynamics of estuarine soundscapes in a marine reserve

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Estuarine habitats, such as seagrass beds, salt marshes, and oyster reefs have unique soundscape characteristics due to variation in the diversity and abundance of resident soniferous species, as well as physical sources of sound from structural aspects of the habitats. Soundscapes provide sensory information to organisms living in those environments that can be used for many ecological processes, such as navigation, communication, and larval settlement. Moreover, soundscape diversity might reflect habitat health or quality. The goal of this study is to characterize spatiotemporal dynamics of soundscape patterns in a mosaic of estuarine habitat types within an estuarine reserve, and the potential processes underlying those patterns. Passive acoustic recorders were deployed at 8 sites in the reserve, and sampled 2 minutes every 20 minutes over 3 months during summer 2014. A daily periodicity in sound levels coincided with a nightly chorus of fish, and was also positively correlated with tidal amplitude. Thus, both biotic and abiotic processes underlie estuarine soundscape characteristics. This presentation will also highlight the relationship between habitat diversity and soundscape characteristics.

Are mooring buoys effective at changing coral reef use patterns and reducing damage?

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Anchoring can be a major source of coral reef damage and mooring buoys are used worldwide to reduce it. However, their use is location dependent and their efficacy is typically untested. This study focused on Miami-Dade County, Florida where a mooring buoy program was initiated in 2009, and compared it to Broward County where one has existed for decades. We used aerial surveys before and after buoy installation to determine if boater use patterns changed after installation. We also used reef damage surveys to determine if damage was reduced following buoy installation and if there was an effect of distance to the nearest buoy. The percentage of vessels using buoys was greater in both counties after buoy installation. However, the percentage of anchored vessels remained relatively constant in Miami-Dade. The installation of mooring buoys correlated with an observed reduction in reef damage, but no relationship between damage and distance to the nearest set of buoys was observed. The reduction in damage after only three years is encouraging, and although only correlational, suggests that mooring buoys do reduce damage. Future studies would benefit from an experimental framework and assessment of alternative sources of reef damage such as commercial fishing gear.

Effects of fragmentation on reproductive effort and short-distance seed dispersal in North Carolina *Zostera marina* beds

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Fragmentation of the seagrass species *Zostera marina* has become increasingly common, and it may threaten the critical ecosystem functions the seagrass provides, such as serving as nursery habitat. Sexual reproduction through flowering and seed dispersal could contribute to the species' potential resiliency or vulnerability to fragmentation. We investigated whether seagrass shoot density or the proportion of flowering shoots differed between fragmented and continuous beds. In addition, we utilized sediment core sampling to quantify the density and distribution of seeds inside and outside of both bed types. Our results revealed that flowering effort did not differ between bed types, but we found significantly fewer seeds in fragmented versus continuous beds. Within beds of a given type, there was no difference in the number of seeds at the center versus the edge, but there were significantly fewer seeds in bare than in vegetated bottom within fragmented beds. Finally, seeds were found in higher numbers directly outside of continuous beds than outside of fragmented beds. These results collectively suggest that seed limitation may inhibit the contribution of sexual reproduction to seagrass recovery from fragmentation.

Quantifying augmented fish and mobile invertebrate production from oyster reef habitat

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Quantification and valuation of ecosystem services is increasingly valuable for conservation and restoration decision making. Oyster reefs are important nursery habitat for fish and mobile invertebrates, but this service is challenging to quantify due to common ontogenetic shifts in habitat use by many species and because of the difficulties in establishing habitat usage. We reviewed the available literature on the increased abundance of juvenile fish and mobile crustaceans in *Crassostrea virginica* reefs in the United States, and modeled the growth and mortality of these species to provide estimates of gross and net production, and uncertainty in production values. Nineteen species were found to be recruitment enhanced by oyster reefs in the northern Gulf of Mexico, compared to twelve in the South and Mid Atlantic. Crustaceans were a more important component of the estimated enhancement in the northern Gulf of Mexico than in the South and Mid Atlantic. Furthermore, total enhancement of species was significantly greater in the northern Gulf of Mexico. Our results suggest that broad regional differences in the magnitude and composition of ecosystem services exist.

Ecologically sound beach replenishment approaches

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The California Coastal Commission regulates development and natural resource use in partnership with local governments and in keeping with Coastal Act policies which include protection, enhancement, and restoration of sensitive habitats. Beach replenishment (also called 'beach nourishment') projects have come before the Commission in past years but their numbers are increasing. Littoral cell sediment supply decreases and sea level rise seaward, and coastal development landward, is causing beach loss (and loss of other coastal habitats) across many of the world's coastlines. Littoral cell sediment budgets naturally ebb and flow but decreases in sediment volume also results from dams, agricultural practices, and coastal armoring (seawalls, harbors, jetties, groins, etc.). This combined with sea level rise and development that anchors the back beach or bluffs equals beach loss. While beach replenishment is often viewed as a "soft solution" it can result in significant adverse ecological impacts to beach ecosystems. However, there are numerous considerations and approaches that the Commission is analyzing and applying on a case by case basis that can decrease or eliminate negative impacts. These include matching source sand to existing sand, project timing, sand deposition location (e.g. surf zone), and total sand volume.

Demography of the threatened coral *Acropora cervicornis*: implications for it management and conservation

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Acropora cervicornis is one of the principal reef building organisms in the Caribbean. It is also considered one of its most depleted coral species; a situation that has prompted the initiation of many restoration efforts throughout the region. Yet, there is not sufficient quantitative demographic data and analysis to effectively guide these efforts. The aims of this study were to (1) perform a population viability analysis employing a size-structured demographic model, and (2) analyze the efficacy of outplanting coral fragments of different sizes. The model was parameterized with data on colony survival, growth, and recruitment collected from 2011 to 2013 at two localities in Puerto Rico. Estimated stochastic population growth rates were 0.717 and 0.844; indicating that the two populations are declining rapidly. The viability analysis predicts that the studied populations will reach quasi-extinction levels of 10% of the initial population size in ≤ 20 yrs. Simulations of different transplantation scenarios indicate that outplanting 75 large (250≤ cm in total length) colonies per year would result in higher asymptotic population size than outplanting smaller fragments. The study offers concrete restorations recommendations for the many managers in the Caribbean that are actively farming this species for restoration projects.

Putting buzzwords to work: how data, representation, and stakeholder perspectives influence the interpretation of resilience for coral reef management

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Coral reef scientists and managers increasingly discuss adaptive management as a global imperative. Instead of single-actor management and stress abatement, ecosystem resilience and participatory feedback are newly fundamental. Broadly defined, ecosystem resilience is the capacity to for an ecosystem to absorb disturbances and reorganize. Although the system may have shifted, it essentially retains the same function, structure, identity, and feedbacks. Few managers have practically incorporated the concept of resilience in decision-making on coral reefs. However, in 2011, the Florida Keys National Marine Sanctuary adopted a novel guideline; resilient reef areas were identified and prioritized in a multi-year review of the sanctuary's zoning. From 2012 through 2014, scientists, agency staff, and stakeholders were engaged – via a specially appointed Working Group and long standing Advisory Council – to improve the zoning network using this and other conservation guidelines. Drawing from interviews, meeting transcripts, and surveys, this research illuminates the informational (i.e., visual representation) and social contexts in which these two groups translated resilience. The interaction of a complex concept – resilience – with stakeholder discourse led to a re-shaping of resilience by sociopolitical narratives. Political ecology provides a lens to reflect on broader, professional implications: can the scientific community effectively inform resilience-based management without considering if and how new management understandings of resilience, in turn, affect the science?

On the size of species' ranges in the sediment-covered deep sea

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Some authors have argued that deep-sea, soft-bottom species have ranges on the 100-km scale; others suggested that ranges are on the 1000-km scale. Morphological studies have provided most of the data, but this approach may not separate sibling species. We used both morphological and genetic data to study range sizes of harpacticoid copepods because they are thought to be poor dispersers. We reasoned that if harpacticoid species had 1000-km-scale ranges, then many deep-sea species will have ranges at this scale.

Our material came from eight stations on the continental rise along the west coast of the United States. We used morphology to combine individuals into nominal species. We then obtained genetic data from the nuclear 18S ribosomal RNA gene and the mitochondrial cytochrome oxidase *b* gene from every individual in each nominal species. We considered individuals to be conspecific when the morphological and genetic data agreed. Five of 30 species (17%) had 1000-km-scale ranges. Thus many harpacticoid species in the deep sea have ranges much larger than 100 km, which suggests that better dispersers should have an even greater proportion of species with 1000-km-scale ranges.

Insight into the responses of deep-sea corals to anthropogenic stressors

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The 2010 Deepwater Horizon disaster released an unprecedented amount of oil at depth in the Gulf of Mexico, with known adverse effects on deep-sea coral ecosystems. During the ensuing cleanup efforts, dispersants were also applied at depth for the first time. The response of deep-sea organisms to both the oil and dispersant are not fully understood. Quantifying these effects on the surrounding communities is crucial to determining long-term environmental consequences. We conducted live exposure experiments to investigate the physiological effects of oil and dispersant exposure on two deep-sea corals, *Callogorgia delta* and *Paramuricea biscaya.* For both species, the treatments containing dispersants had a more pronounced effect than oil treatments alone. In addition, RNA from unexposed and spill-impacted *P. biscaya* was extracted and sequenced using Illumina technology to investigate changes in gene expression. Preliminary findings show an up-regulation of genes coding for Cytochrome p450, Ubiquitin, TNF receptor-associated factors, Peroxidasin and additional genes involved in innate immunity and apoptotic pathways. Our results provide insights into the responses of deep-sea corals to toxin exposure, implications of applying dispersants to oil spills and a novel reference assembly for a relatively under-studied group of corals.

Population dynamics of the tubeworm *Escarpia laminata* at Gulf of Mexico cold seeps

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Vestimentiferan tubeworms are frequently the dominant species of deep-sea cold seeps. These large invertebrates are ecosystem engineers through their provision of habitat but also through the modification of the local chemical environment. To understand more about the community dynamics of cold seeps, it is vital to study the population dynamics of the foundational tubeworms. The lifespans of two of the major tubeworm species in the Gulf of Mexico have been modeled previously, but the tubeworm *Escarpia laminata*, which dominates seeps deeper than 1000m, has not been characterized. In this study, the growth rate of individual tubeworms as well as the mortality and recruitment rates of whole aggregations *E. laminata* were modeled. To measure annual growth, *E. laminata* were marked at depth with a chitin stain and collected one year later, and mortality rates were calculated from the empty tubes collected concurrently. Each sample was used as a reference for a population simulation to estimate the age of each collected aggregation. Aggregations ranged from a few decades to several hundred years old with growth projections confirming that the age of the largest individuals could exceed 400 years.

Assessing the carbonate chemistry of cold-water coral reefs in the deep Gulf of Mexico: implications for resilience in acidified oceans

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The ability of marine calcifying organisms to grow and survive may be severely reduced in the future due to ocean acidification, which causes reductions in both seawater pH and the saturation state (Ω) of the calcium carbonate mineral used for calcification. Among the most vulnerable groups in the deep sea may be cold-water corals, organisms that already persist at low saturation states. We analyzed the carbonate chemistry of water samples collected near deep-water reefs dominated by the cold-water coral *Lophelia pertusa* in the northern Gulf of Mexico. Our results showed that *L. pertusa* reefs are growing at a relatively low pH (pH minima of 7.84) and the lowest saturation state (Ω_{ARAG}=1.19) ever recorded for a framework-building coral, suggesting that this ecosystem may be vulnerable to predicted levels of acidification. However, anomalously high alkalinity measurements directly over large coral mounds (+46±15 μmol kg^{-1} compared to off-reef locations) revealed the potential for local elevation of saturation state via dissolution of exposed coral skeleton or the natural seepage of alkaline water. Therefore, while *L. pertusa* habitats in the Gulf of Mexico will likely be undersaturated in future oceans, localized biological and chemical processes may partially offset the effects of ongoing ocean acidification.

Potential larval connectivity of deep-sea, methane seep invertebrates in the Intra-American Sea

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Population connectivity via larval dispersal is a key process that maintains spatially separate biological populations and communities. Since their discovery, deep-sea chemosynthetic ecosystems have been novel systems within which to test the generality of paradigms developed for shallow-water species. Deep-sea, methane seep habitats are distributed throughout the world, yet we know relatively little about the life history of seep invertebrates, nor patterns and processes underlying population connectivity for these unique biological communities. The goal of this study is to assess the biological and hydrodynamic drivers of population connectivity of deep-sea invertebrates among methane seep sites in the Intra-American Sea. Here, we present the preliminary results of a coupled bio-physical model used to assess connectivity of the mussel, *"Bathymodiolus" childressi*, and snail, *Bathynerita naticoidea*, among eight methane seep sites throughout the Gulf of Mexico and U.S. East Coast. Virtual larvae were programmed with varying pelagic larval durations (PLDs) and behaviors that best matched empirical data. Initial results suggest larval connectivity among sites of varying depths and locations, such as Florida Escarpment (Gulf of Mexico) and Cape Fear Diaper (southeast Atlantic), among a variety of larval behaviors and PLDs. This study is advancing our general knowledge of population connectivity in the deep-sea.

Does an oxygen minimum zone promote population divergence?

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Oxygen minimum zones (OMZs) are large, persistent regions of the world's oceans with oxygen concentrations of ≤0.5 ml/l. The distribution, abundance, composition and diversity of the benthic fauna shift dramatically where OMZs intersect continental margins and some evidence suggest that species with distributions that extend into the OMZ diverge genetically. The abrupt shifts at the genetic, population and community levels suggest OMZs probably impose a formidable selective force for many deep-sea organisms. If larvae are sensitive to hypoxic conditions, the OMZ might preclude dispersal among populations separated by regions of low oxygen and operate essentially as a geographic barrier to gene flow. We investigate this hypothesis by quantifying genetic variation (16S rRNA) of a wood-boring bivalve, *Xylophaga washingtona*, along a depth gradient (100-6000m) spanning the OMZ in the Northeast Pacific. Two distinct clades were apparent, one spanning the OMZ and the other restricted to within and below it. These clades likely represent independently evolving lineages, suggestive of cryptic species. The bathymetric divergence is consistent with the OMZ impeding gene flow and suggests OMZs might play an important role in the diversification of the deep-water fauna.

The short and long term physiological response of the cold-water coral *Lophelia pertusa* to ocean acidification

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Lophelia pertusa is a cold-water coral that provides a structural habitat for many species in the deep sea by secreting a hard skeleton. One of the most profound threats to this species is ocean acidification, the decrease in seawater pH due to anthropogenic CO_2, which has been shown to reduce calcification in a wide number of marine species. We compared *L. pertusa's* net calcification rate under low (pH=7.6) and ambient (pH=7.9) pH conditions over short (two weeks) and long (six months) time periods. During the short term experiment, corals grown in low pH seawater generally exhibited net dissolution of skeletal material (-0.18% day^{-1}), however one genotype displayed positive net calcification (+0.04% day^{-1}). Preliminary results of the long term experiment confirmed that decreased pH resulted in skeletal dissolution in all corals except for the 'resistant' genotype also observed to maintain calcification rates in the low pH, short term experiment. Notably, the net calcification rate of corals in the ambient treatment (pH=7.9) tended to decrease after 2-4 months, potentially indicating a long term tank effect on coral health. Together, these results may indicate that some *L. pertusa* genotypes are more resilient to the effects of ocean acidification than previously expected.

The influence of dietary shifts on fitness as examined through the commercially harvested blue crab, *Callinectes sapidus*

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The physiological condition and fecundity of an organism is frequently controlled by diet. As changes in environmental conditions often cause organisms to alter their foraging behavior, a comprehensive understanding of how diet influences the fitness of an individual is crucial to predicting the effect of environmental change on population dynamics. We experimentally manipulated the diet of the economically and ecologically important blue crab, *Callinectes sapidus*, to approximate the effects of the dietary shift from primarily animal to plant tissue associated with heavy metal pollution. Crabs whose diet consisted exclusively of animal tissue had markedly higher survival and consumed substantially more food than crabs whose diet consisted exclusively of seaweed. The quantity of food consumed had a significant positive influence on reproductive effort and long-term energy stores. Additionally, seaweed diets produced a three-fold decrease in hepatopancreas lipid content and simultaneously increased crab aggression two-fold. Our results reveal that the consumption of animal tissue substantially enhanced *C. sapidus* fitness, and suggest that heavy metal pollution can indirectly reduce crab population growth by inducing dietary changes which decrease fecundity as well as increase mortality. This study provides a baseline for understanding how dietary shifts influence fitness, and has implications for *C. sapidus* fisheries.

Calculating the Time Constant of Mixing in Gastrovascular Fluid Compartments of Perforate and Imperforate Corals

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The implications of perforate vs. imperforate coral colony morphology are largely unknown but may be important to understanding coral response to increasing temperature and acidification in the ocean. Perforate corals have gastrovascular canals that connect all polyps to the entire colony, increasing their internal fluid volume. Imperforate corals do not possess the ability of fluid exchange at the whole colony level, since individual polyps are only connected to their nearest neighbors, and only when the polyps are expanded. The "mixing time" of a polyp is the time needed for the gastrovascular system to disperse an amount of fluid in the coelenteron. This mixing time is a key parameter for determining whole colony integration and response to environmental changes. We have developed a differential equation model for determining mixing time in the coelenteron of scleractinian corals. Using an electrical network model in accordance with oxygen profiles during a light/dark shift inside the polyp, the mixing of the coelenteron can be related to the discharging of a capacitor. Our results show that the mixing time is on the order of seconds to minutes, much shorter than initial estimates. Corals may be able to respond as fast as the environment can change.

Calcification and corrosion in a coralline seaweed

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Coralline algae precipitate high Mg:Ca, the more soluble form of calcium carbonate ($CaCO_3$), which makes them vulnerable to corrosion during summer upwelling along the Pacific coast. *Corallina vancouveriensis*, an articulate coralline alga that inhabits the Pacific rocky intertidal zone, facilitates the recruitment of juvenile invertebrates and macrophytes and provides habitat for a suite of organisms. We hypothesized that the observed lower $CaCO_3$ content of high zone *C. vancouveriensis* specimens was due to increased thermal and desiccation stress from longer emersion times during daylight low tides compared to low zone specimens. We further hypothesized the Mg:Ca ratio would decline in response to thermal stress during emersion time. A two-month reciprocal transplant field experiment between high and low zone *C. vancouveriensis* populations was conducted at Kibesillah Hill, CA to investigate how atmospheric and oceanographic conditions affect the $CaCO_3$ and Mg:Ca of this alga. The Mg:Ca of the thalli were similar for controls and transplants and the average $CaCO_3$ content of high zone thalli transplanted to the low zone increased. These data strongly suggest that emersion stress, not seawater pH, is the major driver of variation in $CaCO_3$ content for *C. vancouveriensis* at this site.

Orientation and impact: Effects of dropping on *Mytilus edulis*

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The shell of the blue mussel, *Mytilus edulis*, provides protection from environmental conditions and predation. Birds such as carrion crows prey upon mussels and drop them to crack their shells. The curved structure of the valves may help resist the impact force when a mussel is dropped. To determine the orientation at impact, we dropped 36 mussels from two different heights (11.9 m and 14.5 m) onto a sand pit. High speed video suggested that impact occurred most often at the posterior and anterior ends of the shell. We measured the compressive strength of similarly-sized live, intact mussel shells in two orientations using an Instron materials testing machine. Mussels subjected to force at the apex of the left valve broke at a higher average load (254 N) with a lower compressive extension (3.7 mm) than those subjected to a force applied dorsal-ventrally (215 N and 6.6 mm, respectively). The higher load and lower compressive extension of the left-right orientation suggests that the structure of the shell disperses stress in a way that avoids compromising the hinge. Animals oriented dorso-ventrally exhibited a more catastrophic failure of the shell.

How do physical stressors impact sponges in Florida Bay?

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Florida Bay, USA, has been subjected to a series of blooms by the cyanobacteria *Synechococcus* spp. from 1991-1995, 2007, and 2013; each with subsequent sponge die-offs. The blooms of the early 1990's killed over 40% of the loggerhead sponges and over 70% of other sponge species throughout western Florida Bay. In addition, winter storms and hurricanes increase the amount of particulate material in the water column for extended periods of time, which appears to cause stress to filter feeding sponges. Our goals were to determine if increased water viscosity caused by blooms or particulates resuspended by storm events adversely affect sponge filtration. We compared bloom-resistant loggerhead *Spheciospongia vesparium* and the volcano *Tethya* sp. sponge species the with bloom-susceptible yellow *Spongia barbara*, the sheepswool *Hippospongia lachne*, and glove *Spongia gaminea* sponge species. We also determined if increased water viscosity or turbidity restricts sponge canals, chambers, or choanocytes, causing reduced filtration and increased sponge mortality. This information is important to improve our understanding of the effects of cyanobacteria blooms on hard-bottom communities and give predictive capabilities to managers regarding the potential effects of blooms as they develop.

Dislodgement force and shell morphology varies according to wave exposure in a tropical gastropod (*Cittarium pica*)

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Wave exposure has strong influences on population density, morphology and behavior of intertidal species in temperate zones, but little is known about how intertidal organisms in tropical regions respond to gradients in wave exposure. We tested whether dislodgement force and shell shape of a tropical gastropod, *Cittarium pica*, differs among shores that vary in wave exposure. After adjusting for body size, we found that *C. pica* from exposed shores required greater force to dislodge from the shore, had larger opercula (the closure to the shell aperture), and were squatter in shape (reduced shell height relative width) than *C. pica* from sheltered shores. These morphological adjustments are consistent with those observed in temperate gastropods, which are argued to represent adaptive responses to the risk of mortality associated with dislodgement.

Corals in a changing climate: A trans-generational perspective

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As atmospheric CO_2 increases, changes in temperature and ocean acidification (OA) are occurring at a rapid rate, threatening marine life such as reef-building corals. While the potential for intra-generational acclimatization is documented, no coral-focused studies have integrated across life stages to test for trans-generational acclimatization (TGA). In a two-part study, we exposed adult *Pocillopora damicornis* to future climate conditions during brooding. Initial experiments identified negative effects of temperature and OA on adult photophysiology, but reciprocal exposure of their larvae suggested metabolic TGA in treatment conditions. Secondly, we tested the ecological outcomes (i.e., survivorship, settlement, and growth) of TGA in a similar adult exposure and offspring reciprocal contrast. After adult exposure to OA, fecundity showed a trend of consistent reduction. Larval survival was greater when adults were preconditioned at high pCO_2. Conversely, larvae exposed to OA conditions for 4 days post-release had lower survival than controls, regardless of parental treatment. One month post-settlement, there was no effect of preconditioning or treatment on the survival of new recruits, but recruits from adults treated with OA had higher growth rates. Our data highlight the importance of TGA as an understudied mechanism for organisms to cope with a changing environment.

Effects of seawater pH on the chemistry of the gastrovascular cavity of the corals *Montastraea cavernosa* and *Duncanopsammia axifuga*

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Respiration and photosynthesis cause large diel excursions of pH within coral gastrovascular cavities (GVC). Few studies have documented and quantified these shifts. Microelectrodes were used to measure changes in pH within the GVC of the corals *Montastraea cavernosa* and *Duncanopsammia axifuga*, during dark and light incubations (respiration vs. photosynthesis), and under control (8.2) and two levels (7.9, 7.6) of reduced seawater pH (ocean acidification). Calcification rates were measured in the light at each treatment pH to investigate the relationship between seawater pH, GVC pH and calcification. The mean GVC pH of *M. cavernosa* in the light was high (>8.5) and similar at all three seawater pH treatments, while in the dark, GVC pH declined with lower pH (<7.3); thus, the diel range in pH within the GVC increased with reduced seawater pH. In contrast, for *D. axifuga,* reduced seawater pH resulted in decreasing GVC pH in both the light (<8.5) and the dark (<7.6). There was no significant correlation between seawater pH and calcification rate, or between GVC pH and calcification rate for either coral species. These results suggest that some aspect of photosynthesis counteracts the effects of seawater acidification in the coral *M. cavernosa* but not in *D. axifuga*.

Unravelling effects of temperature and light on apical growth in the rhodolith-forming, red coralline alga *Lithothamnion glaciale* from Newfoundland

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We carried out manipulative and mensurative experiments to test the effects of water temperature and light on apical growth in the rhodolith-forming, red coralline alga *Lithothamnion glaciale* from southeastern Newfoundland, Canada. During one year, rhodoliths stained with Alizarin Red were grown under orthogonal combinations of five temperatures (ambient, 2, 4, 7, and 10 °C) and three light intensities (~20, 6, and 2 µmol photons m^{-2} s^{-1}) in laboratory flow-through tanks, and at three depths (8, 15, and 25 m) at a site with a large rhodolith bed. Rhodoliths grown in the lab under high light conditions exhibited a two-fold increase in growth rate (366±72 µm y^{-1}) compared to intermediate (168± 63 µm y^{-1}) and low (181± 64 µm y^{-1}) light conditions regardless of temperature. Apical growth at ambient temperature was more highly correlated with PAR accumulation curves than with degree days. In the field, growth rate peaked at 8 m (444±42 µm y^{-1}) and decreased by ~10% with each depth increment to 15 m (406±39 µm y^{-1}) and 25 m (367±29 µm y^{-1}). Overall, results demonstrate that apical tissue growth in *L. glaciale* rhodolith is slow and that seasonal variation in light conditions is more important than temperature in modulating growth.

The Enrichment Effect: Determining how added nutrients and an increase in seawater temperature affect organism performance and growth.

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The focus of this study was to evaluate how nutrient enrichment may offset the ecophysiological response of an intertidal organism to increased temperature stress. A primary goal for ecology in the context of climate change is to determine the role sublethal stressors are having on organism performance and productivity. We evaluated the photosynthetic and growth response of the marine macroalgae *Fucus vesiculosus* to acute changes in seawater temperature in ambient and nutrient-enriched conditions. This study quantified photosynthesis verses irradiance curves (i.e., P-E curves) over a range of temperature conditions, thus characterizing the thermal performance curve for this species. There was an apparent increase in photosynthetic production for nutrient-enriched tissues with increasing temperature to a thermal optimum, following which photosynthesis decreased with small temperature increases. There was also a significant increase in growth for nutrient-enriched tissue compared to ambient conditions. The findings from this study demonstrate how nutrient-enrichment of *F. vesiculosus* tissue affect the photosynthetic response to thermal stress, and help to elucidate future projections for this organism's success in the advent of eutrophication and seawater temperature rise from climate change.

Unraveling the fine mechanisms of particle selection in suspension-feeding bivalves

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Suspension-feeding bivalves (SFB) are confronted with a wide range of suspended material, including plankton of diverse sizes and qualities, debris and inorganic matter. Such mixtures usually contain a high proportion of non-nutritive material and consequently, SFB have developed strategies to sort particles and preferentially ingest high quality material. While this process has been described for decades, the fine mechanisms of particle sorting remains ill-defined. This presentation will summarize our findings on some of the molecular interactions mediating particle selection in SFB. Our results demonstrated the presence in mucus covering SFB feeding organs of lectins that bind microalgae cell surface carbohydrates (CSC), providing a molecular mechanism for particle sorting via strong bonds between mucus and some food particles. In parallel, we showed that the CSC profile of each microalgae species is unique and dramatically modulates particle selection. Results from feeding experiments, using either engineered microspheres with tailored CSC or microalgae whose CSC were blocked, showed that bivalves preferentially ingested carbohydrate-rich particles while they rejected others. Our latest investigations suggest that bivalves are able to perceive energetic deficiencies, regulate the expression of binding molecules to select the most valuable food particles, and *in fine*, satisfy their physiological needs.

Variation in thermal tolerance and swimming performance in three species of mysid shrimp

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Mysid shrimp play an important role in coastal food webs, linking zooplankton to fish. Despite occupying the same trophic level and sharing similar traits, mysid species often differ in behavior and feeding strategy; some are vertical migrators, others prefer benthic concealment. These differences may account for differences in thermal range and predation response of mysids. Temperature is highly correlated with physiological performance, making it likely that changes in ocean temperature will impact species' performance. Here, we investigated the thermal tolerance and thermal sensitivity of swimming performance (a proxy for predation response) in two mysid species from Narragansett Bay, RI (*Neomysis americana* and *Heteromysis formosa*) and one from the Gulf of Mexico (*Americamysis bahia*). We experimentally determined the critical thermal minima (CT_{min}) and maxima (CT_{max}) for each species. CT_{min} and CT_{max} were highest in *A. bahia*, but significant differences were found between *N. americana* and *H. formosa*, despite their coexistence. Curves for thermal sensitivity of swimming performance were similar across species, but *H. formosa* had the slowest bursts and did not significantly differ in swimming performance among temperatures. Swimming performance is an indicator of fitness, and under future climatic conditions, performance curves and peak performance temperature may shift.

The role of the cyanobacterial symbiont in the physiology of *Terpios hoshinota* (Porifera)

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Terpios hoshinota is a demosponge with a high abundance of a cyanobacterial symbiont that is suspected to contribute significantly to the sponge's energy budget. We investigated the role of this symbiont in the physiology of the sponge through a laboratory study on the effects of illumination, and the effectiveness of ampicillin and gentamicin antibiotic cocktail on both the sponge and its symbiont. We used a fully factorial design with light/dark and antibiotic/no antibiotic as treatments and determined the following at the end of each trial: proportion of living sponges, cyanobacterial cell density and chlorophyll-a concentration. Trials were conducted at three antibiotic cocktail concentrations: 100, 175 and 365 μg/ml H_2O. The first significant effect of the cocktail on bacterial density was in the light treatment during the 175 μg/ml H_20 trial. Our results show that a dose of 277 μg/ml H_20 leads to the death of 50% of sponge colonies. Across all treatments, bacterial densities were significantly higher in the dark versus the light treatments, while surprisingly chlorophyll-a concentration did not change significantly. This suggests that the symbiont may be dark-adapting unconventionally and that chlorophyll-a may not be a good proxy for bacterial density in this system.

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

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

Why do sea urchins eat rocks?
Quantifying nutritional value of rock ingestion by the purple sea urchin, *Strongylocentrotus purpuratus*

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Purple sea urchins alter the landscape of rocky substrates through bioerosion. With chisel-like teeth, urchins rasp the substratum ingesting sedimentary particles. This process creates pits or cavities that influence growth, behavior, and survival. However, it is not known if urchins derive any nutritional value from sedimentary rock particles. We compared growth, nutritional status, and food-conversion efficiency among three treatments: smooth glass (no particle ingestion), sandstone (1% organic), and mudstone (5% organic). The starting urchin sizes were not significantly different (test volume = 8.86 ml ± 1.83 sd). Each urchin was housed in an individual cage, in an isolated tank, and fed a restricted rehydrated-kelp diet ($0.5\ g{\cdot}d^{-1}$). We collected all fecal material to quantify organic:inorganic ratios and will dissect the samples to compare body components. Ingesting rock particles does provide nutritional value; change in size over six months was significantly greater in natural substrates than glass controls. Despite differences in organic content, there was no significant difference between sandstone and mudstone substrates perhaps because the sandstone is more friable and urchins consumed more of these particles. This study points to the pronounced effect different substrates can have on a key member of rocky intertidal and shallow subtidal habitats.

Does wave exposure trump other abiotic controls on kelp primary productivity?

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Light, nutrients and temperature have long been considered the 'big three' abiotic factors controlling primary productivity in marine environments. Water motion has been suggested as a fourth factor that could influence kelp growth rates, but few studies have simultaneously measured all four factors in-situ, preventing robust analyses of the importance of water motion relative to light, nutrients, and temperature. We transplanted *Alaria esculenta* (natural source, < 20 cm length and laboratory-reared gametophytes) onto subsurface frames at four sites along a wave-exposure gradient in the Mingan Islands (Gulf of St Lawrence, Quebec). Kelp frames provided a uniform substrate across a depth gradient at each site. Between June and October 2014, we measured light, temperature, nutrients, water motion, and kelp growth (as changes in elongation, blade area, and biomass). Effects of nutrients and temperature on kelp growth were statistically indistinguishable among sites, and the effect of light was only detectable at deeper depths. In contrast, all measures of kelp growth were highest at the site with greatest wave exposure and lowest at the most protected site. Finally, the difference in kelp growth between sites was greatest at deeper depths, suggesting water motion may be increasingly important as light decreases.

Foundation species, biodiversity hotspots, and the landscape-scale multifunctionality of a coastal ecosystem

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Increasing demands on ecosystems to provide food, clean water, and other services challenge scientists to identify how ecosystems simultaneously perform many functions. Here we explore whether secondary foundation species (mussels in our case), habitat-forming organisms that establish within primary foundation species (cordgrass), enhance biodiversity-driven multifunctionality in southeastern US salt marshes. Experiments reveal that mussel aggregations, which only persist in marsh-forming cordgrass, markedly enhance soil accretion, water infiltration, decomposition, aboveground plant biomass, and invertebrate biomass functions on patch scales; effects driven both directly through the engineering activities of the mussels themselves and indirectly through the biodiverse community they facilitate. By mapping aggregations in 12 marshes along 850km of coastline, we further demonstrate that – despite occupying only 1.1% of the marsh surface – mussels widely enhance multifunctionality at the landscape scale. Consequently, secondary foundation species should be incorporated in our understanding of forces regulating biodiversity-ecosystem function relationships and approach to managing ecosystems.

Flow-driven shifts in herbivore guild dominance and subtidal ecosystem functioning

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The diversity-ecosystem function relationship has been extensively studied on the level of individual species, yet information is lacking on the ecosystem-level impacts of realistic changes to species assemblages in natural systems. We studied the effects of wave stress, a primary environmental driver of biological processes, on the composition of macroinvertebrate and fish herbivore assemblages on rocky subtidal reefs in the Galapagos Islands and consequent impacts on the benthic ecosystem. Extreme wave exposure severely limited urchin densities and foraging rates, resulting in greater standing stock of benthic algae. However, contrary to predictions in environmental stress models, fish grazing rates were highest at wave exposed sites. Similarly, the diversity and abundance of herbivorous fishes increased as a function of turbulent flow rates. Colonization of algal communities on experimental plates revealed impacts of fish herbivory on benthic ecosystem functioning that surpass those previously considered for this system in comparison to urchin grazing. We propose an alternative to environmental stress models by describing consumer impacts as a function of consumer mobility and the severity and return time of limiting environmental stressors to explain this novel pattern.

Biodiversity is as important as physics

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Understanding how ecosystems work is of increasing practical importance as humans put ever greater pressure on them. Productivity and resilience are ultimately set by abiotic constraints, but vary widely within these limits as the kinds of organisms that inhabit them change. As numerous experiments converged on the conclusion that productivity and stability increase with biodiversity, the central question has shifted to whether and how strongly biodiversity affects ecosystem processes in the more complex milieu of wild nature. Synthesis of experimental and observational data from a range of systems reaches a surprising conclusion: system-level production and efficiency are often more clearly related to the species composition and richness of organisms—biodiversity, broadly speaking—than to regional or global gradients in environmental factors like temperature, salinity, and nutrient concentrations. This pattern has been documented in phytoplankton, seagrass beds, hard-substrate communities, deep-sea benthos, and forests. Of course biodiversity has been strongly molded by abiotic factors, so they are not independent influences. But these evolutionary relationships are beginning to unravel as a result of human impacts, emphasizing that reliable ecosystem models and forecasts in the Anthropocene will depend as much on composition of biological communities as on underlying physical forcing.

Biodiversity components (richness and evenness) effect on intertidal community structure and functioning: 3 interlinked approaches

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Climate change and human impacts on habitats induce alterations within communities that may impair relations between diversity and functions. Relationships among richness *S*, evenness *J*', community properties (stability, establishment) and functioning (productivity) of benthic intertidal communities were evaluated using 3 approaches. First, we estimated temporal stability of natural communities with different diversity profiles (*S*, *J*', identity and abundance) during 2 years. Second, we manipulated *in situ* habitat forming species diversity profiles to test their? effect on species establishment and community productivity. Third, we used mesocoms to disentangle *S*, *J*', identity and abundance of macroalgal assemblages on community productivity. Our results generally show stronger *S* and *J*' effects on community properties and functions with an increasing control from natural to in situ and mesocoms approaches. Limited effect of S and J' were observed on temporal stability of natural community. *In situ* experiments showed that diversity components affected more the multivariate structure of community than their properties (as diversity indices). Finally, our mesocoms approach did detect distinct richness effect (overyielding) and evenness on productivity. Our results highlight the need of multiple approaches, with limitations and advantages of each, to better anticipate the consequences of biodiversity on ecosystem functioning.

Environmental drivers and spatio-temporal variation in benthic fluxes in the North East Pacific

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Multiple environmental factors are thought to affect benthic fluxes, which are key indicators of ecosystem functioning. In order to determine different drivers of function and spatio-temporal variation of benthic fluxes, we collected sediment cores from contrasting VENUSh and NEPTUNE observatory sites on the British Columbia shelf and slope in May and July 2011, and September 2013 using the ROV ROPOS. Sediment cores were incubated at *in situ* temperature for 12-48 hours to study fluxes of oxygen, ammonium, nitrate, nitrite, silicate and phosphate. Multivariate analyses of benthic fluxes indicated significant variation in flux rates both spatially and temporally, and univariate analyses indicated that larger fluxes of oxygen and phosphate at inshore locations in July 2011 drove much of this variation. Redundancy analysis showed that quality of organic matter (Chl a, Chl a/Phaeo and C/N ratios), sediment characteristics (sediment mean grain size and bulk density), bottom water characteristics (depth and oxygen concentration) and prokaryote biomass explained 52.2% of the variation in benthic fluxes. These results indicate that multiple drivers influence benthic fluxes and that changes in the environment can significantly impact benthic ecosystem functioning.

Factors affecting trophic control of community structure and ecosystem functioning in experimental seagrass (*Zostera marina* L.) mesocosms

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Nutrient loading of coastal and estuarine waters threatens seagrass communities by promoting the growth of micro- and macroalgae, which then reduce the availability of light and nutrients. Populations of epifaunal invertebrates, however, have been shown to mitigate the negative impact of eutrophication through grazing. We performed a factorial mesocosm experiment in summer 2008 to examine the interactive relationships between light, nutrients, and mesograzer presence in experimental ecosystems of eelgrass (*Zostera marina* L.). We found that mesograzer presence strongly reduced epiphytic algal biomass, which remains consistent with previous experimental and field studies. We also observed a synergistic light-by-nutrient interaction that enhanced both epiphyte biomass and mesograzer abundance. The timing of this relationship was suggestive of weaker bottom-up control. Unlike previous studies, we found that light alone rarely affected either epiphyte biomass or mesograzer abundance. We believe this result may be due to a combination of macroalgal shading and persistent grazing. This experiment clarifies the trophic consequences of resource loading of both nutrients and light in an important coastal ecosystem.

Drifting away: A test of the "Outwelling Hypothesis" in the Altamaha River Estuary, Georgia. U.S.A.

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Estuaries are thought to deliver subsidies in the form of dissolved and particulate materials to offshore benthic habitats, an idea known as the "outwelling hypothesis." To determine if this hypothesis holds for the Altamaha River salt marsh estuary in southeast Georgia, U.S.A., we investigated linkages between the outflow of this estuary and hard-bottom temperate reefs located 5-20 NM off shore. Our tests for connectivity consisted of simultaneous release of 1) a fluorescent orange/red water tracing dye, Rhodamine WT, [i.e., dissolved component] and 2) satellite-enabled drifters [i.e., particulate component]. The first deployment was initiated in May 2014, during a period of high river discharge, and resulted in the dye being transported to a reef site 48 km north of the drop site in 4 days, and the drifters ending up in deep Atlantic waters east of Massachusetts in 92 days. The second deployment, initiated in September 2014, during a period of low river outflow, resulted in neither the dye nor drifters making it to offshore reefs. These results suggest that while the conduits exist for the highly heterotrophic reefs off the Georgia coast to receive estuarine subsidies, anthropogenic or natural processes that reduce river outflow could disrupt these connections.

Eelgrass community dynamics across the Northern Hemisphere

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Ecosystem processes are mediated by interactions between resource supply, consumer pressure, and community composition, with the balance shifting along environmental gradients. A frontier in basic and applied ecology is understanding how these multifarious processes interact, and organizing the complexity into predictive models. One promising way forward is the comparative-experimental approach, integrating standardized experiments with observational data. Through the *Zostera* Experimental Network (ZEN, www.zenscience.org) we utilize this approach to study the community ecology of eelgrass (*Zostera marina*), the most widespread marine plant and foundation of important but threatened coastal ecosystems throughout the northern hemisphere. In the summer of 2014, parallel field surveys and experiments were conducted at 50 sites to measure correlations between mesograzer species diversity and eelgrass genetic diversity, predation pressure, and seagrass dynamics. Biodiversity was positively correlated with plant and grazer biomass and production across our global gradients in environmental factors. Predation pressure in these systems decreased with grazer biomass and latitude. These results largely corroborate controlled, small-scale biodiversity experiments and suggest that impacts of biodiversity loss on ecosystems will be of comparable magnitude to those of other global change factors.

Loss of habitat complexity may override bottom-up stimulation in saltmarsh food webs, results from a decade long ecosystem level nutrient press experiment.

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Bottom-up forces can exhibit strong control on the function of food webs and ecosystems. The increase in the release of reactive nitrogen into the biosphere is a global bottom up press experiment. Although, some of the more traumatic effects of nutrient enrichment, such as hypoxia, are well understood we know much less about the effects of long-term moderate eutrophication. We examined the impacts of moderate nutrient enrichment on the production mummichog, *Fundulus heteroclitus*, as part of a 10-year whole ecosystem experiment in a New England, U.S.A saltmarsh. In the initial stages of nutrient enrichment we observed a classic bottom-up stimulation response in fish production. However, after the first six years fish production declined rapidly. We hypothesize the mechanism for the decline is the rapid habitat change associated with eutrophication in our saltmarsh. Indicating loss of habitat complexity can override the bottom up effect of nutrient enrichment. Our results demonstrate that long-term nutrient enrichment can have complex impacts on the production of saltmarsh fish that are not predictable by classic bottom up/ top down control theory.

Persistence of alternate state boundaries in the coastal marine ecosystem of the Aleutian Archipelago

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Kelp forests and urchin barrens are alternate states of community composition that often exist adjacent to one another in temperate marine ecosystems. This study explored the spatial persistence of kelp forest-urchin barren boundaries in the Aleutian Archipelago following the decline in sea otter populations. One-week and two-year long experiments were done to examine 1) if the boundaries between forests and barrens occur across a broad (800 km) spatial scale, 2) if they persist in the same location across years, and 3) how spatially general are biological mechanisms that influence sea urchin behavior at these boundaries. Kelp forest-urchin barren boundaries, found across our study area, persisted in the same location for the one to two years. Urchins moved into kelp forests and persisted for one to two years after all algae were cleared but would not invade kelp forests when 25% or more of the substrate was left covered in kelp. Together, these data show that kelp forest-urchin barren boundaries are spatially stable for at least two years and are maintained by physical abrasion of the seafloor by the kelps, but when the kelps are lost or reduced in abundance, the urchins can invade the forest and extend the barren areas.

Why do marine artificial structures differ from natural rocky reefs? Ecological factors determining their quality as artificial habitats for epibiota.

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Man-made structures are sprawling in marine seascapes because of increasing coastal populations; pressing development and energy demand and greater risk of coastal hazards from climate change. Interest in designing marine developments that maintain vital ecosystems and critical services is growing; but progress has been hindered by poor understanding of the ecology of these artificial habitats. We combined field observations and experiments along the North Adriatic coastline (Mediterranean Sea) to analyze the ecological performance of artificial substrata as habitats for valuable canopy-forming fucoid algae; and clarify the underlying factors supporting or inhibiting their growth. We demonstrated that the growth potential of canopy algae was significantly lower on artificial structures compared to rocky reefs. This unequal success in the two habitats was related to differences in biotic rather than abiotic factors; and the strong biotic control of canopy algae on artificial structures was related to a larger number of consumptive and non-consumptive interactions than on natural reefs. We conclude that biological factors can differ substantially between artificial and natural habitats leading to persistent differences in the structure of habitat-forming biota. Careful consideration of biotic factors should necessary when planning and designing of hard marine infrastructures to ensure the persistence of vital ecosystems.

Crowded together and drifting apart : spatial and temporal extent of green sea urchin (*Strongylocentrotus droebachiensis*) aggregations

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Green sea urchins (*Strongylocentrotus droebachiensis*) aggregate due to favorable environmental conditions, most notably available food resources such as pieces of drift algae. The presence of these aggregations is well documented in barren zones where food resources are both temporally and spatially unpredictable; however, the extent and duration of these aggregations is largely unknown. Field manipulations to examine the spatial and temporal extent of aggregations on drift kelp were carried out in barren zones of the Saint Lawrence. Small ($2m^2$) areas were cleared of large (>20 mm test diameter) urchins and either received a piece of kelp in the center or not. The density of large urchins present was monitored 3, 9, 24, and 48 hours after t=0. The temporal persistence of aggregations was determined by deploying pieces of kelp and measuring the density in the $0.25m^2$ area including each piece until densities returned to pre-manipulated levels. The effect of food is spatially limited (constrained to the $1m^2$ inner area) and temporal persistence was 3-5 days. This work suggests that large-scale population patterns and responses to disturbance could be driven by repeated cycles of aggregation and dispersion driven by spatial and temporal variability in supply of unpredictable food resources, i.e., drift algae.

Host specificity of social shrimps in a sponge holobiont system

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Intimate biological associations comprise a large part of biodiversity and clarifying the nature and the evolution of these associations has been a fundamental quest in ecology and evolution. New studies have indicated that bacterial communities could play an important role in mediating biological interactions; but explicit test remains rare. Here we studied the host specificity of ~40 species of snapping shrimps in the genus *Synalpheus* that live inside sponge canals of ~20 species of Caribbean sponges. In particular, we examined sponges and their symbiotic microbial community together as holobionts. The evolutionary trajectory of *Synalpheus* is likely closely linked to the sponge-holobionts because the sponge offers a protective and stable habitat for the majority of the shrimp's life cycle, while the community of symbiotic bacteria constitutes part of the shrimps' diet. We reconstructed the phylogeny and characterized microbial communities of sponges that are used by *Synalpheus* and found congruencies between evolutionary histories of *Synalpheus* and phylogenetic community similarities of their sponge hosts and symbiotic bacteria. Taken together, our results suggest that phylogenetic similarity of sponge-holobionts can modulate host specificity of mutualistic association.

Effects of baited crab pots on cultivated mussel (*Mytilus edulis*) survival rates

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The shore crab, *Carcinus maenas*, is a voracious predator that has the potential to reduce stocks of *Mytilus edulis* in the benthic cultivation industry. Baited pots are often deployed on cultivated mussel beds to trap and remove crabs. If trapping efficiencies are low, however, crabs may be attracted towards but not enter pots, instead feeing on mussels on the surrounding substratum. We tested whether the rate of loss of mussels attached to plates differed in areas adjacent to baited pots, unbaited pots and areas without pots, at two sea loughs (60 km apart) in Northern Ireland. In Strangford Lough, more mussels were lost from plates adjacent to baited pots than the other treatments. In Carlingford Lough there was no difference in the number of mussels lost from plates placed around any treatment. This difference could be attributed to the different assemblages of mobile benthic predators at the two loughs. The presence of the starfish *Asterias rubens*, which was absent from experimental sites in Carlingford Lough, was thought to be responsible for increased predation rates near baited pots in Strangford. It is, therefore, important to consider local predatory regimes when deploying crab pots as a predator mitigation technique to ensure predations rates are reduced and not enhanced.

Is the bar open? Estimating steelhead abundance in estuaries

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Estuaries provide important rearing habitat for many species of marine and freshwater fishes. Seasonally-closed estuaries in central California are particularly important for steelhead (*Oncorhynchus mykiss*). Juvenile steelhead that rear in bar-built estuaries benefit from enhanced growth conditions afforded by marine derived nutrients. Subsequently, they exhibit increased marine survival and account for greater than 80% of returning adults. Thus, accurately estimating the number of steelhead rearing in estuary habitat is essential for effective management. Using a two-day sampling design and recaptures of steelhead individually marked with passive integrated transponders (PIT tags), we compared abundance estimates generated with mark-recapture models assuming: a) an open population (POPAN and CJS models), and b) a closed population (Ricker method). Monthly abundance estimates from POPAN and CJS were similar to the Ricker method when the closure assumption was met and recapture rates were ≥10%. The open population methods resulted in more precise abundance estimates when the closure assumption was not met or recapture rates were low. In most years, POPAN was the most appropriate technique for estimating abundance while minimizing effort and disturbance to the estuary.

Trapped for life: Effects of ghost fishing lobster traps in the Florida spiny lobster (*Panulirus argus*) fishery

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Ghost fishing is the capacity of lost traps to continue to catch and kill animals. In the spiny lobster (*Panulirus argus*) fishery in Florida, the effects of long-term confinement of lobsters in ghost fishing lobster traps are of particular concern given the estimated tens of thousands of traps lost annually. We compared the nutritional condition of lobsters found in natural habitats to those found confined in existing ghost fishing traps using hemolymph serum protein and dry weight indices. Lobsters from ghost traps had significantly lower nutritional condition than those from nearby natural habitats. In addition, 10 experimental traps simulating ghost fishing were deployed to examine nutritional degradation over a 6-week period; blood serum protein declined significantly at each biweekly sampling period. We estimated lobster mortality in simulated ghost traps by distributing 40 each of the three types of lobster traps (wire, wood–wire hybrid, and wood slat) at three locations in the Florida Keys. We estimated that ghost traps continue fishing for over a year and result in the death of hundreds of thousands of lobsters. Understanding the effects of confinement and mortality resulting from ghost fishing will aid in management decisions to maintain sustainability of the fishery.

Assessing ecological consequences of claw removal on stone crabs (*Menippe mercenaria*) in the field using a non-invasive tagging method

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Stone crabs support a fishery that is considered renewable because crabs are returned to the water after their claws are harvested under the assumption that marketable claws will be regenerated. Stone crabs are also ecologically important as predators that are reliant on large claws for crushing bivalve prey. Despite their economic importance, the fate of stone crabs following claw removal is not well understood. Using a non-invasive tagging method, we examined how claw removal affects stone crab recapture rates, movement patterns, and the likelihood of return to the fishery of harvested crabs. Intact crabs were recaptured earlier (median time of 24 days at large), at a higher rate (22.3%), and at greater distances from the release point (433.1 meters;) than one-clawed crabs (32 days; 9.7% recaptured; 250.3 meters). Reduced crab mobility following claw removal resulted in decreased recapture potential until wounds were healed (unless wounds were large and caused immediate mortality) and may have lowered foraging success for one-clawed and clawless crabs, which are more dependent on soft-bodied prey. Claw removal reduces the foraging abilities of surviving crabs, which delays their potential return to the fishery, and may create cascading effects on prey resources.

The ghost fishing impacts of derelict crab traps in the *Callinectes sapidus* fishery

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The blue crab (*Callinectes sapidus*) is an economically important species with annual landings surpassing 80 thousand metric tons. However, as in other trap fisheries, crab traps become derelict due for a variety of reasons. In order to understand the impact to the environment and marine biomass, we initiated a yearlong field study in 2012 and 2013 to determine blue crab mortality and bycatch associated with ghost fishing using a combination of monthly visits to experimental derelict traps and mark-recapture techniques. Initial catch rates of traps ranged from 1.6-6.9 crabs/trap, whereas new recruitment to the traps over the study period ranged from 1-11.9 crabs/trap. Crabs lived in the traps for up to 5 months after initial capture, and a variety of saltwater and estuarine species were caught in the derelict gear. Current estimates of days to derelict trap extinction ranged from 116 days to 825 days. These results help us to better understand the problem of derelict gear to find effective solutions.

Efficacy of alginate bait for the blue crab (*Callinectes sapidus)* fishery in Louisiana

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Louisiana leads all U.S. states in blue crab *(Callinectes sapidus)* landings, but high fuel and bait costs may soon hinder productivity of Louisiana commercial crabbers. The primary baitfish, Atlantic menhaden (*Brevoortia tyrannus),* is expected to increase in price and decrease in availability with implementation of lower total allowable catch. To reduce costs for fishermen and prepare for potential unavailability of baitfish, we have developed an alternative bait that incorporates natural attractants into a semi-rigid alginate matrix. Lab testing and preliminary field tests show shrimp waste, widely available from Louisiana processors, may be a suitable attractant. We conducted three seasons of testing at three sites across Southern Louisiana to compare catch rates and longevity of standard baitfish and shrimp alginate bait. Catch rates of shrimp alginate baits were equal to or less than menhaden. Percent of total catch ranged from 50% shrimp alginate to 32% shrimp alginate compared to menhaden. Sex ratios of captured crabs do not differ between bait types. Alginate bait remains intact as long, or longer, than standard baitfish. These findings show promise in the alternative shrimp alginate bait.

Combining fishery-independent and fishery-dependent methods: a pilot study on a hybrid approach to sampling reef fishes

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The assessment and management of marine fishes requires data on their abundance, size and age structure, and reproductive status. Traditionally, these data have largely been provided by fishery-dependent (FD) sources which are confounded by non-random sampling, varying management regulations and socioeconomic factors. Increasingly, data are being provided by broad-scale, fishery-independent (FI) surveys that are based on a statistically-valid sampling design, incorporate standardized sampling methodologies, and characterize the entire population. However, FI surveys are expensive and differences in trends in abundance between FD and FI data are often difficult to reconcile. We therefore tested various FD and FI hooked gear methods and also developed and tested a hybrid approach to sampling reef fishes by integrating aspects of both FD and FI methods. We found that the catch and size structure of focal reef fishes were similar between the hybrid method and passive FI methods currently used. Additionally, the hybrid approach typically performed as well or better than purely FD methods. Because the hybrid method was as effective or better than other FI or FD methods for sampling reef fishes, this method warrants further consideration as a research and monitoring tool.

Comparison of sulfite-free melanosis control treatments for shrimp vessels in coastal Louisiana

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Melanosis, also known as "blackspot," is the darkening of pigmentation in fresh shrimp due to an enzymatic bioreaction following oxygen exposure. While no human health concerns have been identified with melanosis, the use of sodium metabisulfites have traditionally been employed to delay this reaction to yield a more aesthetically pleasing product. Sulfites, however, do pose certain health risks and are often used in excess of that permitted by the FDA. In this study we test varying concentrations of two commercially available products containing 4-hexylresorcinol (Everfresh and Prawnfresh) against a standard sodium metabisulfite solution to analyze their efficacy to inhibit the development of melanosis in penaeid shrimp (*Litopenaeus setiferus* and *Farfantepenaeus aztecus*) in coastal Louisiana. Preliminary results show that Everfresh and Prawnfresh are significantly more successful in delaying melanosis than the sodium metabisulfite treatment. Continued testing is necessary to consider other variables that may affect melanosis control such as species differences, seasonality, and onboard handling. The cost-effectiveness and practicality of these products must also be analyzed to make recommendations for use onboard commercial shrimp harvesting vessels.

A new forecasting model for the American lobster fishery using the American Lobster Settlement Index and environmental indicators

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Accurate predictions of fishery recruitment represent the holy grail of fisheries science and management. As is true for many lobster fisheries, spawner-recruit relationships for the American lobster (*Homarus americanus*) in the northwest Atlantic have been particularly elusive to science. Settler-recruit relationships, which track cohorts after larvae have settled to the sea bed, have proven more useful in several species, however. Here we describe a new fishery recruitment forecasting model based on the American Lobster Settlement Index (ALSI), a comprehensive annual diver-based survey that quantifies the abundance of young-of-year lobsters as they populate coastal nursery habitats. The model begins with the settlement index to set initial year-class strength and subjects cohorts to variable growth as determined by thermal regime, as well as proxies for natural mortality, including predator abundance and shell disease prevalence. Projections are validated against independent indicators of recruitment to the fishery. This talk will describe our model development to date. We anticipate that projection models such as this, which use environmental parameters as direct drivers of cohort strength, will allow stakeholders to make enhanced decisions relating to the management and prosecution of this important fishery.

Comparing recovery rates among fishes with various levels of protection inside and outside a no-take MPA in Belize.

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As pressures mount to protect the economic and ecological benefits of its coral reefs and associated fisheries, the Caribbean nation of Belize has increased the area of its territorial sea under no-take protection as well as issued nation-wide harvest bans on herbivorous fishes. In 2011, we set up a long term monitoring program at the onset of the newly enforced no-take area within the South Water Caye Marine Reserve (SWCMR), with 12 permanent transects inside the reserve boundary and 12 outside. An aggressive protocol assesses hard corals and fishes for abundance, diversity, size distribution and condition while generating benthic composition photoquadrats. After eight bi-annual surveys, we found that coral cover and community composition differ between habitats, but are similar inside and outside the no-take area. The abundances of several fish species, however, are significantly higher inside the no-take area, a pattern that presumably existed prior to no-take enforcement. After 4 years of monitoring, we expect that fish species with nation-wide harvest bans (Scarids and Acanthurids) should show no change in abundance or biomass inside the SWCMR when compared to outside the reserve. However, for long-lived species of commercial interest, trajectories of abundance or biomass should differ inside the no-take area.

Are there 'big ones' left in the Gulf of Mexico: an 80-year, multi-species record of trophy fish sizes

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Large fishes are top predators in most marine ecosystems, and evidence of their reduced prominence is a serious concern for ecosystem management. Unfortunately, quantitative data regarding potential changes in the abundances of large, mobile fishes are scarce, hindering evaluation of long-term trends. Utilizing eight decades of records from the three oldest fishing rodeos within the Gulf of Mexico (in Alabama, Mississippi, and Texas), we examined trends in the weights of prize-winning catches as one measure for the abundance of large fishes. All three rodeos have similar characteristics including timing (July–August), length (3 days), and rules (the 3 heaviest fish of a given species earn prizes). Moreover, all three rodeos are distinctly multi-species, providing long-term fishery dependent data for 22 taxa among 4 functional guilds: highly migratory (N=3 species), reef-associated (N=4), estuarine (N=5), and coastal pelagic (N=10). For all guilds except the coastal pelagics, fishes landed presently are as large or larger than at any time in the past. Conversely, for 9 of 10 coastal pelagics, sizes peaked in the 1980s and have declined significantly (up to 75% smaller) since. Life-history, environmental, and trophic drivers explaining the vulnerability of the largest coastal pelagics (relative to other guilds) are being evaluated.

Examining life history traits between two ecotypes of a local North American population of *Littorina saxatilis*

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Littorina saxatilis is a Littorinid snail with the capacity for strong local adaptation, leading to the emergence of distinct ecotypes. Most research on *L. saxatilis* ecotypes has been conducted in Europe, while little is known in North America. A local population of *L. saxatilis* in Long Island, NY (where two of the most common North American ecotypes, 'barnacle' and 'typical', reside) was examined during 2013 and 2014 to determine whether the ecotypes differed in their proportion of brooding females and growth rates. 100 snails per ecotype were collected monthly and dissected to determine proportions of brooding females per ecotype. Growth rates were measured over several months beginning when the snail was a crawl-away juvenile and every 2-3 weeks thereafter by taking images under a stereomicroscope. Some monthly differences in the proportion of brooding females were found between ecotypes—with the lowest proportions in hot summer months and the highest in spring and fall for both years. Growth rates differed between ecotypes, with the typical ecotype growing faster than the barnacle ecotype. Our investigation represents the first in-depth study of ecotypic differences in the snail in the region, providing essential data for further understanding life history in this important evolutionary species.

Gamete recognition proteins affect the relationship between physical gamete traits and reproductive success under increasingly polyspermic conditions

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Sperm availability may influence the evolution of gamete traits in broadcast spawners. Gamete characteristics that are advantageous under sperm limiting conditions might be deleterious with increasing sperm density, as the probability of egg death via polyspermy increases. Gamete traits that can modify the sperm-egg collision rate, such as sperm swimming speed and egg size, and those that can modify the sperm-egg fusion rate, such as compatibility between sperm and egg gamete recognition proteins (GRPs), are known to influence fertilization success. What remains unclear is how these factors interact to influence fertilization success. We utilized no-choice crosses to examine how GRPs affect the relationship between gamete traits that modify the sperm-egg collision rate and reproductive success in the tunicate *Ciona intestinalis*. Crosses were conducted utilizing two different sperm-egg contact times and different sperm concentrations to create increasingly polyspermic conditions. Crossed individuals were sequenced for male and female GRPs. GRP variants were examined for how they interacted to influence fertilization success in models that also incorporated sperm swimming behavior and egg size. Results indicate that interactions between gamete trait, male genotype, and female genotype can influence fertilization success, and the significance of those interactions is dependent on sperm availability.

Sex and the not so single snail: relatedness drives offspring size variation within egg capsules of the intertidal gastropod, *Nucella ostrina*

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Maternal provisioning of resources can have far-reaching consequences for all aspects of an offspring's life-history. Given that the resources available to mothers are finite, they can produce either many small, or fewer large, offspring. In general, the optimal maternal strategy is to produce offspring of a single size. However, allocation strategies are subject to an inherent conflict between mothers and offspring: since mothers typically divide their resources among many offspring at the expense of each individual's fitness, each offspring would prefer a greater share of parental resources. All else being equal, multiple mating by females increases the likelihood that brood mates will be half-, rather than full, -sibs; consuming parental resources at the expense of a sibling therefore entails diminishing inclusive fitness costs as the degree of polyandry rises. Here we used microsatellite markers to quantify parentage and sibling relatedness in natural populations of the marine snail, *Nucella ostrina*. We then asked whether patterns of offspring size variation among hatchlings were best explained by maternal resource allocation, mating system, or some combination of both. Our results show that the relatedness of offspring within a capsules is the only significant predictor of both the mean and variance of hatchling size.

Ecology and phylogenetic history as predictors of marine life history mode

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Biogeographic patterns of marine invertebrates are largely a result of dispersal of early life stages. Because developmental mode directly impacts dispersal potential, factors affecting developmental mode also affect patterns of biogeography, diversity, and abundance. Marine invertebrate life histories can involve either direct development or a larval stage. The developmental mode of any given taxon may be a result of two major factors: phylogenetic constraint and biology/ecology (or a combination). Using generalized least-squares models, we investigated the extent to which these intrinsic and extrinsic factors can predict developmental mode in marine invertebrates. In species of the marine gastropod family Conidae, we examined the effects of phylogenetic history, shell morphometry, prey and habitat types, climate, and environment on egg size and number of eggs per capsule. Surprisingly, our results showed large effects of morphometry but none of phylogeny. Quantifying the predictive power of these variables is a first step in untangling the complex biogeographical patterns observed in marine organisms.

To Flower or not to flower, a seagrass question

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Plants must allocate finite available resources between essential functions, such as growth, maintenance, and reproduction. Clonal plants must also divide these resources between sexual reproduction to form novel genets and asexual reproduction to form genetically identical ramets. In a given environment or physiological state, clonal plants may more heavily invest in either sexual or asexual reproduction. For many seagrass species, the role of sexual reproduction in population resilience and stability has only recently become evident. To determine factors most affecting *Zostera marina* flowering, in situ manipulations of sediment nutrients, light, and rhizome structure were initiated in spring and fall of 2013 in the Chesapeake Bay region. Flowering intensity did not significantly differ between sediment nutrient treatments despite significant increases in growth within fertilized sites and a significant interaction in clonal reproduction between nutrient treatments and the site of the manipulation. Flowering was negatively influenced by disruption in rhizome structure. As such, the influence of nutrients and disturbance on reproduction may vary across geographic space. In combination with other projects, these data provide insights into the role physiological state and environment play on investment in sexual or asexual reproduction in *Z. marina* populations.

Multiple paternity is a shared reproductive strategy in the live-bearing surfperches that may be associated with female bateman gradients, cryptic female choice, and sexual selection

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According to Bateman's principle, female fecundity is limited relative to males, setting the expectation that males should be promiscuous, while females should be choosy and select fewer mates. However, several surfperches (Embiotocidae) exhibit multiple paternity within broods suggesting that females benefit from polyandry. We found evidence for multiple paternity in a basal embiotocid taxon (*Hyperprosopon anale*), indicating that this tactic is a shared reproductive strategy among surfperches. Previous studies found no correlation between mating success and reproductive success (i.e., a Bateman gradient). However, by including samples from a broader range of reproductive size classes, we found evidence consistent with a Bateman gradient in two surfperch species for the first time. Female Bateman gradients in the surfperches indicate that sexual selection is likely complex in this system, with the potential for conflicting optima between sexes. We argue that the complex reproductive natural history of surfperches is characterized by several traits that may be associated with cryptic female choice, including protracted oogenesis, uterine sac complexity, and sperm storage.

Local scale phenotypic plasticity of barnacle cirri within mussel disturbance gaps

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Barnacle feeding appendages (cirri) exhibit phenotypic plasticity in different flow regimes, such as wave-exposed and protected shores. However, there has been no previous research into the spatial scale over which this phenotypic plasticity occurs, even though there is evidence that flow can vary substantially among closely spaced microhabitats. In a field study conducted in northern California, we transplanted intertidal barnacles (*Chthamalus dalli)* to three microhabitats within mussel disturbance gaps: the perimeter and center of the gaps, and between the mussels just outside the gap. We hypothesized that the very different flow intensities and regimes of these microhabitats would result in morphologically distinct cirri. In a 3-week pilot experiment, we found suggestive evidence of morphological differences between the center versus perimeter of the mussel bed gap, and an asymmetry in rates of change in the diameter versus length of cirri. In a second experiment, we sampled transplanted barnacles in these three microhabitats through time (after 0, 4, and 6 weeks) to test whether cirral traits (length, ramus diameter, and setae length) shifted plastically among microhabitats and at different rates. Preliminary results indicate that the ramus diameter may adjust at a quicker rate than the other two dimensions.

Physiological and life history changes in *Placida dendritica* mediated by the invasion of *Codium fragile.*

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Introduced species alter not only the ecosystems that they invade, but also the species that they interact with. When *Codium fragile* was introduced into the Gulf of Maine it quickly became one of the dominant canopy species and is still abundant in many places today. The herbivorous sea slug *Placida dendritica* (Gastropoda, Sacoglossa) is native to the Gulf of Maine and originally fed exclusively on *Bryopsis plumosa*, but has now adapted to feed on *C. fragile*. My research focuses on how the invasion of *C. fragile* affected the physiology and life history of *P. dendritica*. Anecdotal observations indicate that *P. dendritica* grows larger and at a faster rate when feeding on *B. plumosa*. I am examining this by measuring growth and reproduction of animals raised on each algae. The morphology of radular teeth, which is known to be plastic, is one possible reason for the difference in growth on each algae. To look for long-term changes due to the change in food, I plan to compare radular teeth of animals raised on each diet to specimens that were collected before *C. fragile* invaded local ecosystems. The results of this study will contribute to understanding how introduced species affect native species.

Biodiversity and ecosystem productivity in communities of the invasive common reed, *Phragmites australis,* across a latitudinal gradient

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Ecological theory supported by empirical evidence suggests diversity and productivity decrease with increasing latitude. But much less is known about the strength and direction of these latitudinal patterns in non-native communities. In order to investigate whether diversity and productivity vary across a latitudinal gradient in invaded communities, we sampled 3-5 stands of the invasive common reed, *Phragmites australis*, in eight salt marsh sites along the Atlantic Coast of the United States ranging from Massachusetts (42° N) to South Carolina (32° N). Within each stand, we quantified plant species percent cover and counted *P. australis* stems and associated fauna in six 0.25 m^2 quadrats. Within each quadrat, we also took one 15 cm deep sediment core to assess carbon stores. Both live stem density and percent cover of *P. australis* increased from south-to-north, suggesting a positive relationship between latitude and productivity. Faunal abundance and species richness also increased with latitude within invasive *P. australis* communities, whereas plant species richness did not change. Finally, sediment carbon stores increased with latitude. These latitudinal patterns in species diversity and ecosystem function of invasive *P. australis* communities contrast widely reported latitudinal trends for several native communities including salt marshes.

Indirect effects of freshwater discharges on seagrass beds in SW Florida: Mesograzers as mediators of epiphyte growth?

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Seagrass beds in the Caloosahatachee Estuary have declined with increased human development in the watershed, which has altered the timing and volume of freshwater and nutrient inputs. Overgrowth of epiphytic algae may contribute to seagrass declines. Small invertebrate grazers (mesograzers) are thought to aid seagrass through removal of excess epiphytes. We recorded seagrass abundance, epiphyte levels, and mesograzer abundance bimonthly for one year at two sites in the Caloosahatchee Estuary. We then compared these reponses to seasonal and site variations in salinity and other abiotic factors related to freshwater discharges. Seagrass was most abundant at the highest salinity site and during the summer months. Epiphyte levels did not exhibit a clear seasonal or salinity-related pattern but showed interesting correlations with mesograzer abundance. Mesograzer species richness was much greater closer to the mouth of the estuary than the further upstream, indicating a positive effect of high salinity on mesograzer diversity. Reduction in mesograzer diversity by high freshwater discharge events could exacerbate problems of epiphyte overgrowth.

Further description of hybridization in the sea stars *Asterias rubens* and *Asterias forbesi* through the application of species-specific genetic markers

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Hybridization occurs when two separate species reproduce to form hybrid offspring. If the hybrid offspring backcross with individuals of their parental species, the offspring result with varying amounts of the parental genomes. Following the retreat of the Last Glacial Maxima 20 000 years ago, two sea star species, *Asterias forbesi* and *A. rubens* came into secondary contact in the Gulf of Maine where they began to hybridize. Previous research in our lab studied the frequency of hybridization at eight locations along the east coast using morphological identifications as well two nuclear DNA markers (ITS and EF1-4α) to create a hybrid index and measure the frequency and extent of hybridization between the two species. Here, we used Polymerase Chair Reaction (PCR) and sequencing to add additional mitochondrial DNA identifications to the hybrid index. Our findings showed low levels of hybridization (~11%), with only 22 individuals being identified as hybrids in sympatric populations out of the 203 samples. Two of these hybrids are likely second-generation hybrid offspring, and the remaining 20 are first generation. Combinations of traits identified as being hybrid were varying between the individuals. Here we present new hybrid indices comprised of morphological, nuclear, and mitochondrial traits.

Variation in clonal structure of the pillar coral, *Dendrogyra cylindrus*, in Florida and Curacao

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The threatened pillar coral, *Dendrogyra cylindrus*, is a conspicuous yet uncommon coral on Caribbean reefs. It is the only species in its genus within the family Meandrinidae, and thus its extinction would mean the extinction of a genus. Prior to nursery rearing and outplanting of fragments as a restoration measure, the population genetics of the host and its intracellular symbiotic algae (*Symbiodinium*) must be evaluated. Twelve microsatellite markers were developed *de novo* for *D. cylindrus* and six existing microsatellites markers were applied to its dominant *Symbiodinium*. Coral colonies from sites along the Florida Reef Tract and Curacao were genotyped using these markers. Results indicate that *D. cylindrus* is highly clonal in Florida, with dense patches containing just one host genotype. Host populations in Curacao, however, appear to be more diverse and were differentiated from Florida populations. While *D. cylindrus* is known as a gonochoric broadcast spawner, observations revealed that pillars of identical genotype released gametes of the opposite sex, indicating that *D. cylindrus* might be a sequential hermaphrodite instead. The low genotypic diversity and apparent population differentiation in *D. cylindrus* make it imperative that diverse genotypes are incorporated into husbandry and restoration efforts throughout the Caribbean.

Population genetic analysis of a symbiotically luminous cardinalfish using genome-wide RAD markers

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The sea urchin cardinalfish, *Siphamia tubifer* (Perciformes: Apogonidae), a paternal mouthbrooder, inhabits shallow coral reefs in the Indo-Pacific. Brooding males release their larvae into the plankton and the larvae initiate a symbiosis with the luminous bacterium, *Photobacterium mandapamensis*, which they acquire from the environment. Juvenile and adult fish are nocturnally active and use the bacterial light while foraging over the reef. During the day, the fish aggregate in groups among the spines of diademid urchins, and adults exhibit daily site fidelity to a host urchin and significant homing ability if displaced. To examine the possible relationship between site fidelity and population genetic structure in *S. tubifer*, we used double-digest, restriction site associated sequencing (ddRAD-seq) of fish collected from reef sites around Okinawa, Japan. Analysis of over 10,000 single nucleotide polymorphisms (SNPs) across 95 individuals from six discrete sampling locations and times revealed significant F_{ST} values and clustering at a spatial scale as small as eight kilometers. This scale of genetic structuring indicates some degree of self-recruitment and has implications for the timing and location of symbiont acquisition by developing larvae.

Population Structure of the snail *Mexacanthina lugubris lugubris* in Northern Baja California and Southern California

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The snail *Mexacanthina lugubris lugubris* is found in the high intertidal along the coast of Southern California and Northern Baja California where it feeds primarily on the barnacle *Chthamalus fissus*. We previously demonstrated that *C. fissus* populations exhibit moderate geographic structure but lack an obvious latitudinal gradient, which we expected given that *C. fissus* produces a dispersive larval stage. Here we report results from analysis of sequence variation in the mitochondrial cytochrome oxidase I locus and the nuclear elongation factor 1a locus of several *M. l. lugubris* populations. Given that *M. l. lugubris* lacks a dispersive larval stage, we expect that populations of this snail will exhibit significant geographic structure and a latitudinal gradient.

Population genomics of an oyster metapopulation; Implications for restoration

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In the Hudson River estuary improved water quality has motivated the restoration of oyster populations. Some habitats targeted for restoration are in low salinity waters of the upper estuary. Two questions are critical for restoration planning: (1) Is gene flow between lower and upper estuary oyster populations low enough to cause genetic structure? (2) Are low salinity oyster populations locally adapted? We have studied these questions in Delaware Bay and Hudson River oysters using a combination of genomic approaches applied to gene expression (RNAseq) and genomic polymorphisms (ddRADseq). Our results demonstrate that phenotypic plasticity in gene expression and natural selection across environmental gradients both contribute to the broad realized niche of oysters in these estuaries. Strong selection presumably operates every generation in marginal habitats but gene flow was always assumed to be too high for local adaptation. In the Hudson River we found evidence for non-neutral loci (genome scan outliers and allele-salinity correlations) and when these were removed from the data genomic patterns still depicted genetic differentiation between upper and lower estuary populations indicating limited gene flow. These results suggest that hatchery-based restoration of upper estuary oyster populations should use broodstock oysters collected from the upper estuary.

The Phylogeography of *Tenellid* Nudibranchs

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Tenellids are tiny estuarine nudibranchs first described in the 1800s (Nordmann). Since then, over ten different taxonomic classifications have surfaced for this genus, all based on morphological characteristics. *T. adspersa* and *T. fuscata* have both been described as residing in Western Atlantic estuaries, but the only recorded difference between the two are variations in reproductive structures, for example. Scientific literature is also conflicted when it comes to which *Tenellids* inhabit specific ranges. Since *Tenellids* are found in temperate coastal and estuarine waters worldwide (Specimens have been cited in Japan, Brazil, Australia, Africa, Norway, France, Ireland, Spain, the Azov Sea, San Francisco Bay, and stretching along the entire East Coast of the United States), it seems unlikely that they comprise a single species. *Tenellids* are important because they play significant roles in fouling communities: they can produce both lecithotrophic and planktotrophic larvae in the same spawn mass and by the same individual and they can also decimate entire colonies of their hydroid prey within a day. This study seeks to provide an overview of molecular and morphological comparisons between *Tenellids* from around the world to distinguish populations and to place them within a nudibranch phylogeny more appropriately.

Genomics as a powerful tool for lobster fishery

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Delineating fishery management units requires legislation to determine demographically independent populations. To achieve that goal, we genotyped 10,000 filtered SNPs using RAD-sequencing for 586 American lobsters collected in 17 locations, distributed across a large portion of the species' range. Our results highlight the existence of a hierarchical genetic structure separating lobsters from the Gulf of Maine and the Gulf of St. Lawrence. Furthermore, within each region, fine-scale population structuring analysis revealed 11 genetically distinct populations. By selecting and using the most differentiated SNPs for assignement test, 94% of the individuals were correctly assigned to their region of origin and 81% of all individual lobsters were assigned to their respective local population. Overall, these findings demonstrate the increased accuracy of using a large number of SNPs in determining fine scale population structure and conducting assignment analysis in highly connected marine species.

Pioneer epifaunal assemblage of an oyster shell artificial reef: implication for oyster restoration and enhancement of local biodiversity

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Oyster reefs are thought to enhance oyster stocks and marine habitats yet little is known about their associated epifaunal communities in the UK. We investigated how artificial reef modules made from *Ostrea edulis* shells and containing live oysters influenced oyster spat settlement and general local biodiversity by comparing temporal changes in epifaunal assemblages on elevated artificial reefs made from oyster shells and on shells deposited on the seabed. A total of 54 epifaunal species belonging to 7 phyla were recorded on oyster valves. Fifty four epifaunal species, including *O. edulis* spat, were found on the elevated valves while only 24 species and no *O. edulis* spat were found on seabed valves. Multidimensional scaling (MDS) indicated a difference between epifaunal assemblages on reef and seabed shells. ANOSIM Global R value was 0.4967 (P=0.01) indicating that the shell based epifaunal communities differed in some respects but also had species in common. We conclude that elevated reefs and sampling months (seasons) affected species richness plus elevating the shells/reefs accelerated pioneer species succession.

Genotypic diversity and identity influence restoration potential of the threatened coral species *Acropora cervicornis*

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The decline of coral ecosystems worldwide has prompted the development of active restoration strategies to accelerate the recovery of degraded coral reefs. However, our knowledge of factors that influence restoration success lags far behind restoration activity. Genetic diversity can influence processes that transcend population, community and ecosystem dynamics. Here, we investigated the influence of genotypic diversity and identity on the growth, bleaching resistance and survival of nursery raised *Acropora cervicornis* transplants to identify candidate genotypes for active coral restoration. Cumulative survivorship varied more than 3-fold among genotypes while rates of coral growth varied by more than 200% and were significantly influenced by the interaction between outplant density and genotype. Our findings identify important differences in the performance of nursery-raised *A. cervicornis* genotypes and suggest that restoration practitioners should consider both genotype and outplant design when selecting corals for future restoration activities.

Fecundity of nursery reared staghorn coral: As an indication of outplant success

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The staghorn coral (*Acropora cervicornis*) is a foundation species on Caribbean coral reefs which has experienced population declines to a level where natural population recovery is in question. As a listed US Endangered Species Act Threatened species, *A. cervicornis* has been identified as a high priority species in need of active restoration to promote population recovery. *Acropora cervicornis* coral nurseries have been identified as productive restoration methods to promote population recovery by increasing colony abundance and more importantly, by reducing the spatial gap between populations increasing the likelihood of successful sexual reproduction. Nova Southeastern University Oceanographic Center manages one such nursery offshore Broward County, Florida. Survivorship of nursery reared outplanted colonies has been documented, however their sexual reproductive capacity is not well understood. We are addressing this information gap by examining gamete abundance and development in natural, nursery, and outplanted *A. cervicornis* colonies. Tissue samples were collected from each colony type for one week preceding a spawning event. Gametes were found in all colony types, however natural colonies were the most fecund while outplant colonies were the least fecund. Reduced fecundity in outplanted colonies may be attributed to differing colony ages or transplantation stress.

Multiple effects of Caribbean King Crab enhancement on patch reef communities in the Florida Keys

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Coral reefs in the Florida Keys and elsewhere may have degraded beyond the threshold where natural recovery of corals is possible. Most restoration programs directly enhance live coral cover via transplantation of cultivated corals so as to bolster coral spawning stocks and drive recovery via natural recruitment. However, absent appropriate settlement habitat, recruitment failure will continue and reefs in the region will remain largely depauperate of live coral. Here, we present the results of a 12 month study on the effect of stocking the herbivorous Caribbean King Crab (*Mithrax spinosissimus*) on patch reefs dominated by benthic macroalgae. We recorded a significant reduction in the cover of benthic macroalgae in both treatments where crabs were stocked. Moreover, the abundance and diversity of reef fishes increased around reefs where algae and herbivores were manipulated as compared to control reefs. These results suggest that in sufficient numbers the Caribbean King Crab enhances habitat suitability for fishes and perhaps for recruiting or transplanted corals.

Monitoring Functional Recovery of a Restored Oyster Reef: a population ecology and food web approach

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Determining the proficiency of constructed habitats in restoring ecological function and facilitating ecological enhancement is a principal aspect of estuarine restoration ecology. With the aim of evaluating functional recovery, we examined temporal trends in trophic structure, species composition and biomass of epifauna in a newly restored oyster reef (*Crassostrea virginica*) relative to an established natural oyster reef in the Mission-Aransas Estuary, Texas. Oysters and mobile reef-resident epifauna were collected with sampling trays seasonally in 2013. Community trophic structure was investigated with C and N stable isotope analysis. Total epifaunal biomass was not found to be significantly different between reef types or seasons. Oyster abundance was significantly greater in the natural reef during the winter sampling period only. The restored reef community was initially dominated by the filter feeding porcelain crab (*Petrolisthes sp.*), becoming more similar to the natural reef in composition by the final sampling period. Food web analysis indicated similar community food chain length and primary resource utilization between reefs. Our findings indicate the restored oyster reef was successful in restoring forage habitat, productivity and nutrient cycling through the support of epibenthic communities with similar composition and functional characteristics as those found on natural oyster reef.

Assessing the habitat value of alternative substrates for oyster reef restoration

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Oyster reefs, formed by the generational settlement of *Crassostrea virginica*, serve as an important ecological habitat within Texas estuaries. The structural complexities of oyster reefs provide important habitat and spawning substrate for fish and mobile crustaceans and biogenic habitat for benthic invertebrates. Oyster populations have declined worldwide in response to factors such as disease and habitat degradation. Reef restoration is an increasingly used tool to combat habitat losses with oyster shell as the preferred substrate. However, with limited oyster shell available for restoration practices, alternative substrates have been used. Substrate type may affect oyster recruitment and growth, leading to the long-term sustainability of the reef. It is not fully understood how substrate type affects faunal assemblages in early stages of reef development, when substrate may have the greatest influence on faunal recruitment and habitat use. We restored 6 acres of oyster reef in the Mission-Aransas Estuary, TX, in July 2013 using concrete, limestone, river rock, and oyster shell substrates. We are sampling the reef for 18 months to compare oyster recruitment and faunal community development associated with each substrate type. Results will provide information on the ability of alternative substrates to promote sustainable management of oyster reef resources via restoration.

Evaluation of transplantation techniques for nursery reared *Acropora cervicornis* fragments

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Numerous types of materials and transplantation techniques, including but not limited to rope, rebar, cement, wire, PVC, epoxy, nails, cable ties and monofilament, have been used in coral nurseries. All of which have had varying degrees of success and depend on many influencing factors such as species, nursery location, and environmental conditions. The feasibility of a few of these materials/ transplantation techniques was evaluated using *Acropora cervicornis* fragments within an *in situ* coral nursery in Broward County, Florida. Nursery corals were either reared on concrete modules, PVC arrays, floating lines or floating trees. The success of each technique was evaluated based on coral survival and growth, level of maintenance and cost to build and maintain the structures. All corals were evaluated for survival and presence of disease and predation across one year. Growth measurements were recorded for corals on the concrete modules and lines. Survival was highest on the floating nurseries, however, growth was not significantly different between the techniques. Cost per coral was greatest for the concrete module technique, but maintenance was the least. All techniques are practical options for raising *A. cervicornis* and are ultimately dependent on the nursery site conditions, available budget and projected length of project.

The Effect of Sponge Restoration on Fish and Invertebrate Communities in the Florida Keys

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Over the past thirty years, cyanobacteria blooms have periodically decimated hard-bottom sponge communities in the Florida Keys, FL. Among other impacts, this loss of sponges has critically affected the organisms that depend on them for nursery habitat, feeding grounds, and shelter. In an effort to refurbish healthy, sponge-dominated hard-bottom communities in affected areas, experimental restoration of sponge communities is underway but its effectiveness in re-establishing fish and macroinvertebrate abundance, residency, and biodiversity is unknown. We used diver surveys and time-lapse videography to catalogue the abundance, residency, and diversity of macrofauna attracted to restoration sites as compared to disturbed, unrestored sites and undisturbed hard-bottom sites. Preliminary analysis of those data indicates that biodiversity and residency are increased in restored areas, a trend suggesting that sponge restoration also benefits ecosystem function.

Overcoming critical recruitment bottlenecks limiting seedling establishment in degraded seagrass ecosystems

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Processes that influence the establishment of a seedling from a seed are often diverse and complex, with seeds and seedlings navigating a landscape of biotic and abiotic bottlenecks. The primary objective of this project was to identify and overcome recruitment bottlenecks limiting seedling establishment in degraded seagrass ecosystems. We determined the degree to which early life-stage transition rates vary spatially along ecological gradients by planting *Posidonia australis* seedlings at locations with a history of seagrass loss and recovery. 100 seedlings were planted into each of 9 x $1m^2$ plots randomly assigned to one of three caging treatments; (i) uncaged (control), (ii) caged and (iii) half cage repeated at 3 juxtaposed sites at 8 broader geographical locations and monitored for presence/absence at 1, 2.5, 4.5 6.5 months, and 1 year after planting. In general, there were high rates of mortality across all treatments and all sites with some sites experiencing 100% mortality in the first month of development. Mortality appears to be driven by high biological (blue manna crabs, sand dollars) and hydrodynamic activity (waves and swell) rather than water quality processes (nutrients and light). Long term persistence of seedlings may be more a function of 'a recruitment window of opportunity'.

Evaluating functional success of a restored oyster reef through a variety of metrics

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Oyster reefs are important foundational habitats and provide many ecosystem services. A century of habitat degradation caused the ecological extinction of oysters in many estuaries, thus spurring restoration efforts. In this study, nearly four acres of oyster reef habitat were restored in Copano Bay, Texas and a variety of metrics were monitored over two years to assess functional success. The restored reef showed significant oyster recruitment and growth, with oyster abundance and size comparable to reference conditions within the first year. Disease (*Perkinsus marinus*) prevalence remained slightly lower at the restored reef. Resident and transient fauna communities immediately recruited to the restored reef, and abundance and diversity were comparable to reference habitats. Stable isotope signatures of oysters and food resources indicate that sediment organic matter is an important component of oyster diets, contributing a larger proportion relative to suspended particulate organic matter, even at the higher vertical relief of the restored reef compared to reference conditions. Our results indicate that the restored reef is successful in providing important ecological functions when compared with reference conditions, and these functions should translate to the provision of valuable ecosystem services. This work should provide key information to support future restoration efforts.

Bay Scallop (*Argopecten irradians*) Restoration in the Virginia Coastal Bays: The Role of Predation on Spring vs. Fall Cohort Survival

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While the importance of predation in controlling many natural bivalve populations is well established, it is often overlooked in the restoration strategies for depleted populations. Adult bay scallops (*Argopecten irradians*) along the U.S. mid-Atlantic coast spawn multiple times per year, typically once in the early summer and again in the early fall. Larvae generally settle on seagrass leaves to avoid benthic predators, but shift to the sediment surface around 15mm in size when they become less vulnerable to predation. The objectives of this study were to determine how bay scallop size and season of recruitment affect survival and how predation influences survival both seasonally and annually. The goal is to incorporate this information into a restoration strategy for a Virginia seaside lagoon system where bay scallops have been absent since the disappearance of eelgrass in the 1930s. Tethering experiments, conducted in re-established eelgrass during summer and fall of 2013 and 2014, of small (~10 mm) and large (~30 mm) juvenile bay scallops showed significant differences between the two years, likely due to the differences in the predator community. Our results point to the importance employing an adaptive restoration approach which incorporates real-time abundances of predators into restoration activities.

Fish usage of a recently created artificial reef in the Chesapeake Bay

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Restoration of habitats in the Chesapeake Bay has been occurring for many years and the benefits can be seen for numerous organisms in the area. Reef balls have been used to create hard substrate in estuaries that oysters can settle on and establish new reefs. We conducted a study of fish usage on these structures using different types of bait both on and off the restored reefs and an adjacent natural reef. We found that we had a much higher catch per minute rate on the reef than off the reef. This was true with both the plastic bait with smaller hooks and the larger hooks with cut bait. From the data collected during this experiment and a Maryland Department of Natural Resources study we can conclude that fish are more abundant on the artificial reef structure and that white perch (*Morone americana)* are the most abundant of the species that are recreationally caught by hook and line both on and off the reef in this area. This allows us to make the statement that the artificial reefs created with reef balls are not only beneficial to oysters but also used by several of the recreationally important species of fish.

Patterns of fine-scale genetic structure in the eastern oyster, *Crassostrea virginica*

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Recent advances in genetic markers have enabled researchers to identify high levels of relatedness between marine invertebrates residing within close proximity, challenging the idea that most marine populations are genetically homogenous over broad spatial scales. However, genetic structure on multiple scales has yet to be assessed in the eastern oyster (*Crassostrea virginica*). Using sixteen highly polymorphic microsatellite markers specifically designed for *C. virginica*, this project aims to characterize fine-scale genetic structure in natural populations, and examine the effects of landscape and hydrodynamics on settlement behavior. Adult oysters will be collected from six reefs at each of three different regions in North Carolina, and patterns of genetic structure within and among reefs and sites will be assessed. Preliminary data reveal that all microsatellite markers are highly polymorphic (4 – 12 alleles per locus) and that (1) there is significant genetic differentiation among oyster reefs located 10 meters apart, and (2) the amount of genetic diversity varies significantly among reefs patches within a single region. We anticipate that (1) aggregation of kin within sites will be nonrandom and significantly higher than expected by chance; and (2) genetic structure will be greater in areas of weak upwelling due to insufficient admixture of planktonic larvae.

Preliminary Diet Assessment of the Atlantic Sea Nettle *Chrysaora quinquecirrha* in Barnegat Bay, New Jersey using Next Generation Sequencing

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High-throughput DNA sequencing methodologies have proven useful in deciphering the food items of generalist predators but have yet to be applied to gelatinous predators. The use of next generation sequencing (NGS) for the identification of gelatinous animal gut and tentacle content offers a powerful alternative to traditional methods of visual identification. *Chrysaora quinquecirrha* (Atlantic sea nettle) has progressively become more abundant in Mid-Atlantic United State estuaries potentially having detrimental effects on both marine organisms and human enterprises. Full characterization of this predator's diet is quintessential for a comprehensive understanding of its impacts on the food web. Here we tested the efficacy of NGS for prey item determination in the Atlantic sea nettle. We implemented a NGS "shotgun" approach to randomly sequence DNA fragments isolated from gut lavages and gastric pouch/tentacle picks. Over 550,000 contigs were assembled of which 100 contigs were confidently assigned to 23 different taxa including several soft bodied organisms previously undocumented as prey species: [(crustaceans (7), fish (1), ctenophores (1), anemones (3), worms (3), flukes (1), echinoderms (2), mollusks (4), hemichordates (1)]. Our results indicate that a "shotgun" NGS approach is a viable alternative to visual identification methods for identifying Atlantic sea nettle prey items.

Development of a qPCR assay for analyzing viral load and dose-response in Caribbean spiny lobsters exposed to *Panulirus argus* Virus 1 (PaV1)

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Real-time quantitative polymerase chain reaction (qPCR) is a tool commonly used to diagnose, characterize, and study pathogenic viruses. This highly sensitive and specific technique is valuable in determining the susceptibility of a host to infection following exposure to a given dose of viral particles. We developed a qPCR assay to gauge the dose-response relationship in the Caribbean spiny lobster, *Panulirus argus*, exposed to *Panulirus argus* Virus 1 (PaV1). PaV1 infections show variability in pathology across lobster size scales, establishing lethal disease in juveniles and asymptomatic infections in adults. The drivers of this variability in PaV1 were largely unknown, but based on prior experiments we hypothesized that larger lobsters require a larger dose of PaV1 before becoming infected. Using hemolymph from infected lobsters, we determined that this assay detects as low as 10 viral copies and has an efficiency of at least 85%. The qPCR assay has been validated, and results from the dose-response experiments will be available by the time of the conference. QPCR will allow resource managers to more effectively screen lobster populations for PaV1, monitor its impact on the lobster fisheries, and will be an important tool for future aquaculture efforts on *P. argus*.

Comparative phylogeography in a multi-level sea anemone symbiosis: effects of host specificity on patterns of co-diversification and genetic diversity

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Tropical coral reefs achieve much of their success and diversity from a network of biological interactions, yet we know very little about how biodiversity evolves in these complex multi-level symbioses over time and space. Sea anemone symbioses are useful model systems for exploring questions surrounding the evolution of biodiversity in tropical marine ecosystems because they are tightly linked ecological communities that share a biogeographic history, are taxonomically diverse, and vary in their strength of symbiotic association. Here, we use mtDNA barcodes to reconstruct the phylogeographic structure across five co-occurring crustacean symbionts that associate with the corkscrew sea anemone *Bartholomea annulata* on Caribbean coral reefs. We observe no concordant phylogeographic structures across all five symbionts, but all specialist taxa harbor greater genetic diversity than generalists, and we recover previously undescribed cryptic diversity in the cleaner shrimps *Ancylomenes pedersoni* and *Periclimenes yucatanicus*. Species delimitation analyses delimit at least three cryptic lineages in both cleaner shrimps, and thus, a pattern of cryptic speciation is beginning to emerge in this symbiosis among specialist taxa. Our results have applied conservation implications for these commercially harvested animals, and provide important rationale for pursuing Next Generation Sequencing techniques.

The telomere sequence repeat in *Limulus polyphemus*: Can it be used to determine the age structure of the Long Island Sound population?

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We have been studying the population ecology of *Limulus polyphemus* in Long Island Sound to determine if it is growing or in decline. Healthy, growing populations of *Limulus* should have proportionally more newly molted adults, but our studies have shown a low percentage of animals younger than 1-2 years past terminal molt (~11-13 yo). In question is whether these data indicate a true reduction in the replacement of aging adults with younger animals or if they underestimate the LIS population's age structure due to inherently imprecise assessments of carapace wear. Therefore, we are evaluating whether changes in the length of telomere sequences can provide a more accurate estimate of the relative ages of *Limulus* individuals. The *Limulus* telomere sequence is unknown, but based on published telomere studies in insects and closely-related species such as scorpions, we hypothesized that it too would share their insect $(TTAGG)_n$ telomere sequence repeats. Southern hybridization of a digoxygenin-labeled probe $(CCTAA)_3$ to genomic DNAs isolated from *Limulus* amebocytes and control insects revealed that *Limulus* does indeed carry the insect telomere sequence repeat. In addition, we will discuss preliminary results of terminal restriction fragment analysis to characterize telomere lengths in juvenile crabs versus class 3 adults.

Do microbial symbionts and chemical defenses change across latitudes for the sponge *Ircinia campana*?

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Microbial symbionts in sponges are generally host-specific and stable across the host sponge range, but variation within a species has been detected across different environments and latitudes. A latitudinal variation in the palatability of several sponges has also been detected, but no study has investigated whether this pattern coincides with variations in microbial communities. Sponge associated microbes produce many secondary metabolites and changes to the community may result in changes to host's chemical defenses. We compared the microbial communities and chemical defenses of the sponge *Ircinia campana* from five sites (North Carolina, Georgia, Florida, Belize, Panama). Laboratory palatability assays using food infused with crude organic sponge extracts were used to evaluate differences in chemical defenses. The bacterial assemblages were characterized using terminal-restriction fragment length polymorphism analysis and Illumina sequencing of 16S ribosomal RNA genes. Although sponge samples were consistently chemically defended across all sites, *I. campana* from different locations contained significantly distinct bacterial communities. These results show that changes in the microbial community do not necessarily coincide with changes in chemical defenses. Our study increased the number of sponge species known to display latitudinal variation in their microbial symbionts, suggesting that this pattern is more common than previously thought.

Characterizing variation in genetic diversity in naturally and artificially seeded Eastern oyster reefs

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The genetic diversity of groups of interacting individuals, especially for ecological dominants or habitat-forming species, can have profound effects at the population, community, and ecosystem levels, influencing total biomass, resilience from disturbance, invasion success, and the abundance and diversity of other species. However, our understanding of the spatial scales at which genetic diversity is partitioned in natural populations is limited. More importantly, how this diversity is distributed at scales where it has been shown to affect these ecological processes remains largely unexplored. Here we use 10 microsatellite markers to characterize the distribution of genetic diversity over two field seasons at three artificially and three naturally seeded reefs in the Eastern oyster, *Crassostrea virginica*, an economically valuable, habitat-forming species that is found along the Atlantic and Gulf coasts of the United States. We find that naturally seeded reefs harbor significantly greater levels of genetic diversity, and that this difference remains stable across seasons, despite the potential for high gene flow among reefs. Further work is needed to determine how these differences might affect reef productivity and survival, which could have important implications for the design of reef restoration activities.

Genotype and phenotype in a changing ocean: can standing genetic variation in stress responses rescue mussel populations from climate change?

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As physical and chemical features of the ocean change in response to the changing climate, marine calcifiers face the biochemical and physiological challenge of maintaining calcium carbonate shell structure in a more acidic environment. A key component to understanding organismal response to this multifactorial stressor is linking underlying genetic variation to phenotypic variation in stress response. We take advantage of the genomic gradient across the blue mussel hybrid zone (*Mytilus edulis* × *Mytilus trossulus*) in the Gulf of Maine to link genetic variation with variance in calcification rates in response to lower pH, higher temperatures, and reduced food availability. Intertidal blue mussels were collected from midcoast Maine to Cobscook Bay and subjected to a 14-day exposure in a laboratory common garden treatment of climate stress (20°C, pH 7.8, water filtered to 5uM). The control treatment simulated ambient Harpswell Sound summer conditions (17°C, pH 8.1, 0.34mL/individual/day Shellfish Diet 1800). Interestingly, the climate stress treatment rendered a significantly greater variation in calcification rates (change in buoyant weight) than the control treatment, while the means did not vary significantly. Calcification phenotypes are now being linked to underlying genomic variation through a next generation sequencing-based genome reduction SNP assay and genome-wide association survey.

Population structure and demographic history of a trans-tropical gooseneck barnacle, *Pollicipes elegans*

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Many marine species have "anti-tropical" distributions, in which populations occupy the temperate zones of the northern and southern hemisphere but are absent from the tropics. Though common, the biogeographic origins of the anti-tropical distribution are difficult to resolve for most species, as it can arise via vicariance or through trans-equatorial migration, the latter of which is thought to be more common. The intertidal gooseneck barnacle, *Pollicipes elegans*, exhibits a trans-tropical distribution in the eastern Pacific ocean, with disjunct populations in Northern Peru, Northwestern Mexico, and El Salvador, thus providing a unique case to examine the biogeography of a species that may be in the process of becoming anti-tropical. Here, we present new population genomic data for *P. elegans* generated via RADseq, and we explore the utility of a large, short-read genomic data set for resolving population genetic parameters and demographic history using coalescent and simulation-based approaches. Preliminary results reveal subtle but significant population structure, with highest pairwise F_{st} values between Peru and the Mexican populations, which is consistent with previous microsatellite results. We will present results from coalescent-based analyses implemented in IMa2 and approximate Bayesian computation (ABC) that provide genome-wide inference of the demographic and biogeographic history of *P. elegans*.

Predator non-consumptive effects on prey recruitment weaken with prey density

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We investigated how the non-consumptive effects (NCEs) of predatory dogwhelks (*Nucella lapillus*) on intertidal barnacle (*Semibalanus balanoides*) recruitment are influenced by barnacle recruit and adult density. We did field experiments on the Atlantic coast and the Gulf of St. Lawrence coast of Nova Scotia, Canada, spanning the barnacle recruitment seasons (May-June) of 2011, 2012, and 2013. We tested for predator NCEs by manipulating dogwhelk presence near recruitment plates for barnacles, without allowing dogwhelks to access the plates. Firstly, we tested for barnacle recruit density influences on NCEs. Under high phytoplankton abundance (food supply for barnacles; Gulf 2011), barnacle recruit density was high and dogwhelk NCEs were absent. Under moderate food supply (Gulf 2013 and Atlantic 2011 and 2013), recruit density was moderate and negative NCEs occurred. Secondly, we tested for adult barnacle influences on NCEs, for which we manipulated adult barnacle presence in 2012 and 2013 on the Atlantic coast. Negative NCEs occurred in the absence of adult barnacles, but their presence neutralized NCEs. Barnacle recruits and adults chemically attract barnacle larvae seeking settlement, suggesting that recruit and adult barnacle cues, when abundant, can neutralize dogwhelk cue influences. Barnacle food supply indirectly weakens dogwhelk NCEs by increasing barnacle recruit density.

Planktonic larval mortality rates are lower than widely expected

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Knowledge of mortality during the planktonic phase of the typical marine life cycle is essential to understanding population dynamics and managing marine resources. However, estimating larval mortality is extremely challenging, because the fate of microscopic larvae cannot be easily tracked. We used a two-pronged approach to provide reliable estimates of larval mortality: (1) frequent, long-term sampling where the combination of larval behaviors and recirculation greatly reduces larval transport to and from the study area, and (2) an improved method of calculating larval mortality that consists of a vertical life table with a negative binomial distribution to account for the notorious patchiness of plankton. Larval mortality rates of our study species (barnacles and crabs) were 0.14 larvae/d, which produce survivorships over an order of magnitude higher than commonly determined for marine larvae. These estimates are reliable because they were similar for species with similar dispersal patterns. They are conservative because they were conducted in a highly advective upwelling system, and they may be even lower in other systems using our approach. Until other systems can be tested, our improved estimates should be used to inform future models of population dynamics and the evolution of life histories in the sea.

What explains the life history of marine propagules?
A new model for the life history of barnacle larvae

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Dispersal of many marine invertebrates is limited to the larval phase. This larval phase is diverse with regard to duration and feeding mode, even between closely related taxa. In aplanktonic species, the larval phase is nearly absent, while planktotrophic larvae disperse for weeks or months. Vance proposed a model that explains correlations among larval traits, but also their biogeographic distribution. While many taxa seem to follow Vance's model, it does not appear to be universal. We used a comparative framework to investigate larval traits in a taxon that does not seem to follow Vance's model: the Thoracican barnacles (Arthropoda: Cirripedia: Thoracica). We considered the larval traits larval mode, planktonic larval duration (PLD), and egg size, and the ecological variables temperature and three approximations of larval food availability (chlorophyll a concentrations, water depth and nutrient concentrations). We identified relationships that differ from the expectations of Vances' model, and developed a new framework for the life history evolution of barnacle larvae. Our model may also be applicable to other taxa, and identifies the need for new empirical and theoretical studies.

Vertical settlement patterns of bivalves in a northeastern Florida estuary

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The ability of larvae to migrate vertically can be crucial in strengthening dispersal potential as it allows the larvae to somewhat control dispersal. Therefore, understanding larval behavior and depth structure at different life stages can be important to identifying source populations and for predicting range expansion of invasive species. This study examines settlement of bivalves in a northeastern Florida estuarine system. We compared settlement of several bivalve species among different depths and between main channel and feeder creek sites. Vertical distribution of settlement was tested by placing spat collectors at multiple depths at 4 sites, 2 main channel sites and 2 feeder creek sites, and collected every month for 3 months over the summer for 2 years. Spat of the introduced mussel species, *Perna viridis and Mytella charruana*, and native species, *Crassostrea virginica* (oyster), and, *Geukensia demissa* (mussel) were enumerated under a stereoscope. We found that all species were more abundant in the main channel than the feeder creeks with virtually no settlement of introduced species in feeder creeks. *Crassostrea virginica* was the only species to show significant settlement high in the water column, while *P. viridis* and *G. demissa* were most abundant at the lowest depth.

Bring the noise: sound playback increases species diversity on degraded hard-bottom habitat in the Florida Keys

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Planktonic marine larvae respond to a host of cues in search of appropriate settlement habitat. Among these cues, sound can carry biologically relevant information great distances, irrespective of currents. Though disentangling the effects of various habitat cues on recruitment processes is difficult in the field, studies of degraded habitats undergoing ecological restoration affords scientists the opportunity to empirically test specific cues and hypotheses. Florida Bay, a shallow bay lying between the southern tip of Florida and the Florida Keys, has recently experienced drastic ecological changes including sponge-killing cyanobacteria blooms. Once ubiquitous, sponge-dominated hard-bottom habitat - an important nursery habitat for numerous fish and invertebrate species - is now degraded and devoid of sponges over large expanses of the bay. Recordings from sponge die-off areas indicate that the soundscape differs from that of healthy hard-bottom. Within these degraded habitats, we tested the role of sound in recruitment using a sound playback experiment during full and new moons in the summer of 2014. Collections of larvae recruiting into sites where the sounds of healthy hardbottom habitat were played were more diverse than control sites where no sound was played, suggesting that sound serves a strong role in the settlement of numerous types of larvae.

Connectivity between submerged and near-sea-surface coral reefs: can submerged reef populations act as refuges?

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Connectivity is key to coral reef resilience. However, connectivity models rarely account for deep or submerged reefs, despite their widespread occurrence in many coral reef provinces. Here, we model coral larval connectivity among submerged and near-sea-surface (NSS) reefs, investigate differences in dispersal potential for coral larvae from differing reef morphologies, and estimate the potential for deeper reef habitats (> 10m) to provide a source of larvae to shallower reef habitats (< 10m). We used two newly developed, high-resolution models to identify the location and spatial extent of submerged and NSS reefs and to simulate oceanographic currents ('SLIM') affecting larval dispersal in the Great Barrier Reef, Australia. Dispersal patterns for five depth-generalist coral species with differing life histories and dispersal potential were modelled using an Individual-Based Model. NSS reefs were the largest source of coral larvae, but submerged reefs exported a greater proportion of larvae per unit area to other reefs. Larvae originating from submerged reefs also dispersed greater distances. Recruits on shallow-water reef habitats primarily originated from other shallow areas, but two-way connectivity did occur between deep and shallow habitats. The hydrodynamic environment on submerged reefs results in larvae dispersing greater distances, making them important as source reefs following disturbances.

Orientation of substrata and putative predators have marked consequences for jellyfish (*Aurelia aurita*) polyp settlement

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Scyphozoan jellyfish (e.g. *Aurelia aurita*) have a benthic polyp life stage that requires hard substratum for settlement. Coastal urbanisation may provide the polyp life stage with additional settlement opportunities compared to space limited natural habitats, contributing towards localised jellyfish blooms.

To test whether jellyfish polyp settlement was influenced by the orientation of man-made structures, acrylic settlement plates (reflecting materials used widely in aquaculture) were positioned in vertical, upward facing and downward facing orientations within a circular experimental tank. Following the introduction of *A.aurita* planulae larvae, highest densities of polyps were found on vertical and upward facing orientations and lowest on the underside of settlement plates. These findings are contrary to previous studies, where planulae were found to settle predominately on the underside of substrata. Possible drivers of these differences are explored with respect to experimental design during controlled settlement experiments.

Furthermore, we investigated *A.aurita* planulae settlement when presented with high and low densities of putative benthic competitors (i.e. macroalgae and mussels), with dead mussel shells used as structural mimics (i.e. secondary controls). Settlement was lower in high-density live mussel treatments suggesting that such species might decrease the numbers of planulae larvae through ingestion.

Larval biology of the Caribbean octocoral *Antillogorgia americana* and its implications for dispersal

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Interest in the extent of larval dispersal and population connectivity of coral reef taxa has increased exponentially. While new methodological approaches have greatly improved our understanding of the abiotic and biotic factors governing larval dispersal at sea, the role of larval biology in controlling dispersal remains largely unknown, particularly in benthic invertebrates like corals. In this study we characterized spawning, larval development, swimming behavior, longevity, survivorship and settlement of the Caribbean gorgonian *Antillogorgia americana*. In the Florida Keys, *A. americana* colonies kept in outdoor tanks spawned during 3 and 1 day periods, 5 and 20 days after the full moon of November 2014, respectively. Fertilized eggs were positively buoyant and developed into motile planulae over 2-3 days. In the laboratory, larval settlement was first observed 5-12 days following spawning and larvae remained competent to settle for over 60 days. During this period, most larvae remained at the water surface as a result of active swimming behavior. In the predator-free, laboratory environment larval mortality was extremely low (~ 10%). The long pre- and competency periods, allied with active swimming behavior should lead to a high dispersal potential, which may explain the broad distribution of *A. americana* in the Caribbean.

Inferring larval transport mechanisms from barnacle settlement and high resolution physical measurements in a Southern California rocky shore

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Obtaining adequate biological measurements to resolve larval transport is challenging, since larval distributions are patchy, abundance varies with time, and relevant larval distributions must be obtained during episodic larval transport events. Ecologists sometimes use larval settlement and physical time series instead of larval distributions during larval transport to infer larval transport, and whereas obtaining these time-series is relatively less challenging than measuring larval transport, interpretation of settlement measurements can be difficult. We measured barnacle *Chthamalus spp.*, and *Balanus glandula* settlement daily using 12 PVC plates in a Southern California rocky shore from April to July, and from September to December, 2014. Time series of water temperature, circulation, and pressure were also obtained in the nearshore zone, and we measured a range of hydrodynamic conditions. As in previous studies, we found large variability in settlement. For example, for the April to July period, larval settlement started low, followed by even lower values from May to June, and then increased sharply for the rest of the measurement period, coinciding with a change in the structure of the water column. Previous observations in a location ~15 km away indicate different patterns, and we speculate that local processes might influence spatial variability in settlement.

Adaptive larval sampling in nearshore internal tidal bore events

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Recent studies suggest that larval transport in the nearshore zone plays a central role in larval dispersal and connectivity of shallow water species. In Southern California, internal tidal bores and waves can promote onshore larval transport, particularly during spring and summer months when the water column is well-stratified. We combined high-resolution physical measurements (temperature, currents and pressure) with measures of barnacle (*Chthalamus* spp., *Balanus glandula*, and *Pollicipes polymerus*) larval distributions in a nearshore, rocky intertidal region in La Jolla, California, USA. Larvae were sampled spring-summer 2014 using a semi-vortex pump outfitted with a flow meter, that filtered water through a 112µm mesh net. We used a real-time temperature telemetry system to identify the passage of warm fronts associated with the shallowing of the internal tide. As such, we identified seven warm front events, and adaptively sampled the nearshore (within 100m of the rocky intertidal adult habitat) larval distributions at four depths (0.15m, 0.75m, 2m, and 0.2m above bottom), prior to, within, and following the passage of warm fronts. Barnacle nauplii were less abundant than cyprid-stage larvae in most samples. Cyprids were most abundant in mid-depths, except during certain frontal conditions when they moved to surface waters. We will examine the relationship between the hydodynamic conditions during our study and larval distributions, discussing the implications for nearshore larval transport.

The first field evidence of fertilization success in the giant sea scallop

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Fishing down sedentary broadcast spawners challenges their reproductive success by depleting natural aggregations that are thought to promote high rates of fertilization. Here I present the first field experiments on fertilization success in the giant sea scallop, *Placopecten magellanicus*, a commercially valuable sedentary broadcast spawner in the Northwest Atlantic. Building on previous laboratory studies using 24 h time integrated fertilization experiments, we (1) developed and tested a Nitex mesh chamber to measure relative rates of fertilization success *in situ*, and (2) assessed fertilization in series of field experiments progressing from dockside field manipulations to natural population in a coastal estuary. Notwithstanding fertilization chamber artifacts, dockside results suggested that density effects might be detectable in natural populations exceeding 10-fold differences in density. However, in both manipulated and natural populations spanning 10-fold differences or less, we could not detect a significant effect of density or distance on fertilization. We suspect that scallops in the field populations were not spawning synchronously on any given 24-h fertilization trial. If true, differences in fertilization may only be detectable across population density gradients in the event of mass, synchronous, spawning or across more dramatic differences in population density that we could only produce in dockside manipulations.

Coastal plankton and mining industry in northern Chile: why should we be concerned

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An increasing need for energy and water due to mining operations has prompted a growing intervention of coastal settings along the Chilean coast. Among several different potential impacts is the one exerted upon planktonic communities in the area of influence of those enterprises due to the extensive use of seawater. Important volumes of seawater are utilized mainly in cooling systems of power plants and also for desalination purposes. Bays are settings of choice given their protected conditions. In many occasions these activities coexist with MAEBR's, thus one of the legitimate concerns is the impact of the water suction upon the meroplankton of many local benthic species. After several seasons studying a bay system (~30° S) –where seasonal upwelling events are common– we have accumulated ample evidence on plankton distribution and abundance and related it to physical forcing mechanisms. Very high rates of primary productivity and chlorophyll-*a*, presence of abundant and diverse phyto and zooplankton, are common, and retentive conditions within the bay further explain these patterns. Hence, plankton and water use can coexist but mitigation measures based on solid scientific findings must be considered. Funding: Andesiron; FisioAqua.

Enhanced late-stage larval abundance capable of important movement: evidence for generalized retention mechanisms.

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Interaction of larval behavior and local oceanographic conditions can result in novel and discrete patterns of meroplankton distribution, regardless of their preferred adult habitat. With the notion that an embayment represents a coastal feature where plankton can accumulate, during 2013 we pursued an intensive plankton survey program within an area of upwelling-favorable conditions in northern Chile (~30°S). We specifically focused on two important groups, namely megalopae of decapod crustaceans and fish larvae, both exhibiting important mobility capabilities. We hypothesized that a greater abundance of such larvae within the bay involves local physical retention features together with the capability of those larvae to actively move through the water column. Our results show that greater abundance for megalopae and fish larvae occurred during Winter and Fall, respectively, and that greater abundance coincided with a more stable water column, which in turn was the condition in the most protected points within the bay. Megalopae mostly corresponded to local coastal species, while fish larvae mostly corresponded to pelagic species. Evidence of movement came from vertical migration observed during night-day surveys. Thus, retention in these groups occurs in spite of strong advections due to upwelling/downwelling conditions. Funding: Andesiron; FisioAqua.

High-resolution plankton studies in coastal settings represent a fundamental tool for well-informed decision-making: an example from a northern Chilean bay

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Due to ever-increasing use of coastal waters for industrial purposes, it is fundamental to understand the interactions between local biodiversity and oceanographic processes in order to preserve coastal marine ecosystems. Totoralillo Norte (~30° S) is an embayment located within a well-known area of recurring upwelling events, as well as where important part of Chile's mining industry occurs. Intensive seasonal sampling during 2013 and 2014 exhibited an abundant and diverse planktonic community, conformed by 130 phytoplanktonic species and 164 zooplanktonic species. Very abundant diatoms were responsible for most of the high primary production rates inside the bay (13.4 g C $m^{-2}d^{-1}$). Copepods dominated the holoplankton, whereas meroplankton was mainly composed of larval stages of barnacles, mollusks, decapods, bryozoa and fish. Unexpectedly, highest abundances of phytoplankton and zooplankton and highest concentrations of nutrients, chlorophyll-*a* and primary production were recorded during the winter of 2013, attributable to a strong upwelling event around the sampling period even under relatively cold conditions. Intensive studies like this, performed frequently, can help unveil important ecological patterns and related processes; hence guide better-informed decision-making processes. Funding: Andesiron; FisioAqua.

Avoidance of future predators and orientation towards conspecifics: A complex response of blue mussel (*Mytilus edulis*) larvae to chemical cues

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Work on odor cues involved in larval settlement decisions has produced valuable mechanistic information on how larvae detect and follow specific cues to reach appropriate habitat. While the majority of work has focused on cues larvae orient towards (positive), comparably less is known regarding cues larvae detect and directly avoid (negative), especially for smaller, weaker swimming invertebrate taxa. Recent research also highlights the ability of larvae to detect cues that indicate post-settlement suitability of habitat (i.e., future competitors and predators). Larvae could thus encounter a suite of potential cues during transport and settlement, the responses to which have potential implications for establishing settlement and population connectivity patterns. We explored the effects of multiple potentially positive (conspecifics; algal habitat) and negative (post-settlement predators) settlement cues on the behavior of competent *Mytilus edulis* larvae in a simple fluid environment and found that larval behavior differed among cues and varied predictably with *a priori* expectations based on *M. edulis* ecology. Results suggest chemical cues can play a complex role in determining net larval trajectories, even for small, weakly swimming taxa.

The influence of vertical movement on dispersal of American lobster (*Homarus americanus*) larvae

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We applied a bio-physical semi-Langrangian model to predict the drift of larval American lobster from hatch to post-larval settlement. Packets of simulated larvae were released from St. George's Bay, in the Gulf of St. Lawrence, and were allowed to drift within the model domain of coastal Atlantic Canada at 2 km resolution. We set pelagic residency according to temperature-dependant stage durations. Laboratory experiments helped evaluate swimming capability and relative vertical position of four pelagic larval stages under various lighting conditions. We observed variable vertical distribution for first stages, subsurface distributions for intermediate stages, and surface distributions for final stage larvae. We formulated behavioural rules of simulated larvae for each developmental stage from laboratory observations. Vertical movement in the water column significantly influenced simulated dispersal trajectories and distance. In particular, increased vertical movement significantly extended dispersal compared to the static surface distributions often utilized in larval dispersal models. Our results highlight the implications of behaviour on dispersal and connectivity of larval American lobster and demonstrate how incorporation of realistic behavioural inputs into bio-physical models offers a powerful tool to advance understanding of larval transport and recruitment.

A technique for frequent rapid assessment of potential recruits to biofouling communities on floating docks

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The rapid growth of dominant competitors in the hospitable physical environment of artificial structures floating in marine environments is one factor that makes frequent quantification of early settlement patterns in a biofouling community challenging. This study utilized microscope slides housed in microscope slide boxes as settlement plates to determine their suitability for rapidly quantifying early settlement in a fouling community. Twelve boxes, each containing 6 slides separated by 1.5 cm, were suspended 3 meters off the Fox Point Dock in Boston Harbor, Massachusetts in September 2014. After 2.5 weeks, the slides were examined and a tubiculous amphipod species and an assemblage of tunicates dominated the slides. In addition, this study tested how two factors, slide orientation (vertical or horizontal) and slide texture (rough or smooth), affected their settlement. The relative ease of deployment and data collection indicate that this technique should prove useful in multi-factorial designs to frequently test for the abundances of native and invasive species during early settlement and the microhabitat characteristics that affect their settlement.

Temporal and Spatial Relationship of Adult and Planula *Chrysaora quinquecirrha* Barnegat Bay, NJ

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The scyphozoan *Chrysaora quinquecirrha* has become a common nuisance species in Barnegat Bay, New Jersey over the last decade. However, the number of medusa observed in the Bay after Super-storm Sandy has been considerably reduced. Two years after the storm the numbers of medusa observed in lift net samples has remained low. Molecular analysis of planula larvae via qPCR has also shown that numbers of planula larvae decreased following the storm event. This suggests that the damage caused by Sandy impacted the resident population within the Bay. The post storm removal of substrate, containing podocysts, from the Bay may account for the decrease in both adult and larval stages of this organism in 2013 and reduced planula larvae, limited polyp recruitment, and subsequent adults and larvae in 2014. The decline in larval abundance is important as it directly relates to polyp settlement and asexual reproduction of this species, as well as perpetuation of the population. Future studies will be needed to determine the lasting impacts of Super-storm Sandy on jellyfish populations.

Mechanisms of reproductive failure in the barnacle *Semibalanus balanoides*

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Temperature can strongly influence the distribution and abundance of species through its influence on the physiology of adult and early life history stages. Historically, recruitment of *S. balanoides* has been strongly correlated with sea surface temperature, and in some cases range shifts have been associated with reproductive failure. Several hypotheses exist to explain temperature dependent reproductive success in *S. balanoides* including inhibition of fertilization and a number of hypotheses involving the consequences of high temperatures during embryonic brooding. We tested whether fertilization was inhibited by high temperatures and found fertilization was only inhibited at temperatures higher than those typically experienced during the time of brooding. Additionally, we sampled developing embryos from throughout the range of *S. balanoides* along the eastern United States coast and deployed temperature data loggers to better understand the role of both air and water temperatures in determining the reproductive success of *S. balanoides*.

Temporal stability and variation of metapopulation connectivity within a marine system

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As many marine invertebrates have a dispersive planktonic phase, the spatial scale of demographic connectivity among local populations remains a key, but elusive, parameter driving population and metapopulation dynamics. Temporal variation in the scale of connectivity remains, however, largely undocumented despite its recognized importance for predicting population responses to environmental changes. To assess the temporal stability of metapopulation connectivity, we conducted a large-scale survey of a blue mussel (*Mytilus* spp.) metapopulation for five years along a 100-km section of coastline of the Gaspé Peninsula (Québec, Canada). For each year, we estimated the scale of demographic coupling among 27 to 29 sites within our study region using the spatial cross-covariance between adult abundance and recruit density across sites. Despite large inter-annual variability in overall recruit abundance, our analysis revealed stationary distributions of adult and recruit abundance. More importantly, our analysis revealed a consistent demographic coupling among populations at a distance ranging from 12 to 24 km in all but one of the five years studied. The scale of connectivity in this system is thus temporally stable but can occasionally show irregular fluctuations, and our results provide evidence in support of the integration of time-varying connectivity to marine metapopulation and reserve network theories.

Species and stage – specific barnacle larval distributions obtained from AUV sampling and genetic analysis in Buzzards Bay, Massachusetts, USA

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We describe a new method to autonomously collect larvae and environmental data such as temperature, salinity, and circulation. A large volume *in situ* pumping system, recently developed for discrete biogeochemical sampling in the deep-sea, was mounted to the autonomous underwater vehicle REMUS 600 for coastal larval and environmental sampling. The distribution of barnacle larvae was assessed in two cross-shore transects in Buzzards Bay, Massachusetts, USA. The second transect included a complex mission through a deeper channel and sampling at discrete depth intervals. Barnacle larvae were classified into early nauplii, late nauplii, and cyprids, and the mitochondrial COI gene was sequenced to identify 164 individual larvae. *Amphibalanus* sp., *Semibalanus balanoides*, and *Chthamalus fragilis* larvae were found, with *Amphibalanus* sp. the most abundant taxon. Population genetic analysis of *Amphibalanus* sp. categories defined by stage and date indicated significant structure in some comparisons. Nauplii were more abundant than cyprids. In the second deployment, early and late nauplii were relatively more abundant near the bottom. There was no obvious pattern with depth for cyprids, and no clear cross-shore distributional patterns for nauplii and cyprids. Our results demonstrate the utility of autonomous sampling combined with DNA barcoding for studying larval distributions and transport dynamics.

Population Demographics of the Caribbean brown tube sponge, *Agelas tubulata*

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Long-term monitoring is important to understand ecosystem functioning and establish baseline population dynamics for future ecosystem studies. The brown tube sponge (*Agelas tubulata*, formerly referred to as *A. conifera*) is an abundant and long-lived sponge on Caribbean reefs. Populations of brown tube sponges were monitored on Conch Reef off Key Largo, Florida from 2010-2014 within 9 16m-diameter circular plots at depths of 15, 20, and 30m. Detailed field measurements of sponges were used to calculate sponge volume and create a regression between total sponge tube length and sponge volume. Using photographs taken at the time of monitoring to measure tube length, sponge volumes were calculated for individual sponges from 2010-2014. The demographic analysis shows a slight overall population increase for *A. tubulata* at Conch Reef. Additionally, the monitoring reveals severe, but nonfatal erosion (probably attributable to an undescribed disease) affecting many individuals in 2013-2014. This study is only the second long-term demographic analysis of a Caribbean sponge species, despite sponges now being the dominant benthic organisms on many Caribbean reefs.

Butterflyfishes exhibit species-specific responses to changes in Pacific coral reef communities

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Butterflyfishes exhibit feeding preferences for corals that represent a continuum from facultative to obligate strategies, which affect their responses to varying coral community structure. We assessed changes to the benthic community structure of three backreef communities on the leeward side of Guam over two decades, from 1994-2004. These communities include a reef that has been stable and relatively pristine through time, a reef that experienced significant historic disturbance but has been stable in recent years, and a reef that demonstrates a shifting baseline in response to anthropogenic and natural disturbances. Density and behavior of six species of butterflyfishes, including an obligate hard coral specialist, two soft coral specialists, and three generalists of varied dietary breadth, were recorded at each of the sites over time. While the butterflyfish communities were relatively stable through time, there were significant species-specific changes in foraging behavior, largely reflecting site-specific changes in the soft coral communities. Moreover, our results indicate that the soft coral specialists exhibited differential prey preferences that were directly attributable to their ability to tolerate soft coral chemical defenses. Given this tight coupling between butterflyfishes and soft corals on Indo-Pacific reefs, this resource needs to be a focus of future studies.

Sponge erosion under acidifcation and warming scenarios: differential impacts on living and dead coral

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Ocean acidification will disproportionately impact calcifying organisms in coral reef ecosystems as calcium carbonate ($CaCO_3$) dissolution becomes favored. Simultaneously, sponge bioerosion efficiency has been shown to increase as seawater pCO_2 increases. We conducted a 20-week experiment that included a 4-week acclimation period with a high number of replicate tanks (N=144) and a fully orthogonal design with two levels of temperature, three levels of pCO_2 and two levels of sponge to account for the relevant interactions between sponges and both living and dead coral substrate. Coral calcification/dissolution, survival, sponge attachment and erosional efficiency, sponge growth, and sponge symbiont health were evaluated for sponges interacting with living and dead coral substrate at each of the crossed temperature and pCO_2 levels. Additionally, we used empirical observations of individual coral-sponge interactions to develop a stochastic simulation model of carbonate change for small coral clusters (i.e., simulated reefs). Our findings suggest differential impacts of temperature, pCO_2 and sponge bioerosion for living and dead corals. Living coral calcification was significantly reduced by temperature and sponge treatments, with no significant effect of pCO_2, while dead coral dissolution was primarily driven by pCO_2, regardless of sponge presence or seawater temperature.

Spatial analysis of a population of *Amphiprion bicinctus* in the Gulf of Aqaba, Red Sea

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Patterns of settlement, habitat usage, and survival of a population of the endemic two-band anemonefish, *Amphiprion bicinctus*, and its host sea anemones were examined off the coast of Israel in the Gulf of Aqaba. In a 300 X 30 m study site, 1.1 m to 14.4 m depth, every sea anemone was tagged, measured, and identified. These anemones were followed in 13 censuses, and *A. bicinctus*, assigned to one of three size classes, found within each anemone were recorded. More anemonefish associated with the anemone *Heteractis crispa* despite fish having higher mean percent survival in the anemone *Entacmaea quadricolor*. Conversely, more *H. crispa* were unoccupied than *E. quadricolor*, but almost 90% of the anemones hosted fish during at least one census period. Settling anemonefish displayed significantly dispersed distributions in relation to adult fish or breeding pairs, while tending to cluster together. In follow-up censuses, a decade later, numbers of both sea anemones and anemonefish declined by over 50%. The remaining anemones hosted more fish per anemone on average than those in the original population. These results provide data useful for the management of this species and possible rehabilitation of this declining population.

Effects of elevated pCO_2 and light on photosynthesis and calcification in *Halimeda discoidea*

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We hypothesized that ocean acidification (OA) effects on calcifying benthic macroalgal are inextricably linked to light availability. To address this supposition, we examined OA and light effects on the calcifying green macroalga *Halimeda discoidea*, an important carbonate sediment producer in tropical reef ecosystems. An aquaria experiment was conducted to examine elevated pCO_2 and light (saturating vs. sub-saturating) effects on photosynthesis, growth, calcification and crystal morphology. Photosynthetic rates were enhanced under elevated pCO_2 and saturating light. This upregulation of photosynthesis did not enhance calcification of new segments or the number of new segments produced. The lowest number of new segments was produced in the saturating light treatment. Scanning electron microscopy of new segments confirmed net calcification and production of aragonite crystals at 2100 pCO_2 levels. Aragonite crystal size and abundance were unaffected by CO_2 or light treatments. We also examined dissolution of nonliving segments and observed that without photosynthesis dead segments experienced greater dissolution and possessed smaller crystals under elevated pCO_2. Our findings support the hypothesis that light plays a crucial role in calcifying macroalgal responses to OA. We further suggest that *H. discoidea* will maintain its role as a dominant reef sediment producer under year 2100 pCO_2 levels.

Setting the Tone for Coral Settlement: Larval settlement responses to coral reef sounds

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Coral reef communities depend on successful larval coral settlement and habitat selection, since many reef-building corals produce free-swimming larvae that develop in the plankton before attaching permanently to hard surfaces. Coral larvae are known to respond to chemical, microbial cues and substrate characteristics to locate and select settlement sites, but responses to acoustic cues, which may operate over broader spatial scales, are mostly unknown. Reef soundscapes, the combination of physical and biological sounds distinct to the reef community, provide sensory information about the presence and quality of benthic habitat and have been implicated in the settlement of larval fishes, crustaceans and mollusks. Previously, larvae of the Caribbean reef-building coral *Montastraea faveolata* were observed to move toward replayed reef sounds. To test the potential influence of reef sounds on coral settlement patterns, we conducted settlement experiments in which cultures of *M. faveolata* planula, contained in watertight chambers, were exposed to the ambient sounds of reefs of varying quality where acoustic characteristics were found to differ. Settlement was significantly higher in cultures deployed at the loudest and healthiest reef site compared to the most degraded and relatively quiet reef site, suggesting that soundscape cues could play a role in coral settlement.

Sponge overgrowth of corals justifies MPAs on Caribbean reefs; seaweed cover does not.

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Community-level indirect effects have been invoked as an explanation for the negative consequences of overfishing on the competitive interactions between reef-building corals and macroalgae on Caribbean reefs, and this has led to calls for policy action to manage fishing, but some have questioned this justification for marine protected areas (MPAs). We found an explicit indirect effect of overfishing on competition between sponges and reef-building corals from surveys of 69 sites across the Caribbean. Removal of sponge-eating angelfishes and parrotfishes resulted in > 3 fold increase in overgrowth of corals by sponges, with coral-sponge contact increasing from 11.0% to 25.6%, and these sponges were mostly species palatable to sponge predators. Palatable species have faster rates of growth or reproduction than defended sponges, which instead make metabolically expensive chemical defenses. Surprisingly, overfished sites had lower macroalgal cover, contrary to prevailing assumptions about seaweed control by herbivorous fishes. Coral-sponge competition provides an unambiguous justification for MPAs in the Caribbean, while seaweed cover does not, perhaps because herbivorous urchins are more important than fishes in this system.

Connectivity and plasticity of mesophotic corals in the Gulf of Mexico

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Mesophotic coral ecosystems (MCEs) have been discovered and characterized recently as continuations of shallow reefs below recreational SCUBA depths. MCEs appear to be isolated from many stressors affecting shallow reefs, thus Glynn (1996) originally proposed that deeper reefs may act as a coral refuge by providing larvae to nearby shallow reefs. Key questions that underlie Glynn's theory remain unanswered whose elucidation could advance our knowledge of coral ecology and physiology at depth: (1) How well are MCEs connected to shallow reefs, and (2) Can corals adapt their morphology and gene expression to match changing environmental stimuli? To address these questions, an integrative approach combining genetic connectivity using nine microsatellite markers, corallite morphological plasticity, and gene expression profiling was employed to investigate *Montastraea cavernosa*, a ubiquitous depth-generalist species in the Flower Garden Banks and Pulley Ridge MCEs. In addition, a two-year reciprocal transplant at FGB examines the processes behind short-term adaptation to environmental conditions by testing the influences of both environment and genotype on the coral's potentially plastic responses. This research is designed to provide data for improved regional management of deeper coral reef ecosystems and strengthens collaborative marine research through the Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT).

Feeding preferences of the Caribbean sea urchin *Diadema antillarum* in the U.S. Virgin Islands

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The die-off of the long-spined sea urchin *Diadema antillarum* in Caribbean waters in the 1980s coincided with a dramatic increase in macroalgal biomass on coral reefs. An increase in abundance of this keystone herbivore should decrease macroalgae on Caribbean reefs, and scientists and resource managers are interested in its recovery. We investigated the feeding preferences of this herbivore for different macroalgae and cyanobacteria that are common on reefs of the U.S. Virgin Islands. Many of these coral reef algae are chemically rich, and some are known to be chemically defended against generalist grazers. However, the feeding behavior of this important herbivore and its avoidance of chemically-rich macroalgae and cyanobacteria have not been thoroughly investigated. *Diadema antillarum* was more selective than expected in its food choices and tended to avoid some common macroalgae and cyanobacteria. We found that extracts of the brown macroalgae *Dictyota menstrualis* and *D. pulchella* and the cyanobacterium *Dichtothrix utahensis* deterred feeding by *D. antillarum*. These algae are common on shallow reefs of the U.S. Virgin Islands where sea urchins are becoming more abundant, but may not be readily eaten by this herbivore.

Ten Years on Southeast Florida Reefs: Status and condition results from long-term monitoring program

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The Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP) began in 2003 and, in conjunction with the Keys Program (CREMP), provides annual status and trend information along the entire Florida Reef Tract (FRT). Annually, SECREMP visits fixed sites offshore southeast Florida (SEFL) to provide long-term benthic cover trends and coupled with recent protocol changes allows for detection of annual changes in stony coral, octocoral, and barrel sponge demographics. This analysis focuses on the first ten years (2003-2012) of long-term trends in major benthic taxa cover and demographic data for SECREMP (2012-2013). Stony coral and macroalgae cover show no significant change, however, octocoral cover has declined and sponge cover has increased. Interestingly, these changes are seen region-wide, but when examined within counties and sites the trends are not consistent indicating the possibility of local factors having more influence than regional factors. There are inconsistent trends in benthic cover identified between the SEFL and Keys regions. These differences are likely a result of the SEFL ecosystem being the northern extension of the FRT and offshore the highly developed southeast Florida mainland. These regional trend differences also highlight the importance of maintaining a monitoring effort that extends along the entire FRT.

Relative stability of Caribbean coral reef communities over five years even in the face of disturbances

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In recent years, there have been innumerable reports of the declining state of Caribbean coral reefs due to a diversity of factors. To assess changes on particular reefs, we surveyed percent cover, abundance and diversity of corals, gorgonians and sponges on permanent transects on shallow patch reefs in the Bahamas and Belize from 2008-2012. During this period, Hurricane Irene directly impacted our study sites in the Bahamas and a mass sponge mortality event was reported in Belize. Overall diversity was significantly higher in Belize than in the Bahamas. Within each country, the greatest variation in community structure occurred between reefs and transects. In the Bahamas, coral and gorgonian communities remained relatively consistent through time, and although sponge diversity varied over time, this did not follow a linear trajectory. In Belize, coral cover and diversity, and the abundance and diversity of sponges, increased over time. In spite of two events that could have caused major disturbances to these reefs, the general features of the reef communities remained relatively stable. These data suggest that a trajectory of declining coral cover and reef diversity on Caribbean reefs is not universal and that some reefs have maintained their resilience in spite of continuing stressors.

Influence of thermal history and nutrients on lagoonal reef composition on the Belize Barrier Reef System

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Coral reefs are threatened due to global stressors such as ocean warming and acidification, as well as local stressors, which include pollution, sedimentation and overfishing. In recent decades corals have declined up to 80% on Caribbean reefs due to a combination of direct anthropogenic stress caused by increased human activity, and increased sea surface temperature (SST). Temperature stress events are expected to increase in frequency and severity as oceans continue to warm. Although the future for reefs seems bleak, recent research suggests that coral populations from more thermally variable reef environments have the capacity to survive in this changing environment (acclimatization). Here, we investigated the acclimatization ability of corals across the Belize Barrier Reef System (BBRS) using thermal history and other environmental parameters. Using satellite-derived SST measurements from the past decade, lagoonal reef sites (‘nearshore’ to ‘backreef’) along the BBRS were categorized as having low, moderate, or extreme annual temperature maxima and variability. Five sites of each reef type were chosen and surveyed in order to quantify coral species abundance and diversity, nutrient concentrations, and symbiont communities. Our results suggest that coral species diversity decreases at extreme sites (higher temperature and variability) relative to both moderate and low sites.

The rescue effect of heterotrophy during temperature stress of the temperate coral *Oculina arbuscula*

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Rising atmospheric carbon dioxide concentrations since the Industrial Revolution continue to generate increasing global sea surface temperatures (SST). Previous experimental studies indicate that this ocean warming will continue to compromise the coral holobiont (cnidarian host and its symbiotic algae) by reducing both host calcification and symbiont density. However, uncertainty remains as to the combined effects of heterotrophy and increased temperature on the skeletal growth response and symbiont density of temperate corals. Here, colonies of the temperate scleractinian coral *Oculina arbuscula* were collected from Beaufort, NC. Coral colonies were exposed to four feeding treatments (zero, low, ambient and high concentrations of newly hatched *Artemia sp.* nauplii) to quantify the effects of heterotrophy on *O. arbuscula* skeletal growth and symbiont density. The feeding experiment was conducted at two temperatures: 1) current mean annual SST (20°C) and 2) peak average summer temperature (28°C) for the collection site to investigate how heterotrophy influences *O. arbuscula's* ability to cope with thermal stress. Our initial results suggest that heterotrophy in *O. arbuscula* can induce a "rescue effect" when colonies are exposed to increased temperatures, and these results could have broad-reaching implications for previous coral temperature stress studies.

Symbiont acquisition by *Orbicella faveolata* larvae

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The importance of cnidarian-algal symbiosis as the foundation of the reef ecosystem is widely recognized. In a symbiosis as important as this, one would expect vertical transmission to assure the transfer of symbionts. However, among the majority of corals, and in fact among most cnidarians, symbionts (dinoflagellates within the genus *Symbiodinium*) are acquired via horizontal transmission each generation from the external environment. In this study, we examined acquisition of *Symbiodinium* by one to three month old juveniles of *O. faveolata* to determine parental and environmental effects on the symbiont phylotype acquired. Gametes were collected at one site (source) and then the newly settled recruits were reared at a different site (transplant). Symbionts within (1) newly settled juveniles placed at the transplant site, (2) adults from the site of gamete collection and (3) adults from the transplant location were compared genetically at an interspecific level (using variation in the chloroplast 23S rDNA) and an intraspecific level (using microsatellites for the dominant symbiont phylotype). At both levels, symbionts within newly settled recruits differed from those symbionts within adults from the source and transplant populations. However, symbionts within juveniles at the transplant location were similar, regardless of the source of the larvae.

Competition(?) among Caribbean reef octocorals

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Declines in scleractinian reef coral abundances have been reported worldwide. However, octocorals have not followed similar trajectories and at some sites make up increasingly large component of the community. High octocoral densities create the possibility of exploitive competition for resources, interference competition if branches directly interact and, at the least, preemption of space. At two sites on St. John, U.S. Virgin Islands octocoral densities were 16.6 and 8.4 colonies m^{-2}, respectively. 39% and 14% of colonies were in close proximity to a potential competitor, defined as branches within 5 cm each other. An additional 23 and 20% of colonies at the two sites had bases within 5 cm of each other. At the high density site 24% of the colonies in close proximity exhibited damage from abrasion between branches, ranging from the loss of polyps to exposure of the underlying axis. At that same site 24% of the colonies in close proximity to a neighbor exhibited asymmetries in form, in which growth was modified to accommodate neighboring colonies. Long term effects of these interactions are unknown but abrasions require wound healing, and modified growth represents an opportunity cost that limits colony size and fecundity.

Can corals survive a 1-2 punch? Combined impacts of ocean acidification and macroalgae on coral health and recruitment.

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Both macroalgal presence and ocean acidification have detrimental impacts on the heath of adult corals and on the recruitment of future generations, however, these stressors will not occur in isolation and understanding the implications of these factors in combination is critical. We investigated individual and combined effects of exposure to the macroalga *Halimeda opuntia* and ocean acidification on the health of adult corals and on the settlement ability of larval corals. There were interactive effects of the two stressors on the recruitment processes of *Porites astreoides*. Within treatments exposed to low pH, presence of *H. opuntia* significantly increased settlement of *P. astreoides* larvae. However, newly settled corals that were in contact with *H. opuntia* under low pH conditions had significantly less growth compared to those in contact with *H. opuntia* at ambient pH levels. There were no effects of ocean acidification on the photosynthetic efficiency in adult corals. However, contact with *H. opuntia* for four weeks caused decreased photosynthetic efficiency in adult colonies of *P. astreoides*, and *Acropora cervicornis*, but had no effect on *Orbicella faveolata*. *H. opuntia* also caused bleaching in *P. astreoides*. This study highlights the importance of studying the combined impacts of multiple stressors on corals.

The status of coral reefs at Yongle atoll, Xisha Islands, South China Sea

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Xisha Islands are in the central of the South China Sea and form one of the four large islands groups in this region. They include more than 40 islands, reefs and cays, and have considerable ecological and biodiversity value. Yongle atoll is the biggest and one of the most important atolls in the Xisha Islands. The first comprehensive and detailed baseline survey revealed coral communities in the medium healthy conditions. Mean coral cover was 17%, ranging from <5 % to >35 %. Branching corals were most important, followed by encrusting and massive growth forms (48, 29 and 17% of coral cover). *Pocillopora* (29% of total cover in line transects), *Porites* (19%), *Acropora* (17%) and *Montipora* (16%) were four dominant genera. Communities differentiated into four clusters, lower reef slope, outer reef flat, lagoon slope and inner reef flat and upper reef slope. Mean coral cover was the highest on the outer reef flat, followed by the lower reef slope and upper reef slope. The greatest contributor to total coral cover was branching *Pocillopora* (62%) on the lower reef slope, and massive *Porites* (44%) on the outer reef flat. They should be received much more scientific and conservation attention.

Measuring local density of a coral-reef-fish ectoparasite—a window on parasite community interactions

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Small organisms have been understudied in ecology with the interaction between large with small organisms given even less attention. Parasites are conspicuous components of ecosystems. Host-generalist parasites directly affect many community participants and interact with many others. Gnathiid isopods are a common component of the demersal plankton community. On coral reefs these isopods are common reef-fish ectoparasites. Gnathiid parasites can adversely affect fish health, and parasite density can modulate symbiotic reef associations among other community members. In this study we refine our understanding of the spatial and temporal characteristics of gnathiid density and activity using a variety of plankton traps. By comparing counts from different trap designs, we estimate the area of substrate from which traps sample, the average maximum distance juvenile gnathiids travel to find a fish host, and provide preliminary evidence of differential responses to light and scent cues relative to cueless emergence rates. We discuss the extension of this study to refine density estimate confidence intervals in both space and time. Ultimately, this work provides the basis for design of parasite traps suitable for measuring community interactions with gnathiid parasites in the course of coral reef monitoring studies.

Cross-shelf and Latitudinal Benthic Community Investigation in the Nearshore Habitats of the northern Florida Reef Tract

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The Florida Reef Tract (FRT) extends from the tropical Caribbean up the Florida coast into a temperate environment where tropical reef communities diminish with increasing latitude. This study was designed to map the nearshore benthic habitats including coral reefs and evaluate how the benthic communities differ between habitats and along the coast. Benthic communities across the northern FRT from Key Biscayne to Hillsboro Inlet (25.5°-26.3° N) were digitized from 2013 aerial photography at a 1:1,000 scale. Three main hard-bottom habitat types were identified (Colonized Pavement, Ridge, and Inner Reef) that ran parallel to shore and consecutively further away from shore. Five 1 km wide cross-shelf corridors were designated and spaced fairly evenly throughout the region. Five sites per habitat per corridor (70 total) were randomly selected and quantitative data was collected. Significant differences in percent benthic cover between habitats were found in all corridors and within habitat types between many corridors, indicating cross-shelf and latitudinal variation. Corridor 1 (located furthest south) was found to have the highest density of stony corals on the Inner Reef habitat, while Corridor 3 had the lowest. This study also found 38 acres of dense *Acropora cervicornis* patches which tripled the amount previously known.

Development of microsatellite loci for *S. psygmophilum* (*Symbiodinium* ITS-type B2)

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The Mediterranean coral, *Oculina patagonica*, is a putative invasive species that has been spreading at a rate of 22 km per year. *O. patagonica* harbors the endosymbiotic alga *Symbiodinium psygmophilum*, a dinoflagellate characteristically found in high-latitude environments. Inter-or intraspecific variation among the symbiont may have facilitated the host's spread. To determine if symbiont variation is correlated with host expansion, it will be necessary to examine the population structure of *Symbiodinium* across the range of *O. patagonica* and to bring representative symbionts into culture for physiological experimentation. As a first step towards this end, we identified a series of microsatellite loci for *S. psygmophilum* (ITS-type B2) and screened them for polymorphisms using *S. psygmophilum* cultures and host tissue samples. Here, we use these loci to test if *S. psygmophilum*, recently brought into culture, are representative of this host. Future studies will use these microsatellite loci to examine symbiont diversity and structure in *O. patagonica* throughout the Mediterranean and to test for amplification of *S. psygmophilum* in other host species.

Annual surveys of Scleractinian and/or Gorgonian Populations in the Florida Keys from 2011 to 2014.

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In 2011 the Coral Reef Evaluation and Monitoring Project (CREMP) expanded monitoring techniques to include more detailed assessments focusing on population structure and health of stony corals and octocorals. From 2011 to 2014 colony density, size-frequency, and condition were assessed annually at 37 permanent sites for scleractinian corals and 18 permanent sites for octocorals throughout the Florida Keys. Preliminary analysis indicates that total stony coral colony density, averaged for all reefs, in 2011, 2012 and 2013 was 6.23 ± 0.63, 7.30 ± 0.72 and 7.27 ± 0.72 (±SE), respectively. Octocoral colony density, averaged for all reefs, in 2011, 2012 and 2013 was 12.47 ± 1.78, 15.28 ± 1.46 and 13.89 ± 1.35 (±SE). Colony densities for 2014 were not finalized at the time of submission. In order to better understand population dynamics across spatial and temporal scales a more detailed multivariate analysis examining population size class data will be presented; results are not yet available. In conjunction with CREMP's long-term record of benthic spatial coverage in the Florida Keys, these demographic measurements will provide a robust assessment of the temporal response of coral reef communities to a variety of chronic and acute disturbances.

Does Fast Growth, High Survivorship, and Low Mortality Lead to Increasing Barrel Sponge (*Xestospongia muta*) Populations in the Florida Keys?

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Recent evidence indicates that coral reefs in the Florida Keys are transitioning away from scleractinian dominated assemblages to ones increasingly composed of octocorals and sponges. *Xestospongia muta* is a major component of benthic assemblages on deeper reefs in the Florida Keys. This study investigated whether growth, survival, and mortality rates in *X. muta* populations would translate into increased sponge populations on deeper reefs. Beginning in 2009, the Coral Reef Evaluation and Monitoring Project has tracked the growth, survival, and condition of more than 500 *X. muta* colonies at 11 sites. At each site, surveys consisted of 6, 22m x 1m belt transects. Although, density increased slightly between 2009 and 2014, population structure has remained relatively similar. Recruitment has been strong at some sites (>5 recruits per site/year), but interannual variability in recruitment has been high. Growth rates vary widely across individuals, particularly for colonies in the smallest size classes. Although new recruits continually enter the population, it appears potential robust increases in the population are offset by sponge orange band disease, which periodically leads to the partial or complete mortality of larger individuals.

Ultraviolet radiation and coral embryos: DNA damage and survival

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Embryos of broadcast spawning reef corals spend 2-3 days floating near the ocean surface as they develop into mobile, ciliated planula larvae. These embryos may be exposed to high levels of ultraviolet radiation (UVR), particularly UVB (280-320 nm), that stimulates production of thymine dimers in DNA that interfere with replication and transcription, potentially increasing mortality. In an effort to quantify the impact of UVR exposure on coral embryos and identify mechanisms that have evolved to mitigate negative effects, we measured UVR-induced DNA damage in the embryos of two Caribbean corals, *Acropora palmata* and *Diploria labyrinthformis*. Embryos were reared in outdoor tanks shaded by either UVR-transparent or UVR-opaque plastic. DNA damage was quantified in coral embryos daily with an ELISA assay using a primary antibody that binds to thymine dimers. As a further estimate of the consequences of UVR exposure, we also documented embryo survival over time in *A. palmata.* In *A. palmata,* the extent of DNA damage did not differ between treatments, mirroring their similar survival curves. Interestingly, in *D. labyrinthformis*, DNA damage was greater in embryos protected from UVR, suggesting that a lack of exposure to UVR suppresses activation of DNA repair mechanisms needed for normal embryo development.

Latitudinal controls of coral reef community distribution on the northern Florida Reef Tract

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The Florida Reef Tract (FRT) in south and southeast Florida spans approximately 595 km of coastline from the Dry Tortugas in the southwest to Martin County in the northeast transitioning from a subtropical to temperate environment. The relationships between present-day coral reef communities, reef habitat types, and two years of in situ seafloor temperature data were investigated to determine the potential for the poleward expansion of coral reef communities up the eastern United States coast. Benthic cover and density and fish density analyses showed the northernmost FRT benthic communities are dominated by cold-tolerant species. This change occurred south of the Lake Worth inlet at the Bahamas Fracture Zone where the Florida current diverges from the coast and historical coral reef growth is no longer evident. North of this location, the reef habitats encountered more intense and frequent cold water temperature spikes including 420 hours less than 16° C over two years. Present-day reef morphology indicates that this mechanism has been controlling the northern limit of coral reef growth since the Holocene. Results suggest that coral reefs will not likely grow further north along the eastern seaboard in a warming climate, highlighting the importance for the conservation of southeast Florida reef communities.

Efficient light transport through coral skeletons precipitates bleaching response

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Coral reefs are at the forefront of ecosystems adversely affected by climate change due to sensitivity to thermal stress. The foundation of these ecosystems are built on mutualistic endosymbioses with photosynthetic dinoflagellates (representing the genus *Symbiodinium*) which provide fixed carbon to fulfill the energetic requirements of their coral hosts. Anomalously high temperatures can impair photosynthetic efficiency and disrupt these symbioses, resulting in increased morbidity and mortality. However, the response to thermal stress is not uniform across individual colonies, taxa, or events; providing critical insight into bleaching determinants and mechanisms. Although the key determinants are not fully understood, differential bleaching susceptibility has been attributed to a combination of host physiology and morphology and *Symbiodinium* thermotolerance. Here we experimentally demonstrate that efficient skeletal light transport also accelerates the bleaching response among corals. Although the skeletal contribution to the endosymbiotic light microenvironment is normally small, skeletal optical properties become increasingly important as absorbing bodies are lost and the skeleton interacts with more light; creating rapid increases in symbiont light-exposure once bleaching begins. Using 10 coral species with a diversity of skeletal light-transport efficiencies and *Symbiodinium* thermotolerances, we monitored standard indicators of bleaching (coral surface reflectance, symbiont cell & photosynthetic pigment densities, and multiple metrics of *Symbiodinium* photophysiology) under increased temperature (+6° C), increased light (4x initial), or both conditions simultaneously. Although skeletal reflectance and symbiont thermotolerance are both predicted to increase bleaching susceptibility, neither could explain the observed responses. The results indicate that differential skeletal light-transport properties are a key-determinant of differential bleaching susceptibility.

The future of shallow coral reefs may lie deeper than expected

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The decline of shallow coral reefs worldwide has led to renewed interest in the Deep Reef Refugia Hypothesis, which suggests that healthier, deeper corals may provide a source of gametes and/or larvae for their depauperate, shallow counterparts. However, several assumptions of this hypothesis remain untested: (1) vertical and horizontal spatial isolation has not led to reproductively isolated of shallow and deep conspecifics, and (2) larvae generated from deep corals are attracted to and survive in shallow coral reef habitats. We examined compatibility between deep (>30m) and shallow (10-12m) *Orbicella franksi* in Belize where the horizontal distance is minimal and in USVI where this distance is >14km. We found that gametes were compatible between deep and shallow corals regardless of their horizontal distance, yet to different degrees. In Belize, we also conducted larval choice experiments where larvae generated from each depth were given a choice between a deep versus a shallow conditioned tile. Shallow larvae demonstrated no preference, but deep larvae preferred the shallow tiles. There was no significant difference in post-settlement survival at any depth. These results suggest that deep reefs can provide gametes and larvae to assist with the recovery of a threatened, shallow reef-building coral.

What's making all that racket ? Pairing video and passive acoustic monitoring to identify coral reef fish sounds and feeding behaviors

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A small, inexpensive (< $500), portable, short-duration (several hours) video and passive acoustic recorder (VAPAR) was constructed and then deployed at a variety of sites in Discovery Bay, Jamaica. High-resolution video (1080p) and acoustic (48 kHz sampling rate) data from a variety of different reef fish (including Scaridae, Acanthuridae, Pomacentridae, and Mullidae) were collected concurrently at multiple locations in the reef at different depths and times of day. Data were analyzed to measure the soundscape of each sampling period and to identify, when possible, the source (species and behavior) of specific acoustic signals. Tethering experiments were conducted to determine if passive acoustic data can be used to determine prey identity and to quantify the consumption within the detection range of the recorder. These data may provide insights into the interpretation of long-term passive acoustic monitoring of coral reef habitats.

Histopathology of a disease affecting octocorals of the genus *Eunicea* along the Florida Reef Tract

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An ongoing investigation to characterize an octocoral disease affecting multiple *Eunicea* species has confirmed high prevalence along the Florida Reef Tract, from the Dry Tortugas National Park (south) to offshore Southeast Florida (north). This disease affects the entire colony, progressively turning the colony black/purple, and impairs normal colony functions (i.e., feeding, reproduction). To date, a total of 100 samples have been collected for histological examination. Standard microscopy revealed apparently healthy samples had good tissue organization and normal staining characteristics, whereas diseased samples showed a loss of tissue integrity, abnormal staining characteristics, and some pathologic foci. Histopathology of > 30% of diseased samples revealed fungal hyphae in the axes. Deposition of melanin in surrounding tissues by granular amoebocytes (GAs) suggests an active immune response of the coral host. With fluorescent microscopy, a much higher concentration of bacteria was observed in the axes of diseased samples compared to apparently healthy samples; however, deep 16S amplicon sequencing analysis did not show differences in the bacterial community composition between the two. Melanin production by GAs could be triggered by the presence of fungal hyphae or undetermined pathogens or mechanisms.

Characterizing algal symbionts from mesophotic coral reefs in the Gulf of Mexico

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Many coral species common in shallow habitats are also found in the mesophotic zone, from depths of approximately 50 m to the lower limit of the photic zone. Similar to corals in shallow environments, many corals in the mesophotic zone maintain important symbioses with photosynthetic microalgae called zooxanthellae. Despite the importance of the coral-algal symbiosis in corals' ability to thrive in multiple environments, few studies have focused on mesophotic zooxanthellae. This study aims to characterize the algal symbiont assemblages in the coral *Montastraea cavernosa* found at two MCEs in the Gulf of Mexico – Pulley Ridge MAPC and Flower Garden Banks NMS. Genetic profiles obtained using next generation sequencing of the ITS2 region and clade abundance information from qPCR, combined with overall symbiont cell densities, can provide a comprehensive assessment of symbiont community structure. Furthermore, this research addresses the issues of connectivity and photo-adaptation by comparing mesophotic symbiont assemblages and chlorophyll concentration with those from neighboring shallow communities.

Effects of St. Lucie Estuarine Discharge Water and Temperature on Corals and their Symbionts

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Coral health declines have been linked to anthropogenic changes in water quality and temperature. This project will look at direct effects of estuarine discharge water on corals. St. Lucie Reef near Stuart, FL receives increased estuarine efflux resulting from South Florida watershed changes. This research will supplement existing *in-situ* monitoring on St. Lucie Reef with *ex-situ* experimental design to investigate the individual and interactive effects of estuarine discharge water and temperature on two coral species. Ambient and elevated temperatures (25°C and 30°C) and offshore versus discharge water collected from St. Lucie Inlet will be used. Light and salinity will be controlled across experimental treatments and replicates. Potential effects on corals will be evaluated through response variables including growth rate, coral stress gene expression, zooxanthellae density, and chlorophyll concentration. Experimental and *in-situ* data will support collaboration and data sharing with local agencies to inform South Florida's resource management policies.

Bleaching and its Effect on the Competitive Interactions of the Symbiotic Cnidarian, *Anthopleura elegantissima*

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Bleaching is a stress response of symbiotic Cnidarians in which there is an expulsion of algal symbionts from the host organism. This response causes a loss of algal pigment and a whiter appearance of the host. The loss of these symbionts could have major consequences for the host physiology and its capacity to interact with other organisms. Although there are many different causes of bleaching, the one that has resulted in bleaching on a global scale is thermal stress due to high increases in sea surface temperatures. This study focuses on how bleaching from climate change can impact the intertidal organism *Anthopleura elegantissima.* My research work examines the competitive interactions of bleached and unbleached *Anthopleura elegantissima* side by side on microscope slides to see if there is a difference in the way they compete for space. My results show that there is a difference in the competitive interactions between *A. elegantissima's* with different health levels (bleached or unbleached). Unbleached specimens tend to be better competitors than bleached specimens (ex: move/grow faster?). If bleached *A. elegantissima* cannot compete for resources (space or food), growth and reproduction could be compromised and affect population dynamics with important consequences for the intertidal community.

Patterns of *de-novo* symbiont uptake in newly settled *Briareum asbestinum* recruits: effects of light and symbiont availability.

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At the foundation of the coral reef ecosystem is the symbiosis between reef building corals and a genetically diverse group algal symbionts of the genus *Symbiodinium*. Coral growth, survivorship, and thermal tolerance can be strongly influenced by in hospite *Symbiodinium*. Potential flexibility between host and symbiont pairings occurs in the majority of corals that horizontally transmit symbionts, wherein *Symbiodinium* uptake from the environment occurs *de novo* each generation. However, little is known about the initial stages of coral-*Symbiodinium* interactions, particularly the influence of host, symbiont, and environment on *de novo* symbiont uptake. This study crossed high- and low-light treatments with single- and mixed- phylotype *Symbiodinium* inoculations of aposymbiotic *Briareum asbestinum* recruits, and used quantitative PCR to track the *in hospite* abundance of each phylotype through the first few months post settlement. We found phylotype specific effects of light environment on the total number of *Symbiodinium* taken up. Furthermore, there was a tendency for certain *Symbiodinium* phylotypes to be numerically dominate within a polyp during initial uptake, however, these patterns transitioned with time. Our results emphasize the complex nature symbiont uptake and how coral-*Symbiodinium* symbioses are structured.

Comparing Coral Survey Methodology: GoPro® Video vs. AGRRA

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As climate change continues to threaten coral communities, the importance of efficient and accurate assessment of coral reef communities continues to grow. Traditionally, field scientists have relied on manual time intensive surveys methods to quantify coral abundance, diversity, and cover. Here, a team of scientists quantified coral abundance and diversity of 13 lagoonal reef areas, classified into 3 sea surface temperature (SST) environments (low, moderate, and high annual maximum temperature and variability) along the Belize Barrier Reef System (BBRS). Two methods were used: 1) a modified Atlantic and Gulf Rapid Reef Assessment (AGRRA) established survey methodology and 2) a new methodology: video transects using modern GoPro® video technology. At each site, $60m^2$ of reef was surveyed and quantified using each method, with the results of the new method compared to the AGRRA results. The increased efficiency of the video transects allows reef scientists to save both time and money in the field, while maintaining, or even increasing, accuracy of reef survey analyses.

,Morphological analysis of zooxanthellae communities associated with two coral species in Southeast Florida via FlowCAM

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The mutualistic relationship between corals and their endosymbiotic zooxanthellae underpins coral reef ecosystems in the photic zone. The dynamics and components of the zooxanthellae communities associated with *Montastraea cavernosa* and *Pseudodiploria clivosa* at St. Lucie Reef, the northernmost extent of many coral species along the Florida coast, have been characterized recently using classical techniques and next generation sequencing. With the development of the FlowCAM, a new technology that links flow cytometry to microscopy, it is feasible for zooxanthellae morphology, chlorophyll concentration, and zooxanthellae density to all be determined concurrently, increasing analytical efficiency and corroborating information obtained from next generation sequencing analysis on clade identities. Samples from *M. cavernosa* and *P. clivosa* were analysed both using traditional techniques and the FlowCAM. Populations of zooxanthellae from the two coral species exhibited significantly different cell volumes, indicating morphological differences in the clades associated with the two coral species. Differences in zooxanthellae density and chlorophyll estimates between traditional methods and the FlowCAM analysis highlight the difficulty in measuring suspensions with variable densities and different methodologies. FlowCAM analyses coupled with next generation sequencing approaches appear promising for more comprehensive characterization of zooxanthellae communities.

A "Fan" of Fungus: A Study of Aspergillosis on Gorgonia Spp. off Little Cayman Island

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Gorgonia ventalina and *G. flabellum* generally are detached by waves before they perish from old age. Over recent decades, *Aspergillus sydowii* infection has joined wave disturbance as a cause of sea fan mortality. This study focuses on the prevalence of *Aspergillosis* on *Gorgonia* spp. during non-disturbance summer conditions off Little Cayman Island. This site provides a rare opportunity to decouple anthropogenic stress and fungal infection because it is remote and has a small population (<150 people) that generates little pollution.

The mean infection rate at ten sites was 4.5% (n=1019). Infected fans had 1-14 patches covering <12% of their surface area, on average; tissue loss was not observed. The rate of infection increased 4% with each 10cm increase in height (binary logistic regression; Z=2.70; p=0.007). Height is recognized as a proxy for age for the Gorgonian spp., thus older individuals have a higher probability of being infected. The prevalence of disease remained stable between June-October, 2014 (average seawater temperature = 30.3°C, maximum temperature = 31.4°C). This census is documented as a basal level of *Aspergillosis* infection on a healthy reef that should be factored into evaluations of future outbreaks on any reef off the island.

Exploration and Characterization of McGrail, Bright, East and West Flower Garden Banks in the Northwest Gulf of Mexico

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The Flower Garden Banks National Marine Sanctuary (FGBNMS) and adjacent banks in the Northwest Gulf of Mexico (NWGOM) exhibit unique and extensive shelf-edge coral communities. Using remotely operated vehicle (ROV)-based high definition imaging, we conducted 247 stratified random quantitative 100m phototransects to characterize mesophotic reef habitats and fish communities on East and West Bank within FGBNMS as well as McGrail and Bright Banks lying east of the sanctuary. Benthic community composition differed significantly among habitat types across vertical zones. While Scleractinian corals comprised 66-75% of benthic cover on coral caps of East and West Bank, these relatively shallow habitats account for only ~1% of the total FGBNMS area. Mesophotic communities (46-114m) in the FGBNMS were dominated by Scleractinians (many families), black corals (*Antipathidae*, *Aphanipathidae*) and gorgonians (*Plexauridae*, *Ellisellidae*, *Primnoidae*). Dense benthic *Sargassum* spp. covered extensive areas of McGrail Bank, often overgrowing 1-2m diameter *Stephanocoenia intersepta* colonies. Habitat partitioning among grouper and snapper families was distinct with few species occupying both shallow and mesophotic depths within FGBNMS. The results of this study and others in the NWGOM indicate that mesophotic coral habitats are more extensive and ecologically important than previously known, particularly with respect to supporting biologically diverse faunal assemblages.

Size-frequency distribution and population abundance of *Porites astreoides*: The effect of water quality

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High sedimentation rates can limit the development of hermatypic corals and increase their mortality rates. Also, the increase in water turbidity reduces the photosynthetic activity of *Symbiodinium spp*., which provides up to 90% of coral energetic requirements. Thus, it could be expected that poor water quality (PWQ) would alter local population dynamics. The scleractinian coral *Porites astreoides* is one of the most common species inhabiting Caribbean coral reefs that can be found within poor and good water quality (GWQ). However, it is not clear how PWQ affects local population. Hence, understanding the processes influencing its population dynamics may provide valuable insights into how coral reef communities would respond to further water degradation. The aim of this study is to determine whether population characteristics of *P. astreoides*, in terms of (1) size-frequency and (2) population abundance, differ between sites of GWQ and PWQ. Results indicate that size-frequency distributions varied significantly between sites whereas colony densities were similar. Suggesting that water quality may have an effect in population structure but not in population abundance. To better understand these results we will undertake a study on population dynamics to follow growth rate and a histological study to assess reproductive output in *P. astreoides.*

Reef Flat Stomatopod Communities as Indicators of Ecosystem Stress

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Coral reef flat stomatopod crustacea are resilient invertebrates with stable populations determined primarily by habitat availability. Their abundance, diversity and recruitment have been shown to correlate negatively with anthropogenic chemical pollution such as oil and pesticides, making them excellent bioindicators of ecosystem stress. The Indian Ocean island of Mauritius is one of the most densely populated countries in the world and home to a primarily fringing coral reef system. Coral rubble and volcanic rock from thirty 1 m^2 quadrats were destructively sampled to characterize the stomatapod communities at two sites on the island, one on the heavily populated leeward coast and one on the lightly populated windward coast. Both sites hosted similar proportions of seagrass, coral rubble and live coral, so differences in the stomatopod community might suggest an early warning of stress due to chemical pollutants. Both sites hosted eight species of stomatopod and were dominated by *Gonodactylellus spinosus*, which made up 67% and 69% of the individuals sampled, respectively. The windward site hosted 10.8 individuals per m^2 averaging 0.369 individuals per liter of available substrate broken. The leeward sit hosted 2.5 individuals per m^2 averaging 0.151 individuals per liter of available substrate broken.

A new TURF: Habitat quality of the spiny lobster *Panulirus argus* in Bocas Del Toro to assess potential for artificial shelter based fishery

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To evaluate potential for a territorial use rights fishery (TURF) in the Bocas del Toro archipelago we assessed natural habitat quality for adult lobsters and conducted interviews with community leaders. We conducted 30 m transect surveys (n=10) on two reef sites, Punta Caracol (PC) and Porities reef (PR). Habitat quality was measured by rugosity, number and dimensions of holes and ledges, % foraging (sand, algae) area, and % refuge (coral, rock) area. Habitat quality differed between sites with PC having an average rugosity of 65±24cm, greater quantity of larger holes (n=16) and ledges (n=22) than PR, and 2.1 times more foraging area than PR. Both sites had approximately the same amount of refuge area however, excluding *Acropora* and *Porites* sp., PC remained the same while PR had >1% refuge area. T-test showed no significant difference between rugosity (p=0.59) or site differences in foraging and refuge area (p=0.24). No lobsters were observed at either site indicating overfishing. Informal interviews showed a lack of social organization but that the community showed genuine interest. Based on the high quality of natural habitat and community interest we strongly believe that life stage specific artificial shelters could be used to promote lobster growth and recruitment.

Picky eaters at the plankton buffet: selective suspension feeding by giant barrel sponges increases foraging efficiency

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Foraging theory predicts the evolution of feeding behaviors that increase consumer fitness. Sponges were among the earliest metazoans on earth and developed a unique filter-feeding mechanism that does not rely on a nervous system. Once thought indiscriminate, sponges are now known to selectively consume picoplankton, but it is unclear whether this confers any benefit. Additionally, sponges consume dissolved organic carbon (DOC) and detritus, but relative preferences for these resources are unknown. We quantified suspension feeding by the giant barrel sponge *Xestospongia muta* on Conch Reef, Florida, to examine relationships between diet choice, food resource availability, and foraging efficiency. Sponges consistently preferred cyanobacteria over other picoplankton, which were preferred over detritus and DOC; nevertheless, the sponge diet was mostly DOC (~70%) and detritus (~20%). Consistent with foraging theory, less-preferred foods were discriminated against when relatively scarce, but were increasingly accepted as they became relatively more abundant. Food uptake was limited, likely by post-capture constraints, yet selective foraging enabled sponges to increase nutritional gains. *Xestospongia muta* likely has a strong influence on planktonic food webs in the Caribbean, because it is the dominant organism on most reefs and has been estimated to turn over the water-column in as little as 2.3 days.

Characterisation and ecological role of an opportunistic annelid species, *Ophryotrocha cyclops*, at finfish aquaculture sites in Newfoundland (Canada)

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Dorvilleids are opportunistic annelids that inhabit transient, organically enriched environments such as hydrothermal vents, whale falls, and organic deposits beneath aquaculture sites. In Newfoundland (Canada), the complex, predominantly hard-bottom substrates below salmonid aquaculture sites were found to be colonized by conspicuous aggregates of a new, recently described dorvilleid species, *Ophryotrocha cyclops*, simultaneously discovered on whalebones in Greenland. Bacterial mats and *O. cyclops* often coexist at Newfoundland aquaculture sites and are used as indicators of environmental enrichment. To examine whether *O. cyclops* consumes aquaculture derived organic matter and might be involved in benthic recovery processes, we performed stable isotope (carbon, nitrogen and sulfur), lipid, and fatty acid analyses on *O. cyclops* and its potential food sources (including fish feed and feces). Stable isotope data show that the diet of *O. cyclops* sampled from different aquaculture sites varies, and that *O. cyclops* consumes degraded fish feed and possibly bacteria. Fatty acid and lipid characterization further support these results, and provide additional evidence for microbial grazing by *O. cyclops*. The potential role of *O. cyclops* in sulfur cycling and fish pellet degradation at aquaculture sites will be discussed.

Together is better: The importance of heterotrophy and symbiosis for growth of the sea anemone *Aiptasia pallida*

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The health of reef-building corals is determined, in part, by the success of their endosymbiotic dinoflagellates and the availability of exogenous food. A commonly used model system for studying coral nutrition is the sea anemone *Aiptasia pallida*. Although used as a model organism, the relative impacts of exogenous nutrition and nutrition from symbionts have not been well studied. Under stressful conditions anemones, like corals, bleach and may have to rely solely on exogenous food. We assessed the relative importance of exogenous food versus symbiont photosynthate by dividing anemones into four treatment groups and measuring changes in wet mass after 30 and 60 days. The treatments were: neither symbionts nor food (n=20), no symbionts with food (n=19), symbionts but no food (n=22), and both symbionts and food (n=25). Symbionts were removed from anemones using cold shocks and an herbicide, then maintained in darkness. Anemones with both symbionts and food gained significantly more mass than other groups ($p<0.001$). All other groups lost mass and there is no significant difference between the mass changes ($p=0.9968$, 0.3278, 0.2501). This study suggests that the exogenous food and the symbiont-produced photosynthate, together, provide nutritive components necessary for anemone growth.

Unravelling top-down versus bottom-up impacts on coastal algal communities

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Expanding populations of the piscivorous seabird Great Cormorant (*Phalacrocorax carbo sinensis*) are an increasing concern for coastal ecosystems in the Baltic Sea. Previous studies have shown that cormorants can have multiple effects: 1) guano runoff from colonies is high in nitrogen and increases filamentous algal growth, and 2) fish predation (1 kg day^{-1} breeding $pair^{-1}$) leads to decreased fish populations around colonies, potentially causing a trophic cascade and higher grazing pressure on algae due to higher herbivore abundances.

In this study, we experimentally measured the importance of these impacts on algal communities by comparing algal recruitment, growth, and herbivory in herbivore exclusion, fish exclusion, and open control cages around colony and control islands. *Fucus vesiculosus*, an important foundation species, had lower recruitment while filamentous algae had higher recruitment near colony than control islands, likely due to increased nutrient enrichment. Herbivory on some species increased near colonies, indicating that top-down colony effects also occur, but these do not affect all species equally and also vary among years. Cormorants can thus indeed modify lower trophic levels through both top-down and bottom-up processes, though these effects are mediated by local biotic and abiotic factors.

It takes guts to tell us about elusive crustacean prey

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Highly mobile crustacean prey such as decapod shrimp, euphausiids and mysids are vital links in marine food webs. However, their intermediate sizes and characteristic caridoid escape responses lead to chronic underestimation when sampling at large spatial scales with plankton nets or large trawl nets. Here, we utilize fish diets (i.e., fish biosamplers) collected by the National Marine Fisheries Service (NMFS) and Northeast Fisheries Science Center (NEFSC) as discrete sampling units to examine the abundance and distribution of these important prey families over large spatial and temporal scales in the northeastern US shelf large ecosystem (NESLE). We found these prey families to be important to a wide variety of both juvenile and adult demersal fishes of NESLE. Fish biosamplers further revealed a significant spatial shift of prey in early spring. The distributions of mysids and crangonids in fish diets shoaled significantly from February to March. The distributions of euphausiids and pandalids in fish diets shifted northward during March. Of multiple hypotheses for these shifts, prey migration is most strongly supported. Together these results suggest that if sampling bias is addressed, fish biosamplers can be used to assess distribution and abundance of prey species over large spatial and temporal scales.

Predator-prey dynamics and evolutionary defense tactics: Will loss of habitat refuge from crab predators threaten persistence of marine bivalves?

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Density-dependent predation and habitat structure may determine whether prey persist or face local extinction. To determine how density-dependent predation by crab predators may change bivalve mortality with loss of habitat refuge and changes in physical or behavioral defenses, low and medium densities of bivalves were exposed to blue crabs, *Callinectes sapidus*, in two mesocosm experiments. The first experiment examined mortality of soft-shell clams, *Mya arenaria*, and hard clams, *Mercenaria mercenaria*, in sand, shell hash, and oyster shell. The second experiment examined mortality of *M. arenaria* and ribbed mussels, *Geukensia demissa* with defense present or absent. *M. arenaria* in the defense-absent treatment were prohibited from burrowing by a false bottom, and *G. demissa* in the defense-absent treatment were removed from clumps. Bivalves experienced significantly greater mortality in sand than in the structurally complex habitats. In the defense-removal experiment mortality increased overall, and *M. arenaria* exhibited a low-density refuge from predation by *C. sapidus*, while *G. demissa* exhibited a high-density refuge, even when their defenses were weakened (interaction between species and density). Burrowing bivalves may retain a low-density refuge from predation even with the loss of structurally complex habitats, though increased mortality may result in clam densities that are not sustainable.

BiteMap: A simple, scalable assay to quantify predation pressure along environmental gradients

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Salt marshes are important nursery habitats for a variety of juvenile fishes and invertebrates. To quantify spatial and seasonal patterns in predator feeding activity—and thus trophic transfer—we designed a simple predation assay using a standardized prey food item (a disc of dried squid) and deployed across changing seasons and along a primary environmental gradient (salinity). Monthly from June to October 2014, we deployed assays at five marsh sites ranging from near freshwater at the head of the York River Estuary to fully marine at the Eastern Shore of Virginia. We also took grab samples of the prey community to test whether there was a relationship between prey community characteristics and predation pressure. Predation followed a well-described increase with salinity early in the year, but this pattern disintegrated later in the year. Neither aggregate prey abundance, biomass, nor median body size were related to predation pressure at any point. Our study shows that a simple, inexpensive assay captures seasonal and spatial variation in feeding by generalist predators and provides a means for fine-scale mapping of marine predation pressure through space and time—a “BiteMap”.

Seagrass herbivory patterns are altered under ocean acidification.

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Herbivory largely determines the abundance and composition of plants, and plants have evolved different strategies (e.g. low nutritional quality, chemical defences) to decrease such herbivory. These strategies may vary across tissues (e.g. reproductive vs. vegetative) and ages (e.g. old vs. young), as different parts of the plant may contribute asymmetrically to plant fitness. In aquatic systems, the presence of epibionts may further alter within-plant susceptibility to herbivory, as their presence can both increase or decrease herbivory pressure on the plant. We quantified abundance and within-plant feeding choices of an herbivorous fish across a natural gradient of ocean acidification (OA) in *Posidonia oceanica* meadows. Susceptibility of seagrass to herbivory was higher under acidified conditions, where fish were more abundant and actively feeding. Increased herbivory was due to the disappearance of within-plant differences in susceptibility to herbivory, making all leaves equally and highly susceptible. Such feeding behaviour appears to be driven by changes in epibiosis associated with acidification (i.e. decrease in epiphyte load) rather than seagrass defense traits. Thus, OA may critically modify herbivory pressure on seagrass by removing the "associational resistance" provided by epibionts.

Fresh organic matter inputs drive benthic foraminiferal migration

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Benthic foraminifera are marine protozoa representing an important fraction of meiofauna, particularly abundant in coastal environments. They are mainly first consumers, feeding on microphytobenthos and bacteria. They are generally more abundant in superficial sediments (<0.5 cm), where oxygen and food availability are considered to be the most influencing factors defining their niche. However, in intertidal mudflats, their vertical distribution seems to be largely influenced by bioturbation that can bury them up to several centimeters deep in the sediment. Laboratory experiments were carried out in microcosms to better understand the behavior of the intertidal species *Ammonia tepida* after mimed bioturbation events in three different conditions: 1) absence of fresh organic matter (OM) inputs; 2) introduction of fresh OM inputs just after the bioturbation; 3) 15 days-delayed introduction of fresh OM. The results suggest that the presence of fresh OM at sediment surface stimulates the re-migration of buried foraminifera towards the top millimeters of sediment, and that migration is much weaker after 15 days-delayed organic matter adds, maybe due to a reduced metabolic activity after starvation. Moreover, the absence of oxygen in deep sediments does not seem to prevent the motility, suggesting the occurrence of anaerobic metabolic pathways for *A. tepida*.

Anthropogenic effects on upland usage and shoreline development transfer through the nearshore food web

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Economically and ecologically important species can be affected by anthropogenic stressors, particularly in nearshore habitats. We investigated the effects of subestuary upland usage (forested, agricultural, developed) and shoreline development (rip-rap, bulkhead, marsh, beach) on density and diversity of nearshore benthic infauna, fish, crabs, and waterbirds in Chesapeake Bay. Density, diversity, and biomass of infauna were lowest with extensive upland development and higher with forested subestuary upland. Benthic density was lowest adjacent to bulkheads, particularly for long-lived species, and diversity was greatest adjacent to natural marshes. Bottom-oriented blue crab, Atlantic croaker, and spot were more abundant in subestuaries with more riparian wetland and less shoreline hardening. Deep water in front of developed shorelines provided access for large-bodied fish, but reduced shallow-water refuge habitat for small-bodied fishes, juvenile fishes, and crabs. The Index of Waterbird Community Integrity (IWCI), a measure of bird diversity, increased with percent natural marsh and decreased with percent bulkhead along the subestuary shoreline. There were positive correlations between infaunal biomass and bird IWCI, and between littoral fish biomass and bird IWCI. Due to changes in macrofaunal communities associated with anthropogenic stressors, subestuary upland development and shoreline hardening should be reduced to maintain faunal integrity.

Investigating how habitat density can alter intraspecific competition in mesopredators

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Intraspecific competition often has stronger effects on foraging rates than interspecific competition. While these effects become more pronounced as species population density increases, their effects may be mediated by habitat structure. To further explore the role of habitat structure, competition was assessed across increasing habitat density treatments. Competition between one, three, and six *Dyspanopeus sayi* individuals was compared across four levels of increasing seagrass habitat density: 0, 100, 200, 800, and 1200 shoots m^{-2}. Seagrass habitat was mimicked using artificial seagrass units (ASUs). Each treatment combination was incubated for 36 hours, after a 24-hour mud crab starvation period, with 100 dispersed *Mytilus edulis* prey. At the conclusion of the experiment, remaining living mussels were collected and counted. Effects of shifting habitat complexity and population density were assessed by comparing observed and expected consumption rates. As shoot density increased, intraspecific competition was expected to decrease until habitat structure impeded foraging rates. Preliminary results suggest that dense populations of *D. sayi* result in reduced feeding per individual and that increasing habitat density may reduce the effect of competition. Important follow-up studies are needed to elucidate the effects of different habitat structures on intraspecific competition in *D. sayi*.

Habitat size alters predation and prey behavior of the blue crab and hard clam in seagrass

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As habitat loss progresses, continuous habitat is divided into smaller patches which can affect biological interactions, including predation. Seagrass is being lost at a rate of 110 km^2/yr, leading to the emergence of seagrass patches. We examined whether predation and prey behavior differed between seagrass patches and meadows. Seagrass patches may be a poor prey refuge and therefore we hypothesized that predation would be stronger in patches. To test our hypothesis, we utilized blue crabs (*C. sapidus*) and hard clams (*M. mercenaria*), both key species in seagrass food webs. Using tethering and baited resource experiments at two sites in Barnegat Bay, NJ we found that predation on clams can be significantly higher in meadows than in patches. Densities of blue crabs, primary predators of hard clams, were higher in meadows at both sites. At one site, clams buried deeper in meadows to avoid predators. Predation on juvenile blue crabs was significantly higher in patches at one site. Our results suggest hard clams can experience higher predation in meadows, potentially due to a greater density of blue crabs. In patches, blue crabs can experience higher predation and densities are lower. Subsequently, survivorship of hard clams can be higher in patches.

The influence of diet on the stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope compositions of muscle tissue in American lobster (*Homarus americanus*).

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American lobster is the third most valuable fishery species in the United States ($460M in 2013; up from ~$80M in 1980). A portion of this phenomenal increase in landings may be due to what has been called the herring bait subsidy. Lobsters may also have been released from groundfish predation, such that population dynamics may now be more influenced by intra-guild predation (IGP; i.e., cannibalism and crab predation). To evaluate the relative importance of IGP using stable isotope analysis (SIA), we first demonstrated that cannibalism and the herring bait subsidy can be differentiated isotopically in crustaceans. In 2013, we conducted laboratory feeding trials to examine the influence of four distinct diets on lobster isotope signatures. While diets of herring, crab and lobster all increased $\delta^{15}N$ values compared to an assumed natural diet (mussels), only diets of crab and lobster increased $\delta^{13}C$ values. These results confirm that SIA can be used to infer increases in trophic position as well as to partition increases in lobster SIA as a result of herring bait subsidy vs. intra-guild predation. Thus, our study indicates that SIA is an effective tool for quantifying the relative importance of herring bait subsidies and IGP for lobster population dynamics.

Is the grass always greener on the other side? A tale of two herbivory studies from Discovery Bay, Jamaica

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Discovery Bay, Jamaica, is a tropical coastal lagoon with portions receiving substantial submarine groundwater discharge (SGD), high in terrestrially derived nutrients, as well as portions with no SGD. A reciprocal transplant experiment conducted in 2008-2009 transferred shoots from a nitrogen-enriched groundwater (GW) seagrass meadow to a nitrogen-poor, non-groundwater (NGW) seagrass meadow, and compared herbivory against local grass to test for herbivore presence. Surprisingly, the experiment suggested that herbivores avoided the nitrogen enriched leaves (~8% consumption) and preferentially consumed leaves from the NGW which were more stoichiometrically balanced (~17% consumption). As a follow-up experiment, we attempted to assess a risk vs. reward trade-off for the small herbivorous parrotfish by examining how far into a vulnerable habitat, i.e., unstructured, sandy bottom, fish would travel to consume preferred grass. In January 2014, we placed tethers within seagrass meadows and at 3 distances away from the seagrass meadow. We attempted similar experiments in January 2015, choosing just one distance outside the seagrass meadow. Preliminary results suggest that overall herbivory is dramatically reduced (< 2%), herbivore size (using bite radius as a proxy) is considerably larger, and the preference for NGW seagrass does not seem as strong currently when compared with the previous experiment.

Incorporating intraspecific variation and metabolic theory into our understanding of consumer-plant interactions

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While the direction and strength of trophic interactions is a widely investigated concept in ecology, how variability is generated within a single interaction remains less explored. Two possible drivers of this variability include consumer population density and body size, which often exhibit heterogeneity or patterns across space and time. Using field enclosures placed in a southeastern US salt marsh, we orthogonally manipulated the body size and population density of a dominant primary consumer (snail) and measured the subsequent effects (leaf damage and final biomass) of consumer grazing on cordgrass plants. After three months, we found that increasing body size and density multiplicatively reduced plant biomass and shifted the sign of consumer plant interactions from positive (enhanced plant biomass) to strongly negative. However, when both consumer body size and density were incorporated into a single metric, metabolic biomass ($mass^{0.75}$), we were able to parsimoniously explain the response of plant biomass to the manipulated consumer populations. These findings suggest that, when quantifying consumer-plant interactions, we must also consider intraspecific variation within consumer populations. In addition, there remains a need to further understand how metabolic demand may constrain consumer populations and shape species interactions.

Comparing functional responses of a mesopredator across a habitat density gradient

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Predator size and habitat structure greatly influence foraging success and energy transfer in benthic communities. Smaller predators likely perceive environments as having a greater rugosity than larger predators, leading to different foraging behavior when habitat complexity changes. To test this idea, functional response curves were used to investigate how the smaller-sized crustacean predator, *Dyspanopeus sayi*, feeding on *Mytilus edulis* changed their foraging behavior across a gradient of habitat complexity created by *Crepidula fornicata*. There were three *C. fornicata* habitat density treatments (low, middle, and high) and a no structure treatment. Habitat density treatments were based off of mean and ± 1 SD habitat metrics measured in the field. In flow-through mesocosm experiments, individual *D. sayi* were offered one of seven *M. edulis* densities (2, 4, 6, 8, 10, 20, 30 mussels mesocosm^{-1}). After 36 hours, the number of remaining mussels was counted. Functional response curves were expected to shift down and asymptote at a lower prey density threshold as *C. fornicata* habitat density increases. Preliminary results support the expected change in functional response curve. Follow-up experiments will repeat experimental procedures with a larger crustacean predator. By understanding how predator size effects foraging across varying landscapes, better predator-prey models can be developed.

Allele frequency variation in the gamete recognition locus M7 lysin across age classes of blue mussels, *Mytilus spp.*

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Reproductive barriers between species result from a variety of mechanisms including gametic isolation, which can be caused by differences in gamete recognition proteins. A central question regarding the evolution of gametic isolation is why gamete recognition proteins tend to evolve so rapidly and show a pattern of positive selection? One hypothesis is that sexual conflict can drive the rapid evolution and polymorphism since selection often favors different alleles at different sperm densities. The sperm protein M7 lysin evolves rapidly in blue mussels (*Mytilus spp*.) and is polymorphic in *M. galloprovincialis* with alleles G (common) and G_D (rare). Therefore, if M7 lysin is evolving under sexual conflict, we would expect that these alleles would be favored under different sperm densities. Since spawning densities likely vary across space and time, and the larvae settling at any given location can come from a variety of locations, we predict that sexual conflict will result in variation in M7 lysin allele frequencies across cohorts. We compared lysin allele frequencies across multiple adult size (age) classes and across several spat cohorts at locations in southwestern England. Few sites showed significant differences in allele frequency across age classes.

A Dynamic Ecological Model Using Oyster Reef Bioenergetics To Measure And Predict Secondary Production

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Eastern oyster (*Crassostrea virginica*) reefs have been declining to levels well below their historical biomass. Given this loss, restoration strategies to recover oyster reefs and their ecosystem services have increased along the U.S. coast. A common restoration goal has been to increase secondary production resulting from oyster reefs with a focus on commercial species. However, it can often be difficult to predict the amount of secondary production that an oyster reef should produce post-restoration.

Here, I develop a dynamic bioenergetics model that can be used to measure and predict the impacts of oyster restoration projects on different trophic levels of an ecosystem, with emphasis on biomass of fish species that use the reef. Bioenergetic models track energy flows through a system and predict changes in growth and biomass of organisms resulting from changes in the environment and population structures. The model uses current data collected restored oyster reefs in the Gulf of Mexico to track energy flows through the system and I test different scenarios to predict how changes in oyster densities and biomass can impact the amount of biomass in secondary consumers looking at a decadal timeline.

Amphipod use of macroalgal shelters across an intertidal shoreline in the Gulf of St. Lawrence, Québec, Canada

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The amphipod *Gammarus oceanicus* is a conspicuous component of the intertidal fauna of the St. Lawrence maritime estuary and often shelters within different species of macroalgae. In the present study, we examined the short-term temporal dynamics of shelter use by amphipods by experimentally creating standardized microhabitats ("bouquets") of different species of macroalgae (*Fucus vesiculosus*, *F. distichus*, *Ascophyllum nodosum*, *Laminaria digitata*, *Ulva lactuca*, *Enteromorpha compressa)* and placing them at six different shore levels across the intertidal zone. Amphipod colonization (males, females and juveniles) was assessed after each tide during a 15-day period. Highest abundances were consistently observed at the lowest shore level with highest numbers on *F. vesiculosus*, the most common macroalga at this site. Males were most abundant at the lowest level and rare or completely absent at the highest level. Females were generally less common and at times absent from intermediate shore levels. Juveniles were common at the lowest level, rarely found at mid-shore levels and completely absent from the high shore. Our results show that amphiopods use the most common species of macroalgae as a refuge during low tides and that the abundance of genders and life stages varies markedly and inconsistently with shore level.